Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants

by

Joshua N. Hayward
(B.Psych (Hons))

Submitted in fulfilment of the requirements for the degree of:

Doctor of Philosophy

Deakin University

October 2016
Access to Thesis - A

DEAKIN UNIVERSITY
ACCESS TO THESIS - A

I am the author of the thesis entitled “Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants” submitted for the degree of Doctor of Philosophy.

This thesis may be made available for consultation, loan and limited copying in accordance with the Copyright Act 1968.

'I certify that I am the student named below and that the information provided in the form is correct'

Full Name: Joshua Hayward

Signed: [Signature Redacted by Library]

Date: 20/01/2017
Candidate Declaration

DEAKIN UNIVERSITY
CANDIDATE DECLARATION

I certify the following about the thesis entitled “Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants” submitted for the degree of Doctor of Philosophy

a. I am the creator of all or part of the whole work(s) (including content and layout) and that where reference is made to the work of others, due acknowledgment is given.

b. The work(s) are not in any way a violation or infringement of any copyright, trademark, patent, or other rights whatsoever of any person.

c. That if the work(s) have been commissioned, sponsored or supported by any organisation, I have fulfilled all of the obligations required by such contract or agreement.

d. That any material in the thesis which has been accepted for a degree or diploma by any university or institution is identified in the text.

e. All research integrity requirements have been complied with.

'I certify that I am the student named below and that the information provided in the form is correct'

Full Name: Joshua Hayward

Signed: [Signature Redacted by Library]

Date: 28/10/2016
Acknowledgements

Many people lent me their time, expertise, understanding, enthusiasm and ears during the three-and-a-half odd years from when I began this project to now. Without your support, I would never have reached the end, so I hope you will accept my thanks and a share of my excitement and pride in having completed this work. You are all amazing.

Thanks to my family: Mum and Dad for always being around to listen to successes and frustrations, and for giving me the encouragement and belief to push through. Thanks to Ben, Deb, Brad and Megan for blazing the academic trail and offering support and company over coffees, slices and board games. Thanks also to Tess for being my wonderful partner every day, sharing in the highs and lows of PhD, and always helping me keep perspective on life and work.

Thanks to my supervisors, Steve, Helen, and Felice – I appreciate the time and effort you have invested in me, and will endeavour to follow the great examples you have set as academics, educators, and colleagues.

Thanks also to everyone at GLOBE who I have the pleasure of working with day to day, especially my PhD colleagues (completed and current), Peter and the SSDL team who generously helped us enter the world of SD, and the Victorian Government Department of Education and City of Greater Geelong, and all of my study participants for supporting my research.

You have all had an invaluable impact on these last years and the work that is presented here. This thesis is dedicated to you.
Publications arising from this thesis

Articles:


Conference Abstracts:


Executive Summary

Introduction:

One in six Australian adolescents currently suffers from depression. Many factors, including behavioural and social factors, contribute to depression risk. Research has explored the relationship between physical activity, diet, and depression, and subsequent evaluation has led to calls to use these behaviours as lifestyle-focused targets for the prevention of depression. To date no studies have analysed both behaviours’ associations with depressive symptomology in the same analysis for the Victorian adolescent population.

Research Question 1 of this thesis aimed to address this gap in knowledge, and asked “What are the associations and effect sizes attributable to physical activity time, sedentary behaviour, and diet pattern, on depressive symptomology outcomes in a sample of Victorian secondary school students?”

The psychiatric literature contains few examples of interventions targeting lifestyle risk factors. By contrast, the obesity prevention literature contains some 30 years’ worth of evidence on lifestyle behaviour change, and provides high quality guidance on this topic. The obesity prevention literature has limited examples of success in modifying adolescent physical activity and diet behaviours – largely due to the complex, interconnected nature of these behaviours. Current guidance from Cochrane reviews suggests that optimal behaviour change interventions should acknowledge complexity, build community capacity for change, and seek alternative approaches to understanding and changing the
complex drivers of lifestyle behaviour. Currently, there is a gap in the population health literature regarding methodologies that meet these optimal characteristics.

System Dynamics is a methodology that acknowledges complexity by creating graphical models of the interconnected determinants of complex problems, called causal loop diagrams. Using a process called group model building, community stakeholders can be incorporated into the process of creating causal loop diagrams. Causal loop diagrams contain “feedback loops” (closed circuits of two or more causally related determinants) which are considered important drivers of complex problems, and high-value points for intervention.

Creating community-led causal loop diagrams of the drivers of adolescent lifestyle behaviour will identify potential intervention points, seated within the context of a broader complex system of lifestyle determinants. This represents a new approach to acknowledging complexity in lifestyle behaviour, which may satisfy the Cochrane review characteristics of optimal intervention design.

Research Question 2 therefore asked: “What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?”

Although the practise of group model building is well described in the System Dynamics literature, previously reported examples were resource intensive in cost and implementation. This represents a significant barrier to the use of group model building in large-scale population prevention projects, necessitating the development of a less resource intensive approach to group
model building. A supplementary research question – RQ 2.1 – aimed to develop such an approach.

Research Question 2.1 asked: “Does the use of a rapid approach to group model building produce complex representations of the community-level determinants of adolescent physical activity and diet behaviours?”

Multiple studies from the group model building literature have cited a limitation regarding the “representativeness” of causal loop diagrams. Group model building is typically a small group process, and an unresolved question remains over whether the composition of the participant group has a significant impact on the diagram produced by the group modelling process. A gap in the literature was identified regarding methods to compare repeat-methods causal loop diagrams, which would allow for an initial investigation into the effect of group composition on the structure and composition of a causal loop diagram. Social network analysis was identified as a methodological approach that contains analytical tools that can quantitatively characterise the overall structure, and influential variables within a causal loop diagram, enabling quantitative comparison of causal loop diagrams. A final supplementary research question – RQ2.2 – aimed to explore the effect of participant group on the structure and content of the diagrams. The use of social network analysis to identify influential variables within the diagrams also presented an opportunity to answer RQ2 directly.

Research Question 2.2 asked: “What similarities or differences can be observed in causal loop diagrams constructed by independent groups from a
Methods:

RQ1: A cross sectional sample of 3,295 year 8 and 10 students was recruited from 18 Victorian communities. Students were recruited using opt-out consent, resulting in a participation rate of 70.4%. Participants completed a supervised self-report questionnaire comprising the Moods and Feelings Questionnaire – Short Form, an assessment of physical activity and sedentary behaviours during and outside school, and weekly food intake. Surveyed covariates included hours sleep per night, age, socioeconomic status and measured anthropometry. A hierarchical regression analysis stratified by gender was conducted, with dichotomised SMFQ score as the outcome, and screen time, physical activity, and dietary patterns as predictors. Nested regression analyses were conducted to ascertain the variance in SMFQ score attributable to each significant predictor from the initial regression.

RQ’s 2, 2.1, 2.2: A group model building workshop was designed to generate community-led causal loop diagrams of the community-level drivers of adolescent physical activity and diet behaviours. Two participant groups (n=13 & n=14) were recruited, comprised of local government personnel, health service providers and secondary school teachers and students. Purposive sampling was initially used to recruit local government personnel, before snowball sampling was used based on the professional networks of local government participants to locate participants within health service providers and local secondary schools.
All participants provided informed consent. During two 90-minute sessions, each group developed causal loop diagrams of adolescent diet and physical activity behaviours in their community.

Social network analyses (including the calculation of standard network metrics including model density, variable out-degree and variable betweenness-centrality) were used to quantify and contrast the structural characteristics, and individual variables of influence within the two causal loop diagrams.

**Results:**

**RQ1:** Findings supported the existence of associations between physical activity, screen-based sedentary behaviour and diet pattern, and the likelihood of self-reported depressive symptomology among Victorian adolescents. Associations differed by gender; among male participants, attainment of physical activity guidelines was associated with a reduced likelihood of depressive symptomology (OR = 0.91, 95% CI [0.85, 0.97]), and adherence to an unhealthy diet was associated with a greater likelihood of depressive symptomology (OR = 1.18, 95% CI [1.07, 1.32]). Among female participants, attainment of the screen-based sedentary behaviour guidelines was associated with decreased likelihood of reporting depressive symptomology (OR = 0.95, 95% CI [0.91, 0.98]), and higher BMI-for-age Z-score was associated with increased likelihood of depressive symptomology (OR = 1.20, 95% CI [1.10, 1.32]). Effect sizes of individual associations were generally small. Overall, 21.5% of adolescents met the cut-off score for depressive symptomology.
RQ2: Adolescent physical activity and dietary behaviour were strongly influenced by peer culture and social norms, technology use, individual level knowledge and education, time pressure, study pressures and engagement in school. Numerous feedback loops were identified in both causal loop diagrams, and many of the variables considered to be influential drivers were included within those feedback loops. Two examples of these loops included the reinforcing effect of celebrity culture on technology use and peer culture, and the reinforcing effect of the home food environment on adolescents cooking and meal preparation skills.

Discussion:

The main findings of RQ1 were that gender-specific associations existed between lifestyle behaviours and depressive symptomology among Victorian adolescents. Unhealthy diet and physical activity levels were associated with depressive symptomology in males, while screen-time was associated with depressive symptomology in females. Healthy diet had no significant impact on depressive symptomology for either gender.

The main findings of RQ2 were that a rapid group model building approach was an appropriate method for creating community-led causal loop diagrams of the causes of adolescent lifestyle between two community groups. Analysis of the diagrams found that two independent stakeholder groups constructed causal loop diagrams in a similar way, and similarly perceived adolescent physical activity and diet behaviours to be strongly influenced by
sociocultural factors including peer culture, social norms, education, and technology use.

The strengths of this thesis included the high quality data that were collected and analysed under RQ1. The use of an opt-out consent process produced a high response rate among participants, and trained data collectors were used to collect direct-measured anthropometric data, and administer standardised survey tools. The design of the work which answered RQ2 was strong in its use of the established group model building “script” literature, and the experience of the team which delivered the workshops. The work presented here was also subject to some limitations. Although the surveys used to answer RQ1 were standardised, they were largely self-report measures and may be subject to several types of bias. The causal loop diagrams created under RQ2 were qualitative in nature and must only be interpreted in terms of the perceptions of the stakeholders who created them.

This thesis makes several contributions to knowledge. The study undertaken as part of RQ1 contributed high quality epidemiological evidence regarding gender specific associations (and the relative strengths of those associations) between lifestyle behaviours and depressive symptomology in Victorian adolescents. Previously, no such evidence was available for this population. Contributions made by the study undertaken for RQ2 included the rapid group model building approach, which was designed to generate insight into the complex drivers of lifestyle behaviour in multiple community settings. This methodology is appropriate for use at scale, in contrast to previously reported group model building approaches which are lengthy and are designed on a
“setting by setting” basis, limiting their utility in whole-of-population prevention activity. RQ2 also contributes a complex conceptualisation of the drivers of lifestyle-related risk factors for depression. Prior to the completion of this thesis there was no previous grounded logic model for the complex drivers of adolescent lifestyle risk behaviours in Victoria.

This thesis suggests that lifestyle-based prevention of depression should be considered a policy priority. The findings from RQ1 show that lifestyle behaviours are associated with depressive symptomology in adolescents, while RQ2 demonstrates a methodology that could be used at scale to generate insights into the complex drivers of these behaviours. Future population-level prevention activity should employ the group model building process that was demonstrated across multiple sites in order to deliberately engage and empower multiple actors across health and other community services fields to inform and drive local intervention strategies. The successful implementation of opt out consent in the epidemiological work undertaken as part of RQ1 strengthens the case for the feasibility and safety of large-scale “data monitoring” programs in Victoria, which are critical for supporting population-level prevention strategies.

Some unanswered questions and areas for future research are highlighted. Extending the work completed in RQ1, further examination of the lifestyle risk factor – depression association is required. Evidence currently does not satisfy the criteria for causality, although current evidence exists which refutes reverse causality. Future research extending on RQ2 is needed to determine a robust, repeatable method for communities to develop actionable programs on the basis of the insights generated by analysis of the causal loop diagrams. Further, work
may examine how to increase the accessibility of the group model building process, considering the “face to face” nature of the process, which may exclude, or prevent geographically isolated or marginalised community groups from participating.
## Contents

Access to Thesis - A ................................................................................................. i  
Candidate Declaration .......................................................................................... ii  
Acknowledgements .............................................................................................. iii  
Publications arising from this thesis ...................................................................... iv  
   Articles: .............................................................................................................. iv  
   Conference Abstracts: ......................................................................................... v  
Executive Summary .............................................................................................. vii  
Contents ............................................................................................................... xvi  
Index of Figures .................................................................................................... xx  
Index of Tables ..................................................................................................... xxi  
List of Acronyms ................................................................................................ xxii  
Chapter 1: Introduction .......................................................................................... 1  
  1.1 – Overview of Literature Review .................................................................. 2  
  1.2 – Study Aims & Research Questions ............................................................ 3  
     1.2.1 – Study Aims ......................................................................................... 3  
     1.2.2 – Study RQs ......................................................................................... 3  
  1.3 – Overview of Study Methodologies ............................................................ 4  
     1.3.1 - Victorian Adolescent Lifestyle and Depressive Symptoms Study ...... 4  
     1.3.2 – Healthy Adolescent Lifestyles Mapping project ................................. 5  
  1.4 – Study Significance & Contributions to Knowledge .................................... 6  
     1.4.1 - Victorian Adolescent Lifestyle and Depressive Symptoms Study ...... 6  
     1.4.2 – Healthy Adolescent Lifestyles Mapping project ................................. 6  
  1.5 – Thesis Format ............................................................................................. 7
Chapter 2: Literature Review ................................................................. 8

2.1 – Mental Health and Lifestyle Risk ....................................................... 9
  2.1.1 – Mental Health: Prevalence, Impact and Comorbidity ..................... 9
  2.1.2 – Mental Health in Adolescence ....................................................... 12
  2.1.3 – Adolescent Development and Mental Health Risk Factors ............ 13
  2.1.4 – Thesis Publication I “Lessons from Obesity Prevention for the
         Prevention of Mental Disorders: The Primordial Prevention Approach”.... 16
  2.1.5 – Lifestyle Risk Factors and Adolescent Depressive Symptomology . 23
  2.1.6 – Summary of Section 2.1 and Statement of Thesis Aim 1 ............... 25

2.2 – Complexity and Adolescent Lifestyle ................................................. 26
  2.2.1 – Complexity Science ................................................................. 27
  2.2.2 – Adolescent Lifestyle Behaviours as a Complex Problem .............. 32
  2.2.3 – Lenses for Complexity ............................................................. 32
    2.2.3.1 – System Dynamics ............................................................. 32
    2.2.3.2 – Agent Based Modelling ..................................................... 41
    2.2.3.3 – Social Network Analysis ................................................... 43
    2.2.3.4 – Comparison ................................................................... 46
  2.2.4 – Group Model Building .............................................................. 50
  2.2.5 – Previous SD Approaches to Lifestyle Behaviour ......................... 53
  2.2.6 – Applicability of the GMB Process to Multi-Site Intervention Design
          ............................................................................................. 59
  2.2.7 – Quantitative Analysis of Causal Loop Diagrams ......................... 61
  2.2.8 – Summary of Section 2.2 and Statement of Thesis Aims 2 – 2.2...... 64

2.3 – Problem Statement ........................................................................... 67
  2.3.1 – Summary of Critical Literature Review and Aims ......................... 67
  2.3.2 – Research Questions .................................................................... 69
Chapter 3: Study Methodologies

3.1 – Study 1: Victorian Adolescent Lifestyle and Depressive Symptoms Study

3.1.1 – Summary Study Objectives

3.1.2 – Setting

3.1.3 – Participants

3.1.4 – Recruitment Process

3.1.5 – Variables and Data Management

3.1.5.1 – Depressive Symptomology

3.1.5.2 – Diet Pattern

3.1.5.3 – Physical Activity/Screen Time

3.1.5.4 – Covariates

3.1.6 – Data Collection

3.1.7 – Ethical Considerations

3.1.8 – Candidate Contribution

3.2 – Study 2: Healthy Adolescent Lifestyle (HAL) Maps

3.2.1 – Summary Study Objectives

3.2.2 – Setting

3.2.3 – Participants

3.2.4 – Recruitment Process

3.2.5 – Group Model Building Workshops

3.2.5.1 – Workshop Session One

3.2.5.2 – Offline Review One

3.2.5.3 – Workshop Session Two

3.2.5.4 – Offline Review Two

3.2.5.5 – Social Network Analysis of CLDs
3.2.6 – Ethical Considerations ................................................................. 99

3.2.7 – Communication Strategy .............................................................. 100

Chapter 4: Thesis Publication II “Lifestyle factors and adolescent depressive symptomology: Associations and effect sizes of diet, physical activity and sedentary behaviour” ................................................................. 101

Chapter 5: Thesis Publication III “A Rapid Group Model Building Process for Understanding Determinants of Adolescent Lifestyle” ................................. 116

Chapter 6: Thesis Publication IV “Comparing Multiple Stakeholder Perspectives on Complex Determinants of Adolescent Lifestyle Risk” ................................. 148

Chapter 7: Discussion ................................................................................. 182

  7.1 – Main Findings ................................................................................. 182

    7.1.1 – Thesis RQ1 Findings: ................................................................. 182

    7.1.2 – Thesis RQ2 Findings: ................................................................. 184

  7.2 – Strengths & Limitations ................................................................. 188

    7.2.1 – Study Strengths ........................................................................ 188

    7.2.2 – Study Limitations ................................................................. 188

  7.3 – Contribution to Knowledge ............................................................ 190

  7.4 – Study Implications ................................................................. 193

  7.5 – Unanswered questions and future research directions .................. 196

Chapter 8: Conclusion ................................................................................. 199

References ........................................................................................................ 200
Index of Figures

Figure 1: 12-Month Prevalence of Mental Disorder by Age Group in Australia (adapted from (3)) .......................................................... 13
Figure 2: Example of a Reinforcing Feedback Loop .............................................. 30
Figure 3: Example of a Balancing Feedback Loop ............................................... 31
Figure 4: Example of a System Dynamics Model – Stock and Flow Diagram .... 36
Figure 5: Example of a System Dynamics Model – Causal Loop Diagram with Feedback Highlighted (adapted from (58)) ........................................... 36
Figure 6: Example of an Agent Based Model Output Visualisation (adapted from (65)) ..................................................................................... 42
Figure 7: Example of a Social Network Analysis Diagram (adapted from (72)) . 45
Figure 8: The Foresight Obesity System Map (adapted from (57)) ...................... 55
Figure 9: Level of System Insight and Complementary Modelling Approaches (adapted from (51)) ........................................................................ 56
Figure 10: Behaviour Over Time Graph Describing Adolescents Video Gaming/Screen Time Behaviour ......................................................... 90
Figure 11: Example Connection Circle from HAL Maps Workshops .................. 92
Figure 12: Initial CLD from HAL Maps workshop ............................................. 93
Figure 13: Causal Loop Diagram After Offline Review ....................................... 94
Figure 14: Causal Loop Diagram with Post-It Note Feedback ............................. 96
Figure 15: Revised Causal Loop Diagram with Participants Amendments ....... 96
Figure 16: Flowchart of the HAL Maps Workshop Stages and Outputs ............ 98
Index of Tables

Table 1: Ladyman et al’s (45) characteristics of complex problems. ...................... 29
Table 2: Evidence characterising adolescent diet and physical activity behaviours as complex phenomena. ........................................................................................................... 33
Table 3: Overview of thesis papers and study/RQ alignment..................................... 71
Table 4: Composition of workshop streams one and two......................................... 86
List of Acronyms

**ABM** – Agent Based Modelling

**ACT** – Australian Capital Territory

**BMI** – Body Mass Index

**BMI-Z** – Body Mass Index-for-age z-Score

**CI** – Confidence Interval

**CLD** – Causal Loop Diagram

**CMD** – Common Mental Disorder

**DALY** – Disability Adjusted Life Year

**DSM-IV-TR** – Diagnostic and Statistical Manual of Mental Disorder – 4th ed – text revised

**GMB** – Group Model Building

**HAL** – Healthy Adolescent Lifestyle Mapping Study

**HEAG** – Human Ethics Advisory Group

**LG** – Local Government

**LGA** – Local Government Area

**LGBTI** – Lesbian Gay Bisexual Transgender Intersex

**MVPA** – Moderate to Vigorous Physical Activity

**NCD** – Non Communicable Disease

**OR** – Odds Ratio

**PA** – Physical Activity

**PCA** – Principal Components Analysis

**PR** – Participation Rate
QoL – Quality of Life

RQ – Research Question

RR – Response Rate

SD – System Dynamics

SDQ – Simple Dietary Questionnaire

SEIFA – Socio Economic Index for Areas

SMFQ – Short Moods and Feelings Questionnaire

SNA – Social Network Analysis

SSB – Sugar Sweetened Beverage

ST – Screen Time

STROBE - Strengthening The Reporting of OBservational studies in Epidemiology

WHO – World Health Organization
Chapter 1: Introduction

The structure of this thesis is as follows: firstly, a literature review is presented in Chapter 2 that summarises and critiques the literature regarding adolescent mental health, the evidence for adolescent lifestyle behaviour as a potential target for population-level prevention of depression, and complexity science as a best practise approach to prevention. This critique is summarised in the form of a problem statement that underpins the thesis research questions, and the research presented in the body of the thesis. The literature review concludes with a formal statement of the aims and specific research questions investigated in this thesis. Chapter 3 presents a detailed description of the methodologies used to address the research questions and Chapters 4 to 6 present three publications describing the results of the research. Chapter 7 presents the discussion, which outlines the findings along with the strengths and limitations of the research, contributions to knowledge, implications, and future research directions. The thesis ends with a short conclusion in Chapter 8. Appendices are presented, following the references, at the end of the document.

The purpose of this chapter is to provide an overview of the literature review, aims and research questions, study methodologies, and the significance and contributions to knowledge made by the research presented in this thesis. The Deakin University requirements regarding the thesis by publication format are also described.
1.1 – Overview of Literature Review

The literature review begins with an introduction to the current prevalence and burden of mental disorders in the Australian population. The review highlights the importance of the adolescent period as a time in which mental disorders, particularly depression, emerge. Evidence regarding the various risk factors for adolescent depression are introduced and critiqued, with a primary focus on the modifiable risk behaviours, diet and physical activity. The review also critiques the current epidemiological evidence for the associations between diet and physical activity behaviours, and depression in the Australian context, identifying a gap in knowledge regarding strong epidemiological evidence that is generalisable to the Victorian adolescent population.

The literature review also presents a commentary piece (written by the candidate and published in BMC Psychiatry in 2014) that describes the need for a population prevention approach to adolescent depression, which targets modifiable lifestyle behaviours, and takes a complex systems approach to behaviour modification. The three predominant methodological approaches to complexity in population health research are contrasted, and System Dynamics is put forward as an approach that can engage communities, and generate insights into the complex drivers of adolescent diet and physical activity. Group model building, a participatory modelling methodology from the System Dynamics literature, is identified as an appropriate tool for engaging communities in the model-building process. The previous application of group model building to population health is examined, and gaps in the literature are identified regarding the complex drivers of adolescent diet and physical activity in Victoria, and how
quantitative analyses may be used to understand difference between the perceptions of different community groups.

1.2 – Study Aims & Research Questions

1.2.1 – Study Aims

The aims of this thesis are:

1) To establish the associations and relative contributions of adolescent physical activity and diet behaviours, singly and in combination, to the variance in depressive symptoms within male and female adolescents in Victoria,

2) To capture community perceptions of the complex drivers of physical activity and diet behaviour of Victorian adolescents,

2.1) To identify and implement a streamlined approach to group model building in order to create community-led CLDs of adolescent physical activity and diet behaviour drivers.

2.2) To quantitatively identify and compare the model-level and variable-level characteristics of two CLDs of the community-level drivers of adolescent diet and physical activity behaviours.

1.2.2 – Study RQs

Each of the study aims given above was formalised into a research question, which the work presented in this thesis will seek to answer. The research questions which correspond to the thesis aims are:
RQ1 - What are the associations and effect sizes attributable to physical activity time, sedentary behaviour, and diet pattern, on depressive symptomology outcomes in a sample of Victorian secondary school students?

RQ2 - What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?

RQ2.1: Does the use of a rapid approach to GMB produce complex representations of the community-level determinants of adolescent physical activity and diet behaviours?

RQ2.2: What similarities or differences can be observed in CLDs constructed by independent groups from a repeat-methods GMB workshop, regarding the perceived community-level drivers of adolescent diet and physical activity?

1.3 – Overview of Study Methodologies

Two studies were developed to address the research questions outlined above: The Victorian Adolescent Lifestyle and Depressive Symptoms Study, and the Healthy Adolescent Lifestyles Mapping project.

1.3.1 - Victorian Adolescent Lifestyle and Depressive Symptoms Study

The Victorian Adolescent Lifestyle and Depressive Symptoms Study was a cross-sectional study collecting data from 3,295 year 8 and 10 students in
secondary schools in 18 Victorian communities. This study was set within the broader Healthy Together Children’s Evaluation, which measured overweight and obesity prevalence and a number of associated health behaviours and attitudes in primary and secondary schools across Victoria in 2014. Measures employed in the Victorian Adolescent Lifestyle and Depressive Symptoms Study included anthropometry, dietary, physical activity and sedentary behaviours, depressive symptomology, and demographic measures.

This work led to the publication: “Lifestyle factors and adolescent depressive symptomology: Associations and effect sizes of diet, physical activity and sedentary behaviour” which is presented in Chapter 4 of this thesis.

1.3.2 – Healthy Adolescent Lifestyles Mapping project

The Healthy Adolescent Lifestyles Mapping project was a group model building study examining community perceptions of local drivers of adolescent physical activity and diet behaviours in a Victorian community. Two independent groups comprised of local government personnel, health service providers, and secondary school staff and students created causal loop diagrams of the drivers of adolescent physical activity and diet in their community. Structural characteristics and influential variables within the diagrams were identified quantitatively using social network analyses, allowing comparisons to be drawn between the two groups’ causal loop diagrams.

This work led to two publications; “A Rapid Group Model Building Process for Understanding Determinants of Adolescent Lifestyle” presented in
Chapter 5, and “Comparing Multiple Stakeholder Perspectives on Complex Determinants of Adolescent Lifestyle Risk” presented in Chapter 6.

1.4 – Study Significance & Contributions to Knowledge

In this section, the significance of the two studies, and their contributions to knowledge are summarised. Detailed discussion of the contributions and significance of the studies are presented in Chapter 7.

1.4.1 - Victorian Adolescent Lifestyle and Depressive Symptoms Study

This study contributes new, robust epidemiological evidence on the associations between dietary and physical activity/sedentary behaviours, and depressive symptomology in a Victorian sample. Reported rates of depressive symptomology and lifestyle behaviours are also less exposed to response bias than much of the existing literature, owing to the use of an opt-out consent process. The use of opt-out consent in this study demonstrated the feasibility of large-scale “data monitoring” programs, which are important for informing and evaluating population-level prevention.

1.4.2 – Healthy Adolescent Lifestyles Mapping project

This study was the first to conceptualise the complex drivers of adolescent diet and physical activity behaviours at a community level in the Australian literature. The findings contribute new information about important drivers and feedback loops affecting adolescent physical activity and diet, which represent potential targets for intervention in the examined community. The group model
building approach used represented a streamlined approach designed for repeated use across multiple community groups with minimal time and resource burden. This was an advancement upon previous approaches in other research fields, where resource burden was high, and represented a barrier to engagement with community samples.

1.5 – Thesis Format

This thesis is presented in accordance with the Deakin University “thesis by publication” guidelines. Thesis by publication requirements stipulate the inclusion of four published, or publishable works. Of the four works, a minimum of two must be published or in press, with the remaining works being submitted for peer review at a scholarly journal. The work presented in this thesis meets these guidelines, with one published article presented in Chapter 2, a second published article presented in Chapter 4, and two articles currently undergoing peer review presented in Chapter 5 and Chapter 6.

Also in accordance with the Thesis by Publication guidelines, authorship declarations have been completed for each of the publications and manuscripts presented below. Authorship declarations are presented alongside the corresponding manuscripts throughout the thesis.
Chapter 2: Literature Review

This chapter presents a critical review of the literature, which informs the research presented in this thesis. The literature review is presented in three sections, which are outlined here.

In section 2.1, the review examines mental health, in particular depression and depressive symptomology as an area of significant and growing concern for adolescent wellbeing. Current evidence regarding the role of adolescents’ lifestyle risk behaviours, physical inactivity/sedentary behaviour and poor nutrition, in influencing mental health is also reviewed, and the lack of high-quality studies which are applicable to the Victorian setting is identified. The first publication of the thesis explores the established obesity prevention literature for insights into how these risk behaviours might best be modified in adolescence. Findings included that lifestyle risk behaviours may be described as “complex problems” requiring a systems-based approach to modify.

In section 2.2, the concept of complexity is introduced, and adolescent physical activity/dietary behaviours compared against criteria for a complex problem. The three most common methodologies for analysing complex problems are reviewed and, of these, System Dynamics is posited as a useful suite of quantitative and qualitative tools for understanding the causes of complex health-related problems and identifying intervention targets. Methods by which community stakeholders may contribute novel, and community-specific insights to a System Dynamics model of complex lifestyle behaviour drivers are reviewed.
In section 2.3, the reviewed literature is summarised, and the knowledge gaps and thesis aims are formalised as research questions that will be investigated in the remainder of the thesis.

2.1 – Mental Health and Lifestyle Risk

2.1.1 – Mental Health: Prevalence, Impact and Comorbidity

Mental health is more than the absence of mental disorder. Mental health is defined by the World Health Organization as: “a state of well-being in which the individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” (1). Significant departures from this state are conceptualised as mental disorder. The current edition of the Diagnostic and Statistical Manual of Mental Disorders classifies a mental disorder as a “clinically significant disturbance in an individual’s cognition, emotion regulation, or behaviour that reflects a dysfunction in… underlying mental functioning… usually associated with significant distress or disability…” (2).

The largest survey on mental disorder epidemiology in Australia is the Australian Survey of Mental Health and Well Being, for which assessments were taken in 1997 and 2007 (3). Few other countries have survey data of comparable size over a 10-year interval (4). The 2007 survey included 8,841 Australians aged 16-85 and reported that 45.5% (95% CI [44.1, 46.9]) of Australians had suffered some form of mental disorder during their lives (3). The survey estimated that 15.0% (95% CI [14.1, 16.0]) of the Australian population in 2007 had experienced
affective disorders (i.e. depression, dysthymia, or bipolar disorders), and 26.3% (95% CI [24.9, 27.6]) had experienced anxiety disorders (i.e. generalised anxiety disorder, post-traumatic stress disorder, and social phobia, among others).

Population prevalence estimates from the Australian Survey of Mental Health and Well Being were regarded to be of high quality, due to the use of well-validated structured clinical interviews (3). However, some have suggested that the high rate of major depression found may still be an underestimate, due to either measurement error (5) or the use of household sampling, which precludes minorities such as homeless or incarcerated individuals, who are more likely to experience mental disorders (6).

Evidence suggests that mental disorders across many diagnostic categories are prevalent in the Australian community; however the depressive disorders and anxiety disorders are of particularly high prevalence. As such, depression and anxiety are often described as the “Common Mental Disorders” (CMDs) (7, 8). Recent burden of disease studies have provided some insight into the population-level impacts of these disorders. An analysis of data for 291 diseases across 187 countries, found that depression accounts for 2.5% of all disability adjusted life years (DALYs) worldwide (9). The total burden of depression was the 11th highest cause of DALYs of any measured disease in the study and accounted for the highest number of years lost to disability. The same analysis found that anxiety disorders accounted for 1.1% of global DALYs.

Despite ongoing debate, there is a significant body of evidence suggesting that the CMDs are increasing in prevalence. A large, population-adjusted study of
disease prevalence from the 2013 Global Burden of Disease Study data estimated a caseload of 253,314,000 for major depression in the 188 countries for which data were available (10). This represented a significant raw increase of 53.43% in case numbers since 1990 (95% CI [49.05, 58.91]), which remained significant, although reduced in magnitude after adjustment for growth in population and change in age distribution (adjusted increase = 4.24%; 95% CI [2.37, 6.17]). The same study reported major depression to be among the top three causes of years lived with disability in 146 countries.

A recent study of disability adjusted life years attributable to major depressive disorder (also from the Global Burden of Disease study) indicated an increase from 870 DALYs per 100,000 (95% CI [651, 702]) in 1990 to 917 DALYs per 100,000 (95% CI [693, 1174]) in 2010 (9). This represents a 5.4% increase in the burden of disease attributable to major depression over the span of the study. It has been suggested, however, that this increase may be a function of the continuing decrease in DALYs attributable to infectious and other acute diseases over the same period (11). Until recently, major depression which was comorbid with more acute conditions may have resulted in a masking effect, resulting in underestimation of the burden of disease caused by depression. Birth cohorts followed since the early 20th century have also demonstrated increased lifetime risks and earlier ages of depression onset (12-15). An analysis of cross-sectional studies by the Cross-National Collaborative Group found an increase in rates of depression in various countries including the U.S.A., Germany, Italy France, Lebanon, New Zealand, Canada and Taiwan. These studies also revealed
that younger people were more likely to report a history of depression than those born before World War II (16).

A significant number of depression and anxiety sufferers experience severe comorbidities, with estimates suggesting that between 15% and 75% of adolescents with depression also suffer from anxiety (17). Analysis of comorbidity in Australian sufferers found 51% (95% CI [42.6, 59.5]) of affective disorder sufferers also have suffered comorbid manic episodes, suicide attempts, severe role impairments or very low Global Assessment of Functioning scores (3). The burden to the individual is also significant, with studies demonstrating a lower quality of life for CMD sufferers (QoL 4.19; SD = 1.29) as compared to non-sufferers (QoL 5.39; SD = 0.86) (18).

2.1.2 – Mental Health in Adolescence

A US study of lifetime CMD prevalence found that 25% of major depressive disorder cases had their onset by age 19 and 25% of generalised anxiety disorder cases had their onset by age 20 (15). The study sample was notably strong in its use of structured clinical diagnostic interviews, but relied on participant recall for age of disorder onset. Recall bias may have affected the accuracy of this recall, however the authors suggested that this may have delayed the estimated age of onset, and that true onset age may in fact be earlier. Findings from other studies support this hypothesis: the US National Comorbidity Survey Replication (Adolescent Supplement) reported that the average age of onset for anxiety was 6 years of age, and that the average age of onset for depression was 13 years of age (19). Figure 1 below, adapted from the Australian Survey of
Mental Health and Well Being (3), shows 12-month prevalence of mental disorder among Australians in 2007. This graph supports the suggestion that adolescence is a peak period for mental disorder, as 16-24 year old males and females demonstrated higher prevalence of mental disorder than any other age group.

Figure 1: 12-Month Prevalence of Mental Disorder by Age Group in Australia (adapted from (3)).

2.1.3 – Adolescent Development and Mental Health Risk Factors

Although previous research has identified many deterministic factors related to the development of CMDs, such as genetic influences (20, 21) and familial heritability (22), there are further modifiable risk factors in the social and behavioural domains which increase the risk of adolescent depression. Reviews have identified substantial evidence of associations between frequency and quantity of alcohol consumption, drug use, and dieting behaviour and increased
adolescent depression risk, while healthy diet and adequate sleep appear to be protective against depression risk (23). Further evidence suggests associations between media use and increased adolescent depression, and physical activity and positive coping strategies with reduced depression risk, although the evidence is less conclusive (23).

Risk factors for depression associated with pleasurable or rewarding behaviours in adolescence are particularly meaningful in the context of “psychological remodelling” (24). Alongside the various physical changes which take place (including rapid body growth/development (25), sexual development and maturity (26)), many important developmental changes take place in the developing adolescent brain, affecting psychology. Early in adolescence, the limbic and sensorimotor cortices mature, before the later maturation of the prefrontal and dorsolateral cortices (27). This results in a developmental period where adolescents experience greater pleasure from risk-taking and pleasure-seeking activities, before these behaviours are eventually attenuated by the maturation of the prefrontal and dorsolateral cortices, which regulate self-control and executive planning (27).

This psychiatric explanation of the shift towards more pleasurable behaviours during adolescence is consistent with observational studies; Alberga et al (28) reported decreases in positive lifestyle related health behaviours during the transition into adolescence, with reductions in diet quality and increases in screen-based sedentary behaviours such as TV viewing, computer gaming, and internet usage. Further studies examining the transition from adolescence into adulthood have reported tracking of these health behaviours into later life. A recent study of
US adolescents found that health promoting and non-health promoting dietary habits track strongly from adolescence into early adulthood, regardless of initial weight status (29). A study of German adolescents investigating tracking of physical activity behaviours over time found that overall sports participation also tracks from adolescence into early adulthood (30).

The behavioural outcomes of the transition from childhood to adolescence, and from adolescence to adulthood form a strong case for the modification of lifestyle-related health behaviours during adolescence. This is a period marked by significant brain development, which drives a period of plasticity in adolescents’ health behaviours. Although these behaviours undergo change during the adolescent period, the evidence discussed above suggests that the transition into adulthood ends this plasticity, and the behaviours that are exhibited late in adolescence become habituated into adulthood.

In Section 2.1.4 below, the first publication of this thesis, entitled “Lessons from Obesity Prevention for the Prevention of Mental Disorders: The Primordial Prevention Approach” is presented. This publication presents the case for the use of diet and physical activity as potential lifestyle targets for the prevention of CMDs during adolescence. A potential direction for lifestyle-based CMD prevention is examined within the context of the obesity prevention literature, which provides a significant body of evidence regarding best-practise for adolescent physical activity, sedentary, and dietary behaviour change.

This section contains the first publication of this thesis, an examination of the role of lifestyle-based prevention in the prevention of mental disorders, and a reflection on the lessons for such prevention which may be taken from the obesity prevention literature. Presented in this section is the authorship declaration, completed in accordance with Deakin University’s requirements for thesis by publication, followed by the publication itself.

This paper addresses the research questions: “What are the relationships between modifiable lifestyle risk factors and common mental disorders?” and “What are the characteristics of successful lifestyle-based prevention approaches from the obesity prevention literature?”

This piece was published by BMC Psychiatry in September 2014.
# AUTHORSHIP STATEMENT

## 1. Details of publication and executive author

<table>
<thead>
<tr>
<th>Title of Publication</th>
<th>Publication details</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name of executive author</th>
<th>School/Institute/Division if based at Deakin; Organisation and address if non-Deakin</th>
<th>Email or phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joshua Hayward</td>
<td>Global Obesity Centre, CPHR, Faculty of Health</td>
<td><a href="mailto:jnh@deakin.edu.au">jnh@deakin.edu.au</a></td>
</tr>
</tbody>
</table>

## 2. Inclusion of publication in a thesis

<table>
<thead>
<tr>
<th>Is it intended to include this publication in a higher degree by research (HDR) thesis?</th>
<th>Yes / No</th>
<th>If Yes, please complete Section 3 If No, go straight to Section 4.</th>
</tr>
</thead>
</table>

## 3. HDR thesis author’s declaration

<table>
<thead>
<tr>
<th>Name of HDR thesis author if different from above. (If the same, write “as above”!)</th>
<th>School/Institute/Division if based at Deakin</th>
<th>Thesis title</th>
</tr>
</thead>
<tbody>
<tr>
<td>As above</td>
<td>As above</td>
<td>Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants</td>
</tr>
</tbody>
</table>

If there are multiple authors, give a full description of HDR thesis author’s contribution to the publication (for example, how much did you contribute to the conception of the project, the design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)

JH conceived the paper, composed the initial drafts, oversaw drafting and editing of contributions from other authors, and managed the manuscript to submission.

I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.

<table>
<thead>
<tr>
<th>Signature and date</th>
<th>21/07/2016</th>
</tr>
</thead>
</table>

## 4. Description of all author contributions

<table>
<thead>
<tr>
<th>Name and affiliation of author</th>
<th>Contribution(s) (for example, conception of the project, design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felice N Jacka</td>
<td>Contributed to drafts and provided expert knowledge in the field of common mental disorders prevention.</td>
</tr>
<tr>
<td>Elizabeth Waters</td>
<td>Contributed to drafts and provided expert knowledge in the field of knowledge translation.</td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Contributed to drafts and provided expert knowledge in the fields of non-communicable disease, obesity prevention and systems science.</td>
</tr>
</tbody>
</table>
5. Author Declarations

I agree to be named as one of the authors of this work, and confirm:

i. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,
ii. that there are no other authors according to these criteria,
iii. that the description in Section 4 of my contribution(s) to this publication is accurate,
iv. that the data on which these findings are based are stored as set out in Section 7 below.

If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further
v. consent to the incorporation of the publication into the candidate’s HDR thesis submitted to Deakin
   University and, if the higher degree is awarded, the subsequent publication of the thesis by the
   university (subject to relevant Copyright provisions).

<table>
<thead>
<tr>
<th>Name of author</th>
<th>Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felice N Jacka</td>
<td>Signature Redacted by Library</td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Elizabeth Waters</td>
<td>*See below</td>
<td></td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Signature Redacted by Library</td>
<td>25/07/2016</td>
</tr>
</tbody>
</table>

6. Other contributor declarations

I agree to be named as a non-author contributor to this work.

<table>
<thead>
<tr>
<th>Name and affiliation of contributor</th>
<th>Contribution</th>
<th>Signature* and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* if an author or contributor is unavailable or otherwise unable to sign the statement of authorship, the Head of Academic Unit may sign on their behalf, noting the reason for their unavailability, provided there is no evidence to suggest that the person would object to being named as author

7. Data storage

The original data for this project are stored in the following locations. (The locations must be within an appropriate institutional setting. If the executive author is a Deakin staff member and data are stored outside Deakin University, permission for this must be given by the Head of Academic Unit within which the executive author is based.)

<table>
<thead>
<tr>
<th>Data format</th>
<th>Storage Location</th>
<th>Date lodged</th>
<th>Name of custodian if other than the executive author</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a (narrative literature review)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This form must be retained by the executive author, within the school or institute in which they are based.

If the publication is to be included as part of an HDR thesis, a copy of this form must be included in the thesis with the publication.

*Supervisor passed away during candidature.
Lessons from obesity prevention for the prevention of mental disorders: the primordial prevention approach

Joshua Hayward1*, Felice N Jacka2, Elizabeth Waters3 and Steven Allender1

Abstract

Background: Emerging evidence supports a relationship between risk factors for obesity and the genesis of the common mental disorders, depression and anxiety. This suggests common mental disorders should be considered as a form of non-communicable disease, preventable through the modification of lifestyle behaviours, particularly diet and physical activity.

Discussion: Obesity prevention research since the 1970s represents a considerable body of knowledge regarding strategies to modify diet and physical activity and so there may be clear lessons from obesity prevention that apply to the prevention of mental disorders. For obesity, as for common mental disorders, adolescence represents a key period of vulnerability. In this paper we briefly discuss relationships between modifiable lifestyle risk factors and mental health, lifestyle risk factor interventions in obesity prevention research, the current state of mental health prevention, and the implications of current applications of systems thinking in obesity prevention research for lifestyle interventions.

Summary: We propose a potential focus for future mental health promotion interventions and emphasise the importance of lessons available from other lifestyle modification intervention programmes.

Keywords: Obesity prevention, Common mental disorders, Prevention, Intervention design, Complex intervention, Systems

Background

The common mental disorders (CMDs) depression and anxiety, are now presenting as major global public health problems. Recent burden of disease studies have attributed as much as 7.4% of global disability adjusted life-years to mental and behavioural disorders, with 2.5% attributable to major depressive disorder (MDD) alone [1]. Although a matter of some contention, the available data suggest an increase in the prevalence of CMDs [2], particularly in young people [3,4]. Importantly, recent evidence from large-scale prospective cohort studies suggest that physical inactivity and unhealthy diet, are related to the genesis of the CMDs [5-8].

The World Health Organization (WHO) framework for the causes of noncommunicable disease (NCD) proposes that physical inactivity and unhealthy diet are among the key modifiable lifestyle risk behaviours that underlie most NCDs [9]. Recently, there has been an increasing focus on the potential for, and importance of, taking a preventive approach to mental disorders [10] and authors have suggested that programs which also view CMDs as lifestyle-informed NCDs, with population-level lifestyle modification components, may be useful in the prevention of CMDs [11]. In order to elucidate lessons for future CMD prevention, this commentary briefly discusses the relationships between modifiable lifestyle risk factors and CMDs, characteristics of successful preventive approaches to obesity that are of relevance to the prevention of mental disorders, and the role of systems thinking in strengthening lifestyle risk factor interventions.
Discussion

Modifiable lifestyle risk factors and common mental disorders

Since 2009 emerging literature has demonstrated the importance of diet quality to the CMDs [11,12]. For example, the most recent meta-analysis in this field has reported a 30% reduction in the risk for depression in those with high adherence to a Mediterranean dietary pattern (RR = 0.68, 95% CI = 0.54−0.86). [13] While a 'healthy' diet pattern is also associated with a reduced likelihood of depression (OR: 0.84; 95% CI: 0.76, 0.92) [14]. Although dietary data to date have been largely observational in nature, a recent large-scale European intervention supports the contention that targeting dietary improvement can prevent some cases of CMDs [15]. Knowledge regarding the contribution of physical inactivity to depression risk has also increased; a recent systematic review with 30 included studies concluded that physical activity was negatively associated with a risk of subsequent depression [16]. Individual studies show that as little as 10−29 minutes of daily physical activity may be adequate to reduce relative risk of clinical depression in women (RR = 0.9; 95% CI: 0.84−0.96) [7]. A recent review by Sarris et al. [17] examined in detail the evidence for the use of lifestyle modification as a clinical treatment strategy for depression. The report concluded that physical activity, diet, and a range of other lifestyle factors (including mindfulness-based meditation, sleep regulation, social interaction and others) show clear relevance not only for the clinical management of depression, but also for potential population-level mental health promotion. These findings support the contention that diet and physical activity are shared risk factors for many physical and mental disorders and suggest that targeting lifestyle behaviours may be an effective strategy in the prevention of mental disorders.

Modifiable lifestyle risk factors in obesity prevention

Obesity prevention research now has a 25-plus year history of targeted lifestyle behaviour interventions, beginning in the 1980s [18]. The "core" of the obesity problem has long been conceptualised as the result of prolonged energy imbalance, driven by the same lifestyle risk factors discussed in relation to CMD above (physical inactivity and unhealthy nutrition). Recently, obesity prevention research has begun to understand the complex nature of the relationships and interdependencies between physical inactivity and unhealthy nutrition, concluding that these behaviours can be resistant to change if targeted in isolation [19]. Recent work in the obesity prevention field therefore provides valuable insights into how CMD prevention may similarly target these lifestyle risk factors and in this paper we examine this in relation to a particularly high risk time of development; that of adolescence.

Waters et al. [20] have reviewed the childhood obesity prevention intervention literature focusing on studies including controlled designs since 1997. The most recent update included 55 obesity interventions that took place between 1993 and 2010. The review located 8 interventions which specifically targeted 13–18 year olds, and reported that all programs targeted physical activity outcomes, and that six of the eight targeted a range of nutrition-related targets. Several studies within this sub-group reported significant increases in the measured lifestyle outcomes, with three studies reporting significant dietary improvements [21-23] and five studies reporting increased indicators of physical activity [21,24-27], however in some interventions these effects were not sustained over time [23].

Some key limitations were noted within these studies. The majority of the evidence reviewed was derived from interventions with short-term funding, based on strategies that optimally require long-term funding support for effect longevity (school-based programs requiring direct funding from investigators, etc.). Accordingly, the overall effectiveness of these interventions was modest (−0.15 (95% CI −0.21, −0.09) BMI-2 points, [20]). Leaders in obesity prevention suggest these modest results reflect a failure to anticipate the complexity of drivers of population lifestyle behaviours, the potential plasticity of risk factors when addressed in isolation, and post-intervention effect dropoff. The review noted that the most promise seems to lie with programs which comprehensively target multiple risk factors, coupled with psychosocial support and environmental change [20].

A second theme emerging from obesity prevention is the Community Capacity Building (CCB) approach, an innovative method of developing sustainable skills, resources, and organisational structure, around a shared health promotion goal, within the community itself [28]. This approach addresses complex, interrelated risk factors by using broad community engagement to tailor intervention approaches to the specific set of social and environmental circumstances that exist within that community.

There have been recent interventions drawing on this framework, including the "It's Your Move" (IYM) project in the Barwon South-West region of Victoria, Australia [29]. The intervention focussed on community engagement to foster flexible intervention strategies across multiple community sectors and organisational levels. The program was deemed to have successfully reduced overweight and obesity in adolescents, and although some nutritional behaviours remained unchanged, the program did observe increases in active transport in the intervention group [29]. Recent analysis suggested that schools which had large increases in readiness for change throughout the intervention demonstrated significant BMI decreases at followup [30].
Complex interventions in CMD prevention

The importance of taking complex, multi-component approaches to prevention is also increasing recognised in CMD research. A review by Weare and Nind highlighted several characteristics of successful school-based mental health promotion programmes, finding that universal programmes, which are embedded within the school curriculum and culture, as well as build teacher capacity and knowledge, and involve the wider community, have demonstrated a wide range of benefits to children’s mental health, social, and educational outcomes [31].

An Australian example of this approach was the Gatehouse Project, a group randomised trial employed to address risky health behaviours and improve emotional well-being in secondary school aged children [32]. This approach embedded strategies within the school curriculum to improve students’ emotional management and interpersonal communication skills, while promoting inclusiveness within the classroom. This intervention was successful in reducing risky health behaviours, including substance use and antisocial behaviours. Although this intervention was not successful in directly reducing students’ symptoms of emotional problems [33], the complex strategies employed to achieve improvements in risky health behaviours in this study have been adopted widely around the globe in both high and low income settings. Existing observational data on Australian adolescents supports the contention that using such multi-component, integrated strategies to address lifestyle-related behaviours may result in positive benefits for mental health outcomes in this age group [5,34].

The systems perspective: new frameworks for working at scale

As understanding of the complexity of lifestyle risk factor interventions has increased, prevention science is observing a gradual shift from individual risk-factor approaches, through multiple risk-factor approaches, community capacity and multi-level approaches, to a recent emphasis on systems thinking as a framework for addressing complexity.

The systems perspective acknowledges not only the existence of the multiple causal factors which drive complex health problems, but highlights their interrelated and “dynamic” associations as an important consideration for any intervention program [35]. Systems thinking has gained some traction in obesity research, being observed a gradual shift from individual risk-factor approaches, through multiple risk-factor approaches, community capacity and multi-level approaches, to a recent emphasis on systems thinking as a framework for addressing complexity.

The systems perspective acknowledges not only the existence of the multiple causal factors which drive complex health problems, but highlights their interrelated and “dynamic” associations as an important consideration for any intervention program [35]. Systems thinking has gained some traction in obesity research, being observed a gradual shift from individual risk-factor approaches, through multiple risk-factor approaches, community capacity and multi-level approaches, to a recent emphasis on systems thinking as a framework for addressing complexity.

Summary

A systems perspective, which posits that complex problems lack simple or obvious solutions, shows that prevention efforts must be based in a deeper understanding of the dynamic complexity of modifiable lifestyle risk-factors [19,35]. Current complex, multi-component approaches to CMD prevention have had mixed success but show promise for further development. To capitalise on lessons learned from the obesity prevention sphere, significant collaboration with existing complex population-level lifestyle interventions appears critical.

Abbreviations

BMI: Body mass index; CCB: Community capacity building; CMD: Common mental disorder; CVD: Cardio vascular disease; DALY: Disability adjusted life year; IFM: It’s your move; MDD: Major depressive disorder; NCD: Non communicable disease; NHANES: National Health and Nutrition Examination Survey; WHO: World Health Organization.

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

JH conceived the paper, composed the initial drafts, oversaw drafting and editing of contributions from other authors and managed the MS to submission. SA, FJ & EW contributed to subsequent drafts and provided expert knowledge in the fields of NCD, CMD and KT & E respectively. All authors read and approved the final manuscript.

Authors’ information

JH holds a Bachelor of Psychology (honors) and is a PhD candidate at the World Health Organization Collaborating Centre for Obesity Prevention at Deakin University, Australia. FJ is an associate professor in the Deakin University School of Medicine based at Barwon Health, Australia, and is an honorary Research Fellow at the University of Melbourne. EW is a professor at the University of Melbourne and chairs the Jack Brockhoff Child Health and Wellbeing program at the University of Melbourne School of Population and Global Health. SA is a professor in population health and is the co-director of the World Health Organization Collaborating Centre for Obesity Prevention at Deakin University, Australia.

Acknowledgements

SA is supported by funding from an Australian National Health and Medical Research Council/Australian National Heart Foundation Career Development Fellowship (APP1045836). SA is a researcher within a NHMRC Centre for Research Excellence in Obesity Policy and Food Systems (APP1041020). SA is supported by US National Institutes of Health grant titled Systems Science to Guide Whole-of-Community Childhood Obesity Interventions (1R01HL115485-01A1).

Author details

1World Health Organization Collaborating Centre for Obesity Prevention, Deakin University, 1 Gheringhap St, Geelong, Victoria 3220, Australia. 2The University of Melbourne, 5/207 Bourke St, Carlton, Victoria 3053, Australia. 3Jack Brockhoff Child Health and Wellbeing Program, Melbourne School of Population and Global Health, The University of Melbourne, 5/207 Bourke St, Carlton, Victoria 3053, Australia.

Received: 3 April 2014 Accepted: 29 August 2014

Published online: 10 September 2014

References


2.1.5 – Lifestyle Risk Factors and Adolescent Depressive Symptomology

Section 2.1.4 above, in justifying the use of adolescent diet and physical activity behaviours as lifestyle prevention targets, describes the state of the literature that has examined the associations between adolescents’ diet, physical activity, and sedentary behaviours, and their depressive symptomology.

While a number of studies have examined either the association between adolescent diet and depressive symptomology, or the association between adolescent physical activity/sedentary behaviour and depressive symptomology, there is a lack of studies that have examined the effect of both of these behaviours in the same analysis. Further, some studies do not stratify analyses by gender, despite the existence of findings demonstrating gender differences in the associations between markers of lifestyle health and mental wellbeing (31). Of the studies that have examined the diet-depression relationship, and physical activity/sedentary behaviour relationships in the Australian setting, only one study has reported on both associations simultaneously. Hoare et al conducted a longitudinal analysis of adolescents in a school-based intervention study in the Australian Capital Territory (32), finding that males who were inactive at baseline, and remained inactive at follow-up reported a higher level of depressive symptomology than their active peers by 2.5 points out of a 26-point depressive symptomology scale ($b = 2.55, 95\% \text{ CI } [0.78, 4.32]$). For female adolescents, those students who increased their takeaway food consumption from “monthly or less” to “weekly or daily” between baseline and follow-up also showed a higher level of depressive symptomology than their peers who maintained a “monthly or less” level of consumption ($b = 1.82, 95\% \text{ CI } [-0.05, 3.71]$).
The study by Hoare et al (32), while methodologically rigorous, was based on a sample collected for an intervention evaluation study which was confined to schools within the Australian Capital Territory, the smallest Australian state or territory, which is the second least populous being comprised of one urban centre with a population of approximately 393,000 (33) and a land area of approximately 2,350km² (34). Hoare et al also acknowledged potential respondent bias with an initial follow-up response rate of 74.5% from an initial response of 56.6% (32). The sample analysed by Hoare et al was drawn from a region dissimilar in both size and population to the rest of Australia, and was designed to evaluate an intervention programme, rather than to measure health outcomes across a whole population. This limits the generalisability of the findings reported by Hoare et al to the Victorian population, which is the second largest of any state or territory (5.99 million residents) and occupies a land area almost 100 times larger than that of the ACT (~227000km² vs ~2350km²) (34), notwithstanding the potential impact of response bias.

It is important to note that much of the literature in this area is associative, and it is therefore difficult to rule out reverse causality. Examples from the literature have reported that depressive symptoms may be considered a cause of low levels of physical activity (35) while other studies have reported that depression leads to poor diet, sedentary behaviour and low physical activity, due in part to the lack of self-efficacy experienced by depressed adolescents (36). Despite this apparent conflict, one study by Jacka et al has tested and appears to refute the reverse causality argument in the relationship between diet and depression (37). It appears likely that there may be a number of distinct causal
pathways between adolescent lifestyle behaviours, obesity, and depressive symptomology.

2.1.6 – **Summary of Section 2.1 and Statement of Thesis Aim 1**

Depression affects nearly 1 in 6 Australians (3), and is becoming more prevalent over time (9, 10, 12-15). Depression emerges early in the life course, especially during adolescence (3, 15, 19). Although many depression risk factors are non-modifiable (20, 22), many behavioural and social factors (including drug and alcohol use, lack of sleep, poor diet, and physical inactivity) are implicated in depression risk (23) and appear to increase during adolescence (28).

Growing evidence regarding the relationship between physical activity, diet, and depression has led to the assertion that these behaviours should be pursued as lifestyle targets for the prevention of depression (38). Although several studies have explored these relationships, only one Australian study has explored the physical activity-depression, and diet-depression relationship in the same analysis (32), and this study is not generalisable to the Victorian adolescent population. To address this gap in understanding, the thesis aim 1 was formulated:

* Aim 1: To establish the associations and relative contributions of adolescent physical activity and diet behaviours, singly and in combination, to the variance in depressive symptoms within male and female adolescents in Victoria.

To this point, the literature review has been concerned with the relationship between lifestyle behaviour and depressive symptomology during adolescence, which Aim 1 seeks to address. Recently, there has been a shift in the prevention science literature (as discussed in Section 2.1.4) towards the use of
complex methodologies to better understand and attenuate risk factors for disease. Section 2.2, below, commences an examination of these complex methodologies, and how they can be applied to lifestyle risk behaviours in adolescence to better support and inform the prevention of adolescent depressive symptomology.

2.2 – Complexity and Adolescent Lifestyle

The commentary piece in Section 2.1.4 above summarised the lessons from the obesity prevention literature, for adolescent physical activity and diet-based prevention of depression.

Section 2.1.4 concludes with the argument that effective strategies to modify adolescent physical activity and diet behaviours need to be based on a complex approach. This approach should allow system elements to be identified and responded to at multiple levels, acknowledge unique local contexts and settings, build capacity and readiness for change within communities, and maximise the degree to which programmes can be “embedded” within the existing health system (39).

This section of the thesis will introduce the concept of “complexity science” in more detail, present the three dominant methodologies which are used to explore complex problems in the population health literature, and establish an appropriate methodological approach by which useful insights into the complex determinants of adolescent physical activity and diet behaviours may be efficiently generated and analysed.
2.2.1 – Complexity Science

Although there is no universally agreed definition for what constitutes complexity science, it is an approach that broadly aims to understand how the behaviour of a system is affected by the interaction of its constituent parts (40). This approach to understanding systems has been increasing in popularity within the population health literature, and has been described as a perspective which may offer new insights into problems previously considered intractable at a population level (41). In light of the growing popularity of this perspective, with its focus on the interactions between system “parts” some have described reductionist analytical approaches as over-simplifications of the causes of ill-health (42, 43). Reductionist approaches, whilst valuable for their statistical integrity, and high internal validity, have been criticised for assuming that the components of a system operate predictably, and independently of the broader system in which they are embedded (40). The complex systems perspective suggests that it is this failure to acknowledge the system within which a determinant is embedded that has hampered previous efforts to improve some population health problems (44).

In a review of previous efforts to define the core features of a complex system, Ladyman, Lambert & Wiesner identified seven core characteristics of “complexity” from the literature, being: nonlinearity, feedback, spontaneous order, robustness & decentralised control, emergence, hierarchical organisation and numerosity (45). While other attempts to define complexity have focussed on less tangible concepts, such as “human ignorance” (46), the list presented by Ladyman et al (45) provides a definition of complexity which can at least be
compared against the population health literature, and encapsulates many of the core characteristics of complexity suggested by other authors (40, 47, 48). Table 1 provides a summary of the definitions of each of the characteristics of complexity offered by Ladyman et al (45).

Notably, Ladyman et al do not assert that a problem must satisfy every one of their complexity criteria to “be complex”, due to the poor consensus in the literature regarding how to define complexity. However, feedback, and numerosity (the existence of many, interacting system elements) are posited as particularly important to the characterisation of a problem as complex (45).

Feedback is a prominent focal point for the complex systems literature (45), and is addressed by each of the complexity science methodologies commonly used in the population health literature (49). System Dynamics (which will be introduced in more detail in following sections) employs a modelling methodology which is particularly well-suited to communicating feedback processes (50). As represented using the conventions of System Dynamics, feedback occurs where a sequence of causally connected variables form a closed circuit, or loop. Where feedback loops occur, a change in one variable triggers a consequent change throughout the loop, which magnifies (reinforcing loop), or reduces (balancing loop) the initial change. Examples of reinforcing and balancing feedback loops are given below in Figures 2 and 3, using System Dynamics notation.
Table 1: Ladyman et al’s (45) characteristics of complex problems.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonlinearity</td>
<td>Systems are non-linear where the “superposition principle” (that the response of a system to two or more elements in combination is proportional to the response to those elements in isolation) does not apply. Small changes in the “micro-level” system elements may lead to disproportionately large “macro-level” outcomes.</td>
</tr>
<tr>
<td>Feedback</td>
<td>Feedback occurs where a part of the system interacts with another part of the system, in a way that is affected by the outcomes of its previous interactions with the system.</td>
</tr>
<tr>
<td>Spontaneous Order</td>
<td>System behaviour arises from the aggregated effects of a very large number of uncoordinated interactions throughout the system.</td>
</tr>
<tr>
<td>Robustness &amp; Lack of Central Control</td>
<td>System behaviour is not produced by a central or “key” set of elements which can be easily manipulated. Complex behaviour is also robust to perturbations throughout the system.</td>
</tr>
<tr>
<td>Emergence</td>
<td>Emergence is demonstrated where patterns or outcomes arise from the interaction of system elements, but where the interacting system elements do not display those patterns or outcomes.</td>
</tr>
<tr>
<td>Hierarchical Organisation</td>
<td>Hierarchical organisation occurs where the system elements appear to be organisable into several distinct groupings, which interact with both the “level” above and “level” below.</td>
</tr>
<tr>
<td>Numerosity</td>
<td>Systems have numerosity if there is a high number of elements to the system, and the elements are engaged in many interactions.</td>
</tr>
</tbody>
</table>
Figure 2 shows a reinforcing loop (denoted by the “R” loop symbol in the centre of the figure), containing four variables; “Participation in sport,” “Social connectedness with teammates,” “Perception of sport as a stress reliever,” and “Enjoyment of sport”. This loop describes the non-linear relationship between sports participation and the enjoyment of sports as a source of social support and stress relief. In this loop, an increase in participation in sport causes social connectedness with teammates to increase. As social connectedness with teammates increases, an individual’s perception of sport as a stress relieving activity increases, as they associate participation with the support they receive from their peers. As perception of sport as a stress reliever increases, enjoyment of sport increases, as the individual begins to value the stress relieving benefits of sport, which in turn reinforces the amount of sport that the individual participates in.

Figure 2: Example of a Reinforcing Feedback Loop
Figure 3 shows a balancing loop (denoted by the “B” loop symbol in the centre of the figure), which also contains four variables; “Consumption of junk food,” “Weight gain,” “Health related concern,” and “Dieting behaviour”. This loop describes the non-linear relationship between junk food consumption and weight gain. In this loop, an increase in junk food consumption causes weight gain. As weight increases, an individual’s concern for the state of their health increases, as they notice the increase in their body weight. As individuals’ concerns about their health increase, dieting behaviour increases, as the individual attempts to slow or reverse the rate at which they are gaining weight. As dieting behaviour increases, the initial consumption of junk food is decreased, balancing the feedback loop.

Figure 3: Example of a Balancing Feedback Loop
2.2.2 – Adolescent Lifestyle Behaviours as a Complex Problem

While complexity science promises a new and innovative approach to examining health-related problems, the systems perspective is not useful for all problems (51). It is important to establish that the problem under investigation demonstrates characteristics of complexity. In Table 2, Ladyman et al.’s criteria for complexity (45) are compared against evidence from the literature to affirm that adolescent diet and physical activity are complex problems.

2.2.3 – Lenses for Complexity

Just as there is no unified definition of the term “complexity science”, there is no single methodology used to study all complex problems. Within the population health literature an array of methodologies are used, however the majority of studies typically employ one of three approaches: System Dynamics, Agent Based Modelling or Social Network Analysis (49). In the following sections (2.2.3.1 – 2.2.3.4) these approaches are introduced and contrasted.

2.2.3.1 – System Dynamics

System Dynamics is an approach to modelling the many, interrelated determinants that drive a complex problem. A recent narrative review of the practice suggested that the core pursuits of System Dynamics are best characterised as: the identification of all sources of influence over a situation or problem; and the understanding of the specific interactions and interrelationships between these sources of influence (52). This is usually achieved through the creation of graphical models, examples of which are included in Figures 4 and 5, below.
Table 2: Evidence characterising adolescent diet and physical activity behaviours as complex phenomena.

<table>
<thead>
<tr>
<th>Aspect of Complexity*</th>
<th>Study</th>
<th>Behaviour</th>
<th>Finding/Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback</td>
<td>Metcalf, Henley &amp; Wilkin (53)</td>
<td>Physical activity</td>
<td>Failure of physical activity interventions to successfully decrease BMI in school-based interventions, even when activity levels appeared to increase, may be due to increased activity time in school, leading to a decrease in activity time outside of school, compensating for the intervention effect.</td>
</tr>
<tr>
<td>Feedback</td>
<td>Hall, Hammond &amp; Rahmandad (54)</td>
<td>Diet</td>
<td>Regulation of dietary intake is subject to a range of self-regulating feedback processes, including biological feedback cues such as hunger and satiety, and social and environmental feedback cues.</td>
</tr>
<tr>
<td>Robustness &amp; decentralised control</td>
<td>Hammond (55)</td>
<td>Physical activity and diet</td>
<td>A diverse set of actors affect energy balance (physical activity and diet), including families, schools, retailers, industry, government, media, and others. Each category of actors is motivated by different drivers, has different goals, and may respond to intervention efforts in different ways.</td>
</tr>
</tbody>
</table>
Interventions successfully intervening on one group may be offset by compensatory action from others.

<table>
<thead>
<tr>
<th>Hierarchical organisation</th>
<th>Glass &amp; McAtee (56)</th>
<th>Health behaviours</th>
<th>The factors which affect health-related human actions and behaviours may be represented by nested hierarchies of influence, ranging from biological, to familial, social and economic factors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerosity</td>
<td>Butland et al (57)</td>
<td>Health behaviours</td>
<td>Individuals decisions and abilities to engage in healthy eating and physical activity behaviours are influenced by a broad range of factors, including psychological desires (i.e. engaging in pleasurable activities), opportunities for activity or access to healthy options, social and cultural influences and norms, policies, and media influences.</td>
</tr>
</tbody>
</table>

*Aspects of complexity taken from definition by Ladyman et al (45).*
System Dynamics models are represented as a network of variables and causal linkages, and feature a combination of three types of variables, and two types of connections (50). Variable types include stock variables (representing the accumulation or draining of some quantity of interest), flow variables (that define the rate at which a stock variable accumulates or drains), and auxiliary variables (any other causal factor). Connection types include “constant flows” which represent the movement of quantity in or out of a stock variable, as determined by the flow variables, and “information links” which represent a generic causal relationship between auxiliary and flow variables. Information links are shown with a “polarity” denoted by a plus (+) sign where the causal association is positive, and a negative sign (-) where the causal association is inverse.

Diagrams which use all five of these elements are referred to as “stock and flow diagrams.” An example stock and flow diagram is given in Figure 4. Stock and flow diagrams are particularly useful for precise simulation, particularly where the outcomes of interest are tangible amounts or quantities of an entity, resource, or attribute (50).

Diagrams may be created using only auxiliary variables and information links. These models are known as Causal Loop Diagrams (CLDs) and are frequently used in qualitative applications (see Figure 5). The simplified form of CLDs makes them particularly effective for clearly demonstrating nonlinearity and feedback loops, and communicating ideas about complexity to stakeholders. CLDs may also be produced more quickly than stock and flow diagrams (50).
Figure 4: Example of a System Dynamics Model – Stock and Flow Diagram

Figure 5: Example of a System Dynamics Model – Causal Loop Diagram with Feedback Highlighted (adapted from (58))
Figure 4 shows a simple stock and flow diagram describing the spread of infectious disease through a population. The two stock variables – susceptible population, and infected population (shown inside rectangular boxes) describe the number of individuals within a population who are susceptible to the disease but not currently infected, and the number of individuals who are currently infected. In a stock and flow diagram, individuals move between these stocks, at a rate determined by the flow variables (shown as “pipes” between the stock variables). New individuals can enter into the system at a specified rate through the flow variable “births,” leading to an accumulation of susceptible individuals. The “source” for births is represented by a cloud symbol, as the whereabouts of individuals prior to their birth is of no consequence to the model, which investigates drivers of the spread of infectious disease. Similarly, individuals can leave the system via the flow variable “death” which removes a given number of individuals per unit of time from the stock of susceptible individuals. Individuals may also die due to the infectious disease, which removes a number of individuals per unit of time from the stock of infected individuals. Again, clouds are used to represent the destination of these individuals, as the question of where individuals go after death is not consequential in this model.

The rate variable “Infection rate” defines the number of individuals per unit of time who move from the susceptible population and accumulate in the infected population. As the stock of infected individuals grows, the variable “Exposure to infected individuals” increases, due to the increasing number of interactions between those who are infected and those who are susceptible. This increase in exposure further increases the initial infection rate per unit of time,
representing a reinforcing feedback loop that speeds up the spread of disease as the prevalence grows.

Similarly, as the stock of infected individuals increases, public concern over the severity of the disease increases, spurring investment in better treatment of the disease. Over time, this increases the recovery rate, which moves individuals back into the susceptible but uninfected population stock as better treatment options lead to more effective treatment of the disease.

Figure 5 shows a CLD, describing the system which affects decisions to act on a system, and the intended and unintended outcomes that can arise as a result of action (58). This CLD is characterised by its restriction to using auxiliary variables, and information links only. The diagram describes the variables that affect the decision-outcomes system, and specifies causal linkages between each of these variables. The diagram describes how a gap between the perceived state of the system and the desired (or “goal”) state leads to an increase in planned actions to reduce the gap. An increase in planned actions leads to the implementation of actions, which brings about a change in the state of the system. As changes in the system are perceived by the intervenor, the “gap” which was meant to be reduced, may be seen to either shrink or grow depending on the success of the intervention, which leads to either an increase or decrease in future planned actions. Alongside this process, the CLD also shows that changes in the actual state of the system can lead to “ramifying effects” or results of actions which were not intended. These ramifying effects can simultaneously reduce the intended impact of planned action, or create unintended actions, which dampen the intended change in the system state. The CLD contains several feedback
loops, which are emphasised in the model by the emboldened blue arrows. The largest feedback loop encompasses seven variables, and is a reinforcing loop flowing clockwise around the diagram. This loop is indicated by a capital “R” inside a clockwise arrow, which is located in the centre of the loop. Two other feedback loop labels indicate balancing loops, a three variable clockwise loop in the middle left of the diagram, and a four variable counter-clockwise loop in the lower centre.

CLDs emphasise the visual representation of feedback loops. As shown in Figure 5, a single CLD may contain a number of feedback loops, many of which can overlap, sharing common variables and causal connections. From a theoretical perspective, System Dynamics takes the position that the behaviour of a system is largely determined by the interplay of the various feedback loops which affect it (59). Over time, different feedback loops may have greater or lesser effects on an outcome of interest, depending on the state of the rest of the system. Studies from the System Dynamics literature identify generic places to intervene in any system, based on the identification of feedback loops, and other structural aspects of System Dynamics models (60). Many quantitative System Dynamics studies examine “loop dominance” in systems, seeking to identify the set of loops which are most influential in determining the behaviour of a system (61).

Quantitative System Dynamics models typically employ stock and flow diagrams, and are analysed as a set of simultaneous equations. Each model variable is defined as a function of the other model variables that causally affect it, producing a set of simultaneous equations that determine the overall behaviour of the system (49). The ability of System Dynamics (both CLDs and stock and flow
diagrams) to create models containing many variables also makes it a useful approach for modelling systems with determinants at multiple organisational levels (i.e., proximal, intermediate and distal determinants) (49). System Dynamics models are also useful for demonstrating the complexity of a system to its stakeholders (62). Stakeholders also commonly participate in the model-building process, particularly in the creation of CLDs (63) which provides a framework for the inclusion of stakeholder knowledge and perceptions within a System Dynamics model.

The identification of an appropriate scope for a System Dynamics model represents one limitation of the approach. System Dynamics models are prone to the inclusion of excessive detail (50), which increases the difficulty of developing a simulation model, particularly in stock and flow diagrams, and may reduce the usefulness of CLDs where communication is one of the desired outcomes. The visual complexity of System Dynamics models can also present a barrier to clear communication of insights about complex systems, particularly with stock and flow diagrams where many of the model conventions require explanation to understand and feedback loops are harder to identify (50). Finally, model validation is difficult in System Dynamics – even where simulation models produce behaviours consistent with historical data, it is difficult to know if the behaviour in reality is caused by the same mechanisms as those defined in the model (50).
2.2.3.2 – Agent Based Modelling

Agent based modelling (ABM) quantitatively simulates the behaviour of individual agents within a bounded space, over time (49). In ABM, behaviour is simulated at the micro or agent level by defining the internal characteristics of each agent, as well as the ways in which the agent will respond to the simulated space, and other agents. During simulation, behaviour is observed at the macro, or population level, allowing for emergent patterns in agent behaviour to be observed (64).

One advantage of ABM is that actors’ behaviour at the macro level can be represented using graphical visualisations. Figure 6 shows the visualisation from a small ABM in which two groups of actors were programmed with the goal of moving past each other in opposite directions through a hallway (65). The Figure gives four snapshots of the visualisation, firstly the features and dimensions of the simulated hallway space, followed by the state of simulated actor behaviour at three time points (time = 0, 10, and 15 seconds). Actors’ characteristics are shown according to shading (grey actors move left to right; black actors move right to left). Based on the micro-level simulation defining actors’ goals (to move in a specified direction through the hallway), the visualisation demonstrates the emergence of a macro-level pattern of behaviour among actors: the formation of “columns” of actors as the groups move past one another in order to reach the far end of the hallway. Further examples of the applications of ABM in the population health literature include models of tuberculosis spread (66) and the effect of built environments on neighbourhood walkability (67).
ABM allows researchers to test various methods of intervention through repeated simulations under different conditions (68). Comparison of different intervention strategies via simulation allows various scenarios to be tested, and is a strength of ABM where experimentation is not possible. For example, ABM has been used to optimise building design for evacuation efficiency and injury prevention during emergencies (69).

When programming an ABM it is rare that a set of micro-level equations that are consistent with measured data and evidence will also produce emergent properties of the system which are consistent with observed phenomena (68). Typically, researchers must either prioritise an “evidence-based” approach that may produce difficult to interpret or spurious emergent behaviours, or introduce assumptions regarding agent characteristics in order to produce an ABM that faithfully recreates observed complex phenomena. ABM outputs are also difficult to interpret where the number of causal factors is large, which can lead to the
necessary exclusion of some known explanatory factors from the model. Such exclusion can expose the approach to challenges on the validity of its outputs. This has led to suggestions that findings from ABMs should be considered as essentially qualitative, even in well-developed models (68).

ABM is further limited by its inaccessibility to non-experts. Visualisations produced by ABMs communicate the emergent behavioural patterns demonstrated by agents, but the causal factors which give rise to the behaviours are only visible at the code level. ABM is optimised for testing hypothesised interventions, rather than for identifying new intervention targets; the approach allows potential intervention strategies to be tested once a degree of confidence in the outputs of the simulation model has been reached, but there is little in the ABM literature to suggest how ABMs may be used to identify potential points of intervention.

2.2.3.3 – Social Network Analysis

Network analysis is an approach to modelling complex systems based on sets of interconnected nodes. In network analysis, models analyse how nodes influence, and are influenced by, the other nodes with which they share a specified connection (49). Within population health research, NA is often applied to the investigation of social structures, and is referred to as “Social Network Analysis” (SNA) (70).

SNA is an approach for investigating the influence of social structures on a problem of interest. Whereas individualist approaches (such as ABM) are focussed on the properties of the individual, SNA investigates the degree to which social ties between individuals are related to an outcome of interest (68). SNA
typically investigates one of two network types; “ego” networks which investigate
the social connections centred around one entity of interest, or “global” networks
which investigate all relationships between all entities within a specific context
(71).

Social network graphs contain two key elements - “nodes” that represent
social entities, and “edges” which represent social connections. Nodes are often
coded using shapes or colours to differentiate the characteristics of entities within
the network. Edges may be either “undirected” if a social connection is
functionally identical for both entities (i.e. co-workers, romantic partners) or
“directed” if there is an asymmetry to the connection (i.e. news anchor and
viewer, author and reader). Figure 7, below, contains an example of an undirected,
global network graph, representing organisational structure within a company
(72). In this diagram, colour denotes the department that an individual belongs to,
and shape differentiates managers (diamonds) from frontline employees (circles).
The diagram illustrates the connections between the managers and their teams,
revealing that in some cases employees did not have a direct relationship with
their own manager (as seen in the green team), and some managers (as seen in the
blue team) had more connections with other teams than with their own.

SNA can be used to examine a number of aspects of a network, including
indicators of the overall network structure, such as model density (the proportion
of all possible connections that are actually present), path length (average number
of edges required to connect any two nodes), and average number of edges per
node. SNA may also be used to characterise the nature of relationships between a
set of nodes, and quantify the potential influence of a given node within the
network, identifying nodes that are connected with a higher proportion of other nodes in the model, or nodes that represent intermediaries, essentially “bridging” large numbers of other nodes within the network (71). These network or node level outcomes may be compared against measured outcome data, in order to examine the effect of a social network on a given outcome (68). Applications of SNA in population health research have included studies of the influence of school social structures on obesity outcomes (73), the effects of professional relationships on evidence-based practise adoption among health practitioners (74), and the influence of friendship structure on general health among disadvantaged children living in supported housing (75).

Figure 7: Example of a Social Network Analysis Diagram (adapted from (72))

A strength of SNA is that it can be used to analyse the effect of a highly structured, precisely defined social network on a given outcome. Participants
require no particular specialisation to be able to provide accurate data on their own social relationships, which lends a high degree of face validity to the approach. SNA can identify the structural characteristics of entire social networks, as well as the relative influence of individual entities within networks. This allows SNA to address research questions at different levels, including how the structure and composition of entire social groups is related to an outcome, and how key individuals within networks may be related to the diffusion of an outcome throughout a social network.

SNA is subject to some limitations – primarily the approach focuses on the effect of interpersonal relationships, to the exclusion of individual characteristics, environments and settings, or time. Social network data is also difficult to generalise due to the precise focus on specific social groups. This limitation also necessarily cannot be overcome using techniques such as randomisation, as randomised individuals may not share any social connections, and sampling of large population groups is generally not feasible due to the time and resource burden required to collect complete network data from large participant groups (68).

2.2.3.4 – Comparison

Of the three methodologies described above, this section will argue that System Dynamics is particularly well suited to offer insights into the drivers of adolescent lifestyle behaviours, and identify potential targets for population-level intervention design.
Section 2.2.2 presented evidence supporting the argument that adolescent diet and physical activity can be characterised as complex problems. According to Ladyman et al, important features of complexity include nonlinearity, feedback, and numerousity (45). Evidence from the population health literature was presented which affirms that a number of these characteristics are observable in adolescent physical activity and dietary behaviours. Of particular note was the evidence regarding the numerousity of diet and physical activity, with the study by Butland et al describing well over 100 variables that directly and indirectly affect these behaviours (57).

When considering the complex methodologies presented above, System Dynamics appears most suitable for investigating adolescent lifestyle behaviours based on their numerousity, as System Dynamics aims to identify “all sources of influence” over a problem (52). ABM, by comparison, calls for a parsimonious approach to model building, focussing on a small number of explanatory factors (49), which may necessitate the exclusion of some known determinants from the model. Where determinants of diet and physical activity are excluded from a model, they will necessarily also be excluded from any conclusions regarding possible intervention or prevention strategies simulated by an ABM. SNA is also restricted to the analysis of social relationships. While peer and social networks are known determinants of adolescent lifestyle behaviours, they represent only one facet of the numerous determinants of adolescent lifestyle.

Evidence from the obesity prevention literature suggests that physical activity and diet-focussed intervention strategies are most successful where they adopt a community-based, capacity-building approach (76). Stakeholders working
with complex problems commonly participate in the model building process in System Dynamics, and evaluation of participatory System Dynamics modelling projects suggest that stakeholder participation in System Dynamics modelling increases participant capacity to understand and respond to complexity in health problems (77). This aligns with criteria of community capacity and readiness for change from obesity prevention studies (78). By contrast, ABM requires specialisation in modelling techniques and computer programming, and is therefore less amenable to participatory approaches. SNA can produce social network graphs using survey data collected from participants, however there is no suggestion in the literature that participation in the creation of a social network graph builds understanding or capacity around complex systems.

A further strength of System Dynamics within the context of prevention science is the solution-oriented nature of the methodology, in comparison to ABM and SNA. Although ABM is able to simulate the behaviour of a system over time, its main goal is to create an in-silico experimentation space for emergent behaviours among agents. The successful creation of an ABM does not, in itself, produce any actionable insights into potential interventions for a system. Hypothesis generation after the creation of the ABM is required, in order to create testable intervention scenarios. Further, SNA creates a framework for quantifying the effect of social networks on a complex outcome, but does not, in itself, generate any actionable insights for intervention. System Dynamics, with a focus on system structure as a driver of complex problems, suggests common structural characteristics within System Dynamics models which represent intervention targets. Examples of these are given in Donella Meadows’ influential publication
“Places to Intervene in a System” (60). System Dynamics therefore represents a hypothesis-generating methodology, as the approach provides both a method to conceptualise a complex system, and a method to identify potential intervention targets to respond to it.

Based on these factors, System Dynamics is a promising methodological approach to begin to address the gap in knowledge regarding practical approaches to inform intervention design that acknowledge complexity, build capacity and readiness for change within communities, and embed responses within existing health systems.

System Dynamics offers analytical tools based on a complex approach, and allows system elements to be conceptualised at multiple levels, while providing a framework for the identification of potential intervention points within the existing complex system.

The knowledge gap described above also cites the need for an approach that acknowledges local contexts and settings, and strengthens capacity and readiness for change within communities. Although System Dynamics modelling as an academic exercise does not directly address these needs, they may be addressed using participatory modelling methods from the System Dynamics literature. An approach to facilitated stakeholder participation in the construction of System Dynamics models, called group model building, will be presented in the following section.
2.2.4 – Group Model Building

Group model building (GMB) is a practical tool from the System Dynamics literature that provides a structured, workshop-based process by which stakeholders can participate in the creation of a System Dynamics model – most frequently a causal loop diagram (CLD) (79). Where CLDs are informed directly by stakeholders, they are generally accepted to be a representation of participants “mental models” – defined by Doyle and Ford as an internally held representation of the perceived structure of an external system (80).

The practice of including stakeholders in the model development process has existed since the 1980s (81), however well into the late 20th century, the approach was ill-defined, with no unifying “taxonomy of approaches” to describe a formal process by which to engage stakeholders in model creation (82). It was not until 2012 that a system for formalised reporting of GMB methods arose in the literature with the publication of GMB scripts, a standardised framework for reporting and sharing GMB methods (63).

Scripts are used to create GMB workshops by joining complementary scripts together, with each script describing one activity or “part” of the overall workshop (63). Each activity, as defined by its script, completes a necessary step in the CLD building process, such as identifying model variables, identifying complex interconnections, or reviewing and expanding upon progress from previous activities. Scripts also clearly identify the required inputs and outputs of each activity, to ensure consistency in the workshop procedure and consistent, efficient development of the CLD. The largest current resource for GMB scripts is...
the “Scriptapedia” database created by Hovmand, Rouwette, Anderson, Richardson and Kraus (83).

GMB has been applied broadly within the health-related literature. Publications describe various GMB workshops developing CLDs to support the planning and design of responses to environmental damage caused by transport infrastructure development (84), health priority setting in the New Zealand Ministry of Health (85), and strategies to increase adherence to occupational health and safety guidelines in Australian drilling and mining industries (86). Further afield, GMB has been used to identify drivers of urban redevelopment (87), boost recruitment and retention of New Zealand army personnel (88) and support the development of policies for sustainable fisheries (89).

Efforts to evaluate the effectiveness of GMB are still in their infancy, however one study has found that the GMB process appears to improve capacity to appreciate, and respond to complexity among individuals who participate in GMB workshops (62). Other evaluations of the GMB process have found that participants see the resulting CLDs as fair representations of their own perceptions, as well as the perceptions of other participants. This suggests that participants feel that the GMB process adequately captures the complexity of a problem, as it is perceived by all participants who are involved in the model-building process (77). Other studies have suggested that GMB also produces models that are more likely to stay closely related to the desired topic, and contain less unrelated or extraneous information than other decision processes (90). GMB is also believed to lead to group decisions and actions which are rated more positively by participants than decisions reached by other methods (62), however
there remains an ongoing need to formally evaluate the actual effectiveness of actions arising from GMB as compared to other methods.

These are important strengths of the GMB process in light of the importance of community capacity building as one of the recommendations for best practise in population-level lifestyle prevention. Community capacity building can be defined as the ability of a community to identify, address, and respond to health problems (78), and building this capacity can be achieved by equipping communities with skills and resources to address the problem, and generating commitment to actions (91, 92). The improvement in participants’ ability to recognise and act in response to complex systems conferred by participation in GMB, as well as the potential improvement in the quality of, and engagement with, decisions and actions means that the GMB process is closely aligned with the goal of building community capacity concerning complex health problems.

Section 2.1.4 outlined that effective strategies to modify adolescent physical activity and diet behaviours need to be based on a complex approach which allows system elements to be identified, and responded to at multiple levels – which is achievable using the System Dynamics approach to modelling complex systems. The use of GMB and involvement of community stakeholders in model construction provides for the acknowledgment of unique local contexts and settings, and appears to build capacity and readiness for responding to complex problems within workshop participants. The creation of models that are specific to a given community also means that intervention ideas can be identified, and
responses can be embedded within a conceptualisation of the existing health system for that community.

2.2.5 – Previous SD Approaches to Lifestyle Behaviour

A small group of studies from the obesity prevention literature report on GMB and other System Dynamics modelling approaches to understanding the complex drivers of lifestyle related disease. No studies to date have reported directly on the complex drivers of adolescent physical activity and diet behaviours – the nearest examples from the literature have viewed these behaviours indirectly through the lens of childhood obesity (93, 94) rather than adolescence. Despite the focus on a different age group, and an indirect perspective on diet and physical activity, the studies are important to acknowledge, as the findings and limitations of previous research may inform a more refined approach to address the knowledge gap identified above.

The Foresight obesity model represented an early effort to understand the sources of influence behind the obesity epidemic in the United Kingdom (95). The programme did not represent a group model building project in the form described above, but involved a collaboration of more than 300 childhood obesity experts to create a causal loop diagram of all causes of obesity in the United Kingdom.

The resulting CLD, named the “Foresight Obesity System Map” (shown in Figure 8), contained over 100 variables grouped into seven thematic clusters. Clusters included food production and consumption, individual and social psychology, individual physical activity and the physical activity environment, and physiology. The project aimed to improve the United Kingdom government’s
understanding of the complexity of the obesity epidemic, as well as deliver a qualitative tool that could be used to assist policy makers to define and test policy options (57).

Since its publication, authors in the obesity prevention literature have reflected on the Foresight map’s influence in steering obesity prevention research away from “ineffective single intervention approaches” (95), and the realisation that these previous approaches were likely never well positioned to create meaningful impacts on childhood obesity (96, 97). Reviews of obesity-related policy in Australia and New Zealand (98), and the United Kingdom (99) identify the Foresight map as a source of influence over subsequent policy decisions.

The initial success and influence of the Foresight map can be examined within the context of Hovmand’s “hierarchy of systems insights” framework (51). The hierarchy of systems insights describes the different types of insights that System Dynamics modelling can generate, and which modelling approaches best support the generation of those insights (see Figure 9) (51). The systems insights are listed, ranging from surface level (concepts such as “there is a system”, and that system components “are related through feedback”) through to moderate level insights (how systems can be transformed through the addition or modification of feedback loops, or what kinds of generic “system archetypes” can be useful for exploring systems) and deep system insights (identification of dynamics structure which produce the system behaviour, where the precise leverage points for intervention are, and understanding the counterintuitive characteristics of the system). The right-hand column of the diagram describes the modelling approaches best suited to producing these insights.
Surface level insights may be developed by adopting simple modelling approaches such as small or partial system models. These models use the same conventions as CLDs, but focus on a small number of key variables and causal links, excluding stocks, flows and rate variables. For moderate insights, qualitative causal loop diagrams are typically required (described here by Hovmand as “informal causal maps”). At the level of deep insights, simulation models are required, typically in the form of fully quantified stock and flow diagrams, which require significant time and expertise to develop.

The overall impact of the Foresight model suggests that it successfully generated insights at the surface level. For example, the subsequent discussion of the shortcomings of single-strategy obesity prevention (95) shows an increased

<table>
<thead>
<tr>
<th>Desired System Insight</th>
<th>Modelling Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is a system.</td>
<td>System Pictures</td>
</tr>
<tr>
<td>The components of a system are related through feedback.</td>
<td>Informal Causal Maps</td>
</tr>
<tr>
<td>How people might think about a system?</td>
<td></td>
</tr>
<tr>
<td>Where one could intervene?</td>
<td></td>
</tr>
<tr>
<td>What is transformation?</td>
<td></td>
</tr>
<tr>
<td>What is the generic structure?</td>
<td></td>
</tr>
<tr>
<td>What are the implications of accumulations and nonlinear relationships?</td>
<td></td>
</tr>
<tr>
<td>What systems can generate the dynamic behaviour?</td>
<td></td>
</tr>
<tr>
<td>Where are the leverage points?</td>
<td></td>
</tr>
<tr>
<td>When do boundary conditions determine behaviour?</td>
<td></td>
</tr>
<tr>
<td>Why do things happen?</td>
<td></td>
</tr>
</tbody>
</table>

Figure 9: Level of System Insight and Complementary Modelling Approaches
(adapted from (51))
awareness of the existence of a complex obesity system, and that the many parts of the obesity system were interdependent, and subject to feedback.

Despite these successes, the Foresight model was not effective at the moderate insight level, despite its closer resemblance to a CLD than a partial system picture. This may be due to the extreme visual density of the model, and the fact that the model does not follow generally accepted conventions for presenting CLDs, such as the use of uniformly curved lines to accentuate feedback loops, and the minimisation of “crossovers” in the causal connections (100). Although the visual density of the model implies interconnection and feedback, the actual examination of causal structure within the model is difficult.

A further limitation of the Foresight model was the construction based on stakeholder views from national experts, who were set the task of defining a model that represented the entire United Kingdom (57). This “top down” approach to model building means that the Foresight map does not capture any information about specific community contexts or settings, and many of the variables that are included in the model are effectively non-modifiable, including “individualism”, “genetic or epigenetic predisposition to obesity” and “social depreciation of labour”. This led to some criticism of the Foresight map, based on the difficulty of visually interpreting the model content, and the lack of modifiable or locally relevant insights. One journalist wrote that the top-down, macro-level focus of the model fostered no new ideas except “the banal point that the many factors that contribute to obesity all influence each other” (101). The criticism is a further demonstration of the importance of engaging stakeholders in the modelling
process, in order to capture information about local contexts and environments and ensure that the model provides insights that are relevant and actionable.

Subsequent studies have made significant progress towards overcoming these limitations by adopting the GMB approach introduced in the previous section. Two recent examples of GMB studies that were related to lifestyle health presented CLDs of obesity causes in both individual communities (93) and in large multi-site projects (94). Allender et al (93) conducted a series of GMB workshops with community stakeholders in a regional Victorian community to develop a CLD of childhood obesity drivers. By constructing a community-led CLD, Allender et al were able to create a diagram that was sensitive to local contextual factors. For example, the diagram identified cultural problems in local sporting clubs acting as a barrier to sports participation in children. The framing of the workshops as an investigation of childhood obesity determinants at a local level also produced more modifiable content within the model, providing a community sensitive resource that could form the basis for local planning of systemic obesity prevention responses.

Brennan et al (94) employed a GMB approach to create community-led CLDs of childhood obesity causes. As part of the evaluation of a large, 49-community childhood obesity intervention program, the research team held GMB workshops in each of the study communities. Between 2010 and 2014, stakeholder groups were convened in each community, and each stakeholder group participated in a one-day GMB workshop. CLDs created by this workshop process were “compiled” by the researchers into a general model that represented the perceptions of the entire 49-community cohort of participants. The researchers
highlighted feedback loops found in the CLD as important contributing factors to childhood obesity in the study communities.

The studies by Allender et al (93) and Brennan et al (94) demonstrate the capacity for GMB to produce insightful representations of the perceived drivers of lifestyle-related health problems at a community level. Both studies, however, only address the drivers of physical activity and diet behaviour via their relationship to obesity in children, and are subsequently only indirectly related to the health behaviours and age group being considered in this thesis.

This led to the development of the second aim of the thesis:

*Aim 2: To capture community perceptions of the complex drivers of physical activity and diet behaviour among Victorian adolescents.*

2.2.6 – Applicability of the GMB Process to Multi-Site Intervention Design

Although GMB has previously been employed to capture community perceptions regarding the drivers of complex health problems (such as in the GMB studies by Allender et al (93) and Brennan et al (94)), studies are yet to examine how GMB might be applied in larger, multi-setting prevention programmes. The best practise recommendations for lifestyle-focused prevention discussed in section 2.1.4 state that in addition to being guided by complex frameworks which conceptualise the system at multiple levels, building community capacity, and acknowledging local contexts, successful lifestyle-based prevention strategies must operate across multiple settings, using a range of intervention strategies (39, 102). While Systems Dynamics and GMB are based in
the theory of complexity, appear to build capacity among participant groups, and can be used to generate insights that are relevant to local contexts, it is less clear whether the GMB process is appropriate or feasible to deploy in multiple settings as a tool to inform prevention strategies in multi-site projects.

No studies thus far have explicitly addressed this application of GMB, however Brennan et al’s (94) study of childhood obesity determinants in 49 communities, represents a conceptually similar project. As described above, Brennan et al conducted a series of one-day GMB workshops to evaluate policy changes following a 7-year, multi-site intervention programme, however the context of Brennan et al’s study as an evaluation programme means that it may not directly translate to the goal of informing intervention design.

Brennan et al’s (94) evaluation process was conducted under the banner of a large intervention programme, and was therefore able to leverage existing relationships between the researchers and community stakeholders to recruit participants into the GMB workshops. The use of GMB to inform intervention design at the outset of a new intervention program would necessitate the recruitment of stakeholders with whom researchers are yet to develop a relationship. In the absence of pre-existing relationships between participants and researchers, time commitment is a significant barrier to engagement in community populations (103), and guidance from the GMB literature suggests that up to 10 hours of pre-workshop engagement per participant group may be required to generate sufficient “buy-in” among potential participants where relationships are yet to be established (51). For many multi-setting intervention programmes, due
to these time and resource costs, such a requirement would become unfeasible as the number of intervention sites increases.

Given the prevention focus of the work presented in this thesis, in order to address aim 2 (capture community perceptions of the complex drivers of physical activity and diet behaviour among Victorian adolescents) in a way that is translatable to best-practice prevention, a GMB approach that minimises the time burden of participation is required. This informed aim 2.1 of this thesis, which revolved around the creation of a GMB process that allows for the capture of community perceptions regarding the complexity of adolescent lifestyle behaviours, while meeting the practical constraints of multi-site prevention activity discussed above. Aim 2.1 of the thesis is given below:

Aim 2.1: To develop a streamlined approach to GMB in order to create community-led CLDs of adolescent physical activity and diet behaviour drivers.

2.2.7 – Quantitative Analysis of Causal Loop Diagrams

Typically GMB is a process with a recommended group size of between 5 and 17 participants (51). Both Allender et al, and Brennan et al, utilised groups of approximately this size in the construction of their childhood obesity CLDs (93, 104). Although the group numbers in these workshops are small the models are presented as a representation of perceived drivers of obesity within the whole community.

However, low participant numbers in this process challenge the representativeness and generalisability of the CLDs beyond the small number of participants who were “in the room” when these maps were created. This issue
has been raised as a limitation in both applied GMB studies (93), and in theoretical discussions (105). In practical terms, the use of samples of 5-17 participants in community-based GMB studies means that only a small proportion of the community are represented, and that CLDs created by a small group may be inconsistent with the perceptions that are held by the broader community. Should this be the case, CLDs created by small groups should not be generalised as representations of community perceptions or used as a basis for planning or evaluating community responses to complex problems, as they have been in the literature (93, 94). Despite the theoretical importance of this issue, it has not been investigated in the GMB literature. Further work is required to examine the influence of different participant groups on CLD content.

In order to address this concern, a method for the comparison and contrasting of multiple CLDs is required. The comparison of CLDs will allow for a preliminary investigation into whether CLD structure and content are highly dependent on the composition of the group that created it, or whether perceptions of population-level health problems are consistent enough across communities that CLDs created by small samples are similar in content and structure.

To date only one study has proposed a methodology for analysing differences between CLDs (106). The approach employed Venn Diagrams to identify common variables between CLDs, but was restricted to the identification of common variables across multiple CLDs. The use of Venn Diagrams prevents the approach from accounting for the causal connections between variables, which give rise to the structural characteristics of CLDs and underpin much of the theory of System Dynamics. There is therefore a gap in knowledge regarding methods
for quantitatively comparing multiple CLDs, using methods that account for both
the variable content of the model, and the structural characteristics of the model.

Social Network Analysis techniques and recent advances in computing
power now make it possible to quantify the contents and structure of CLDs. As
introduced in section 2.2.3.3, Social Network Analysis is typically used to analyse
social structures, and the influence of social interactions on an outcome of
interest. At its core, however, SNA represents a suite of analytical tools which can
be used to analyse networks of connected nodes, and in doing so can identify
structural characteristics of entire networks, as well as individual nodes of
influence within networks, based on their relative position within the network.

McGlashan et al (107) applied these SNA techniques to an obesity CLD to
provide a quantitative summary of the overall characteristics of the model.
McGlashan et al outlined a number of SNA measures which could be translated
into quantitative descriptions of different aspects of a CLD. Quantitative
outcomes included measures of the average causal connections per variable in the
CLD, the proportion of possible causal linkages which exist in the model (i.e.
number of causal linkages in the model relative to the number of causal linkages
which would be present if every variable was connected to every other variable),
the relative influence of a given variable on other variables within the model, and
the identification of important “moderator” variables, which featured on important
causal pathways through the CLD.

The ability of the SNA technique to quantify the overall characteristics of
the CLD, as well as the influence of individual model variables makes SNA an
ideal method for comparing multiple CLDs. This gave rise to thesis aim 2.2, which is presented below.

**Aim 2.2:** To draw on SNA techniques to quantitatively identify and compare the model-level and variable-level characteristics of two CLDs of the community-level drivers of adolescent diet and physical activity behaviours.

### 2.2.8 – Summary of Section 2.2 and Statement of Thesis Aims 2 – 2.2

Current understanding suggests that maximising success in lifestyle behaviour modification requires approaches which acknowledge complexity, build community capacity, and seek novel approaches to understanding interconnected drivers of lifestyle behaviour (39).

“Complexity” is poorly defined in the literature, however one review asserts that complex problems demonstrate a number of defined characteristics (including nonlinearity, feedback, and hierarchical organisation) (45), which are consistent with observations regarding adolescent diet and physical activity behaviours (53-57). Several analytical approaches can be used to explore the causes of complex problems (49), however System Dynamics represents a suitable approach to investigate the complex determinants of adolescent lifestyle behaviours.

System Dynamics modelling is amenable to the inclusion of stakeholders in model development using a process called group model building (GMB) (50). GMB, a highly structured participatory modelling practice, is an effective approach for stakeholder-led modelling (51). Evaluation studies suggest that GMB promotes capacity for change within stakeholder groups (62), and the
process represents a novel approach to understanding the complex drivers of adolescent diet and physical activity behaviours (55). Currently, no studies have applied GMB methods to understand the drivers of lifestyle behaviours in adolescents in Australia. In order to address the gap in understanding regarding the complex drivers of adolescent physical activity and diet behaviours, the second aim of this thesis was proposed:

Aim 2: To capture community perceptions of the complex drivers of physical activity and diet behaviour of Victorian adolescents.

Despite the successful use of GMB in obesity and other population health-related studies, studies are yet to examine how GMB might be applied in larger, multi-setting prevention programmes. While evidence supports GMB as a tool for building complex representations of health problems, and building community capacity, it is less clear whether the GMB process is feasible at scale in the context of informing intervention targets in multi-site prevention projects requiring multiple workshop processes in different settings.

One example from the literature has reported on a multi-site GMB project that involved 49 separate workshop groups, however these workshops were executed over multiple years as part of an intervention evaluation. The study also drew on existing relationships with community groups, which would not exist prior to an intervention program. Given the significant time and resource burdens involved in GMB recruitment where there is no pre-existing community engagement, this approach would be inappropriate for use as a tool for informing intervention design in multiple sites. Given the prevention focus of the work
presented in this thesis, and in order to address thesis aim 2 in a way that is translatable to best practise for prevention, a GMB approach that minimises this time and resource burden is required. This informed aim 2.1 of this thesis:

**Aim 2.1: To identify and implement a streamlined approach to GMB in order to create community-led CLDs of adolescent physical activity and diet behaviour drivers.**

GMB is typically a “small-group” process involving between 5 and 17 participants (51). Low participant numbers in this process challenge the representativeness and generalisability of the CLDs beyond the participants who directly contributed to them (93, 105). In practical terms, the use of small groups in community-based GMB studies means that only a very small fraction of the community is represented, and the perceptions of a small group may differ from that of the broader community. This assertion has not been investigated in the literature.

In order to address this concern, a methodology is required which allows for the comparison and contrasting of multiple CLDs from groups in repeat-methods GMB studies. Comparison of CLDs in this way will allow for an initial investigation into whether the content of CLDs is highly dependent on the sampling frame, or whether CLDs created by small groups contain similar content. Social Network Analysis (SNA) techniques and recent advances in computing power make it possible to quantify the contents and structure of CLDs. SNA provides analytical tools which can be used to identify structural characteristics of a whole CLD, as well as individual variables of influence within
a CLD, based on relative position within the model. SNA represents a promising method for comparing multiple CLDs, and by extension providing some insight into the variability of a CLD attributable to the particular participant group that constructed it. This gave rise to thesis aim 2.2, which is presented below.

*Aim 2.2: To quantitatively identify and compare the model-level and variable-level characteristics of two CLDs of the community-level drivers of adolescent diet and physical activity behaviours.*

2.3 – Problem Statement

2.3.1 – *Summary of Critical Literature Review and Aims*

The literature review above began by reviewing the current evidence describing the scope and severity of depression and depressive symptomology among Australian adolescents, and its associations with poor diet and physical inactivity. The first section of the review highlighted a gap in the Australian literature examining the associations between adolescent diet and physical activity behaviours and depressive symptomology. Currently, there are no studies investigating the associations of diet and physical activity, and depressive symptomology that are generalisable to the Victorian adolescent population.

The literature review also examined the literature regarding current best practise recommendations for population-level physical activity and diet behaviour modification. In light of the current recommendations that intervention strategies should acknowledge complexity, operate in multiple settings and
contexts, build community capacity, and seek new approaches to understanding the interconnected drivers of lifestyle behaviour, the predominant methodologies for studying complex population health problems were reviewed. Of the three most often used methodologies, System Dynamics was found to be an adaptable and accessible approach to modelling complex problems. System Dynamics includes a participatory modelling practice, group model building, which can be used to identify intervention targets, and engage community members in the creation of complex models.

Previous examples of the application of Systems Dynamics and group model building to population health issues were reviewed, and knowledge gaps were identified. The GMB literature was not found to contain any examples of community-led models of adolescent physical activity and diet behaviour drivers. Previous GMB processes which had been applied in conceptually similar fields, such as childhood obesity were reviewed, but were found to contain barriers to implementation in multi-setting interventions where repeated workshops would be required. The process was also found to typically operate with small participant groups, which raised unresolved questions about the generalisability of complex models created using the GMB process.

In order to address the concerns regarding the representativeness of GMB outputs, methods that could be used to compare models as an initial examination of the consistency of perceptions between community groups were reviewed. Social Network Analysis was found to be a promising technique that can be used to generate quantitative descriptions of overall model structure, and identify structurally important variables within models.
In order to address the gaps in knowledge identified by the literature review, the following thesis aims were proposed:

**Aim 1:** To establish the associations and relative contributions of adolescent physical activity and diet behaviours, singly and in combination, to the variance in depressive symptoms within male and female adolescents in Victoria.

**Aim 2:** To capture community perceptions of the complex drivers of physical activity and diet behaviour of Victorian adolescents.

**Aim 2.1:** To identify and implement a streamlined approach to GMB in order to create community-led CLDs of adolescent physical activity and diet behaviour drivers.

**Aim 2.2:** To quantitatively identify and compare the model-level and variable-level characteristics of two CLDs of the community-level drivers of adolescent diet and physical activity behaviours.

2.3.2 – Research Questions

**RQ1:** What are the associations and effect sizes attributable to physical activity time, sedentary behaviour, and diet pattern, on depressive symptomology outcomes in a sample of Victorian secondary school students?

**RQ2:** What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?
**RQ2.1**: Does the use of a rapid approach to GMB produce complex representations of the community-level determinants of adolescent physical activity and diet behaviours?

**RQ2.2**: What similarities or differences can be observed in CLDs constructed by independent groups from a repeat-methods GMB workshop, regarding the perceived community-level drivers of adolescent diet and physical activity?

The outcomes of studies addressing these questions are reported in original research articles, presented in Chapters 4-6, which in addition to the commentary paper in Section 2.1.4 above, fulfil the requirement of the Deakin University “Thesis by Publication” format. Table 3 shows the alignment between each of these articles, the study from which they draw their data, and the thesis RQ’s that they address.
Table 3: Overview of thesis papers and study/RQ alignment.

<table>
<thead>
<tr>
<th>Publication Title</th>
<th>Study/Data source</th>
<th>Thesis RQ addressed:</th>
<th>Specific publication RQ:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lessons from Obesity Prevention for the Prevention of Mental Disorders: The Primordial Prevention Approach.</td>
<td>Narrative literature review</td>
<td>n/a – component of critical review</td>
<td>What are the relationships between modifiable lifestyle risk factors and common mental disorders? What are the characteristics of successful lifestyle-based prevention approaches from the obesity prevention literature?</td>
</tr>
<tr>
<td>Lifestyle Factors and Adolescent Depressive Symptomology: Associations and effect sizes of diet, physical activity and sedentary behaviour.</td>
<td>Victorian Adolescent Lifestyle and Depressive Symptoms Study</td>
<td>RQ1: What are the associations and effect sizes attributable to physical activity time, sedentary behaviour, and diet pattern, on depressive symptomology outcomes in a sample of Victorian secondary school students?</td>
<td></td>
</tr>
<tr>
<td>A Rapid Group Model Building Process for Understanding Determinants of Adolescent Lifestyle.</td>
<td>Healthy Adolescent Lifestyles Mapping Project</td>
<td>RQ2: What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?</td>
<td></td>
</tr>
<tr>
<td>Comparing Group Perspectives from a Repeat Methods GMB Project on Adolescent Lifestyle Determinants.</td>
<td></td>
<td>RQ2.1: Does the use of a rapid approach to GMB produce complex representations of the community-level determinants of adolescent physical activity and diet behaviours?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RQ2.2: What similarities or differences can be observed in CLDs constructed by independent groups from a repeat-methods GMB workshop, regarding the perceived community-level drivers of adolescent diet and physical activity?</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 3: Study Methodologies

This methodologies chapter provides an extended description of the methods employed in the two studies that comprise this thesis. Although each of the papers presented in Chapters 4 – 6 below contain the required detail for publication, this chapter contains a more complete account of the development, settings, and execution of the research.

3.1 – Study 1: Victorian Adolescent Lifestyle and Depressive Symptoms Study

3.1.1 – Summary Study Objectives

The objective of this study was to collect cross-sectional anthropometry and survey data from secondary school students in years 8 and 10 across 18 Victorian communities. Measures included direct-measured anthropometry, and self-reported diet, physical activity, screen time, sleep behaviours, depressive symptomology, and demographics. This study sat within a broader research programme – the Healthy Together Childrens Evaluation, the full methodology of which has been presented in previous publications (108).

3.1.2 – Setting

Data for this study were drawn from the baseline assessment of adolescents participating in a cluster-randomised control trial on adolescent anthropometry and obesogenic behaviours (108). Participants were recruited from year 8 (aged 14-16) and 10 (aged 16-19) classes in consenting secondary schools.
and data collected during school Term 3 (July-September) 2014. No significant differences were observed between intervention and comparison communities for BMI Z-score at baseline allowing the data to be combined for cross sectional analysis.

3.1.3 – Participants

Participants were 3,295 year 8 and 10 secondary school students from 18 LGAs across Victoria, Australia. Year 8 and 10 students were chosen in order to capture adolescents across the 14-16 year age window, which was identified as a key age range of interest in the introductory chapter of this thesis. Secondary students in other year levels were not included in this study, as the research programme only had enough capacity to survey two year levels within the target communities. Students in years 11 and 12 were specifically excluded as their commitments during the final two years of high school severely limits their ability to participate in studies, and participation may have caused them to be absent from assessments or other critical activities during school hours. The sample consisted of n=1,528 students from year 8 and n= 1,767 students from year 10.

3.1.4 – Recruitment Process

Within each LGA, all secondary schools in the region were randomised into a list. The recruitment strategy was designed to recruit at least one school per LGA, and previous research experience suggested that the likely school-level response rate would be around one in three (33%). After randomisation, the first three schools in the list were approached to take part in the study. Where no schools accepted the invitation, the next three schools were approached, and the
process was repeated until a consenting school was identified. There was no exclusion of schools where more than one out of three schools accepted the invitation. In total, 146 schools were invited, with 23 schools opting into the study.

Once one or more schools from each LGA consented to participate, all year 8 and 10 students were invited to participate in the study. Students were recruited using opt-out consent, whereby an information letter containing the plain language statement and consent forms were sent home with the student. Students were deemed to be consented into the study unless a parent or guardian returned a withdrawal of consent form to the school, or the student withdrew their own consent on the day. The approach was modelled on international examples of opt-out consent processes, and evidence supported its safety for use with children and adolescents (109). The use of an opt out consent approach was given impetus by a history of opt in consent projects in the region which typically recorded response rates between 10% and 60%, exposing studies to greater risk of response bias (110). Subsequent analysis has reinforced the importance of this approach, with analyses finding evidence of significant underestimation of obesity prevalence in population-based samples where response rates are low (111).

All materials used during the recruitment process are included in Appendix B.
3.1.5 – Variables and Data Management

3.1.5.1 – Depressive Symptomology

The outcome of interest to the study, depressive symptomology, was measured using the Moods and Feelings questionnaire – Short Form (SMFQ) (112). The SMFQ asks participants to respond to 13 items, stating whether, in the last two weeks, the item has been “not true”, scored as zero, “sometimes true” scored as a one, or “true” scored as a two. Items are based on the DSM-IV-TR criteria for major depressive disorder, and include examples such as “I felt miserable or unhappy”, “I felt so tired I just sat around and did nothing”, and “I hated myself”. Scores on this scale range from zero to 26, and can be dichotomised using a validated cut point of eight, with a score of eight or more representing “caseness” based on depressive symptomology (112). Using this cut point has demonstrated specificity of 60% and sensitivity of 85% for clinical depression in adolescent participants.

3.1.5.2 – Diet Pattern

Dietary intake was measured using the Simple Dietary Questionnaire (SDQ). Items from this questionnaire were used to measure fruit, vegetable, takeaway, energy-dense nutrient-poor snack foods, sugar sweetened beverage (SSB), caffeinated beverage, energy beverage, sweetened dairy and plain dairy consumption. Up to 25 different food groups across more than 150 survey items can be measured using the full SDQ, however for the current study only those food groups mentioned above were included due to time constraints during data collection. For fruit and vegetable intake, participants indicated how many serves
of fruit and vegetable they had consumed per day, on average, over the last week. Possible responses began at zero and increased in half-serve increments up to “more than seven serves per day”. For takeaway foods, SSBs, caffeinated beverages, energy beverages, and sweetened and plain dairy consumption, participants indicated the frequency of consumption within the last fortnight on an eight-point scale. Possible answers ranged from “rarely or never”, or “once a fortnight” through to “two times per day” or “three times or more per day”.

The SDQ was based on the 2003 Australian dietary guidelines (113) and is used in the current study to assess dietary intake against the current Australian dietary guidelines, which were updated subsequent to the creation of this tool (114). When the tool was created, the recommended dietary intake for adolescents was four serves of vegetables and three serves of fruit per day, with the 2013 update amending this figure to five serves of vegetables daily for adolescent girls, and five and a half serves of vegetables daily for adolescent boys, and two serves of fruit daily for both adolescent girls and boys. The half-serve increments and wide range of possible responses relative to the adjustment of the guidelines in 2013 (less than one serve) means that the SDQ remains a suitable tool to measure fruit and vegetable consumption. The SDQ has been tested in Australian adolescent populations and demonstrates good test-retest reliability over one to two weeks, and good validity when assessed against a 24-hour food recall. For example, vegetable consumption demonstrated the following psychometrics: Test-retest r = 0.760, p < 0.05, Validity r = 0.419, p < 0.05, and fruit consumption performed similarly: Test-retest r = 0.725, p < 0.05, Validity r = 0.569, p < 0.05) (115).
3.1.5.3 – Physical Activity/Screen Time

A seven day Likert scale was used for students to indicate their total physical activity time and sedentary behaviour time over the last week. Items for this part of the questionnaire were taken from the Core Indicators and Measures of Youth Health Survey (116). Students were prompted to indicate how much time they had spent being physically active, “including during physical education class, lunch, after school, evenings and spare time” including “skating, bike riding, running… and any other activities that make you sweat, breathe harder or be out of breath”. Students chose one option from a six-item Likert scale indicating how many minutes of physical activity they had done on each of the last seven days. Each item represented a range of minutes, with students choosing one from: none, one to 14 minutes, 15 to 29 minutes, 30 to 59 minutes, one to two hours, and more than two hours. Test-retest reliability for this item was moderate overall, with responses for individual days of the week ranging from kappa = 0.42 (Friday) – 0.51 (Tuesday).

A similar item was presented for screen time, prompting students to indicate for each of the last seven days, “how many hours (outside of school) did you spend sitting or lying down looking at a screen… [for example] watching TV and movies, playing video games, video chatting, text messaging or surfing internet sites…” Students chose a response for each day from a 5-point Likert scale, ranging from “none” through “less than 1 hour per day”, “1 to 2 hours per day”, “more than 2 hours but less than 5 hours per day”, and “5 or more hours per day”. Test-retest reliability for this item was moderate overall, with responses for
individual days of the week ranging from $\kappa = 0.43$ (Saturday) – 0.52 (Thursday/Sunday).

As each participant was asked to quantify the amount of physical activity and screen time per day, responses for each day were dichotomised according to whether or not the participant achieved the relevant Australian guideline for physical activity (greater than 1 hour/day) (117-119) or screen-based sedentary behaviour (less than 2 hours/day) (118-120) on that day. This enabled the generation of two categorical variables, one that specified the number of days that the participant attained the recommended physical activity guidelines in the last week, and one that specified the number of days on which the participant attained the screen time guidelines in the last week. The Core Indicators survey was developed from the Canadian physical activity (121) and sedentary behaviour (122) guidelines, which are identical to the current Australian guidelines for physical activity and sedentary behaviour.

3.1.5.4 – Covariates

Participants height, weight and waist circumference were measured by trained data collectors, using standard equipment. The manual which formed the basis of data collector training is provided in Appendix C. Height was measured using Charder HM200P stadiometers (Charder HM-200P Portstad, Charder Electronic Co Ltd, Taichung City, Taiwan). Weight was measured using A&D UC-321 scales (A&D Precision Scale UC-321; A7D Medical, San Jose, CA). Height and weight were measured according to procedures that have been described in previous publications (108). Height and weight were used, in
conjunction with age, to calculate a standardised BMI Z-score according to WHO growth references (123).

The amount of time spent sleeping per night was measured using a nine point Likert item, with participants responding to the question “During the past 7 days, how much time did you usually spend sleeping per night?” Possible responses began at “less than 5 hours” and increased from “5 hours” to “more than 12 hours” in 1-hour increments. Participants’ sleep time was not altered for the analysis, and was treated as an ordinal variable. The item was written for this questionnaire and did not come from a standardised measure. The item was constructed in order to capture self-reported sleep duration around United States National Sleep Foundation recommended guidelines for adolescents of 8-10 hours per night (124). The specified range of less than five to more than 12 hours per night enabled the identification of students who had failed to achieve at least half of the recommended sleep hours per night, as well as students who had met and exceeded the recommendations. Previous research has shown sleep during adolescence to be associated with both physical activity, and depression (125, 126). The question also enquired specifically about the last seven days, providing the participants with a clear boundary to the time period under investigation – a feature of sleep assessment which has been shown to be important to maximise the accuracy of self-reported sleep among children and adolescents (127).

Demographic variables including, age, gender, area of residence, and school were collected by the survey. The Socio Economic Index For Areas (SEIFA) was used to generate a measure of relative advantage/disadvantage based on participants usual suburb of residence (128). Based on the distribution of
students’ individual SEIFA scores by postcode, a categorical variable was generated, ranging from 1-10 which described which decile of the sample’s socioeconomic advantage/disadvantage distribution for each student.

The paper questionnaire which was used to collect all survey items, along with the data collection sheet which was used to record direct-measured anthropometry are included in Appendix C.

3.1.6 – Data Collection

Data collection took place across multiple sessions within each participating school, on the same day where possible. One or two classes at a time were called to a large room within the school, often a gymnasium or multi-purpose room. Upon arrival students were reminded of the study’s aims, the procedure they would experience as participants, and their right to withdraw from any or all aspects of the study at any time. Class groups were then divided in half, with one half being measured on the anthropometry outcomes, while the other half completed the paper survey. Groups swapped over to complete the remaining measurements at the halfway mark of the session. Sessions typically took approximately one hour – with half an hour being spent on the paper survey, and half an hour on anthropometry measurement at approximately 3 to 5 minutes per child. Anthropometry was measured at one of several stations, each of which was staffed by two data-collectors who double-measured all anthropometry outcomes. If results differed by more than 0.05kg in weight, or 0.5cm in height, a third measure was taken and the result averaged. One data collector ensured that the students waiting to be measured were kept away from participants being measured.
for privacy, and to coordinate the movement of students in and out of measuring stations. A final data collector stayed with the questionnaire group to facilitate the survey and assist students with its completion. At least one staff member from the school was present at all times to meet legal supervisory obligations.

3.1.7 – Ethical Considerations

The methodology described above was given ethical approval by the Deakin University Faculty of Health Human Ethics Advisory Group (HEAG) (Approval Number: 2013_095), the Victorian Government Department of Education (Approval Number 2013_002013) and the Victorian Archdiocese of Melbourne (Approval Number 1909), Ballarat, Sandhurst and Sale. All participants were provided with approved plain language statements and consent forms. (Study approval letters, plain language statements and consent forms are provided in Appendix D).

3.1.8 – Candidate Contribution

Although this study sat within the broader Healthy Together Childrens Evaluation program – several contributions were made by the candidate to the development of both the Healthy Together Childrens Evaluation, providing for the creation of the Victorian Adolescent Lifestyle and Depressive Symptoms Study. Direct contributions to the development of these studies included being part of the team that constructed the battery of tools that comprised the self-report survey. Specifically, the candidate was one of two researchers who reviewed and directly recommended the depressive symptomology measurement tool used here (SMFQ) and Quality of Life index (HRQoL - not analysed in this study). The candidate
had also previously published research in adolescent weight perception and body image, and so provided guidance to the team on the selection of items related to these constructs. Beyond this initial contribution, the candidate led one of the three data collection teams during the pilot phase of the study, and was involved in the collection and entry of data in the pilot phase, and full data collection phases in 2013 and 2014.

3.2 – Study 2: Healthy Adolescent Lifestyle (HAL) Maps

3.2.1 – Summary Study Objectives

The objective of this study was to develop causal loop diagrams of the perceived community-level drivers of adolescent physical activity and diet behaviours, in one community in Victoria, Australia. Workshop participants were drawn from local government, health service providers, and teachers and students from local secondary schools. The methodology for this study has been presented in summary in the publications below. This section describes the methodology employed in the Healthy Adolescent Lifestyle Maps project in greater detail.

3.2.2 – Setting

The workshops were designed using the GMB script literature (83). Scripts guide participants through a series of participatory tasks designed to examine participants’ cognitive representations of interdependent causes and effects of the drivers of a specific problem or situation. Scripts help give structure to the workshop processes, and maximise repeatability and fidelity (63). The workshop
The process which was tested in this study was divided into two 90-minute participatory sessions. Each session was followed by an offline review process conducted by the researchers.

3.2.3 – Participants

Three specific participant groups were identified as populations of interest for the study. Firstly, the local government organisation in the target community had an active health promotion team, funded under a large, whole-of-state preventative health initiative, promoting healthy diet and physical activity behaviours in adolescents. This group had existed for more than two years, and had a mandate to work directly with adolescents in schools within the local government area’s geographic footprint. The group had therefore had extensive exposure to adolescents in this setting, and had been responsible for lifestyle-focused health promotion in this setting. Secondly, the community was host to a broader group of health service providers who were a further population of interest. A variety of private and public providers existed within the community, whose services were available to adolescents from the area. This group was targeted for its experience working with adolescents outside of the school setting, and for working with potentially at-risk or disadvantaged adolescents. Thirdly, secondary school teachers and students were identified as a population of interest. Secondary school teaching staff were targeted because of their direct daily contact with adolescents from the community, and students were targeted for their lived experience negotiating the determinants of adolescent lifestyle behaviours in their community.
3.2.4 – Recruitment Process

Recruitment was conducted using a snowball sampling strategy, beginning with initial, purposive recruitment within the local government health promotion group, who were subsequently asked to recommended contacts in the other two participant populations.

The candidate met with the team leader and health promotion officers from the local government, who agreed to participate in the study, and provided contact details for 15 individuals within the health promotion team. The initial invitation of personnel within the local government organisation led to the recruitment of 13 staff (two were unable to participate due to work commitments), and the recommendation of eight secondary schools, and 11 health service providers.

Based on these recommendations, eight schools were invited to participate, and a total of four schools accepted the invitation. The schools who accepted the invitation were asked to identify one teacher who could participate, along with up to four students. Schools were given discretion over which students to invite, however students in leadership positions, or students with a known interest in health or health-related subjects were suggested as ideal candidates. The recruitment in the schools led to a secondary school participant group of four teaching staff and nine students. Of the four schools who did not accept the invitation, two expressed that the school did not have the time or capacity to send participants to the workshop, and two did not respond to the invitations.
Based on the recommendation of the health promotion team, invitations to participate were extended to representatives from 11 health service providers from within the local government area footprint. In total, four individuals accepted the invitation and were recruited into the study. The organisations represented by these participants included one local youth counselling service, a family health service for disadvantaged groups, a health insurer, and a large regional health service with interests in research, primary care, and service delivery across all age groups. Seven individuals did not accept the invitation with 3 responders citing work commitments that prevented them from participating. One responded to say that her work involved children only and was outside the scope of the workshop content, and one responded to say that her work was situated in an adjacent local government area, and was therefore geographically removed from the community in which the study was based. The remaining two individuals did not respond to the invitation.

Inclusion criteria for local government participants included: working for the local government organisation within the specified community, in a role that is directly or indirectly concerned with adolescent health, or that has led the participant to have some knowledge or special interest in the area of adolescent lifestyle-related health. Inclusion criteria for school teacher participants included: Being either a leading teacher at the school (Principal, assistant principal, or other leading position) or being a teacher at the school with a specialised interest in adolescent health (i.e. health teacher, physical education teacher or equivalent). Inclusion criteria for school student participants included: having been indicated by the school teacher participant at that school as being a mature student, who
could contribute to a discussion around adolescent physical activity and diet behaviours. Exclusion criteria for all groups included any persons who did not work within the local government area under examination, or whose experience was with children or adults to the exclusion of adolescents.

As participants were recruited into the study, they were allocated into one of the two independent workshop groups. Initially, participants were allowed to self-select into whichever workshop stream was more convenient for their work or school schedule. Some participants indicated an ability to participate in either workshop stream, and these participants were allocated by the candidate in order to create equal sample sizes in each group to the extent possible. The composition of each group is shown in Table 4, below. All materials related to the recruitment process described above are provided in Appendix B.

Table 4: Composition of workshop streams one and two.

<table>
<thead>
<tr>
<th>Stream 1</th>
<th>Stream 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LG Health Promotion team</td>
<td>LG Health Promotion team</td>
</tr>
<tr>
<td>Secondary schools</td>
<td>Secondary schools</td>
</tr>
<tr>
<td>School 1</td>
<td>School 3</td>
</tr>
<tr>
<td>Teachers</td>
<td>Teachers</td>
</tr>
<tr>
<td>Students</td>
<td>Students</td>
</tr>
<tr>
<td>School 2</td>
<td>School 4</td>
</tr>
<tr>
<td>Teachers</td>
<td>Teachers</td>
</tr>
<tr>
<td>Students</td>
<td>Students</td>
</tr>
<tr>
<td>Health Service Providers</td>
<td>Health Service Providers</td>
</tr>
<tr>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>
3.2.5 – Group Model Building Workshops

The design of the GMB workshops employed in this study was an extension and refinement of a previous GMB project undertaken investigating complex determinants of educational attainment in regional communities, developed by the candidate during the early stages of this PhD candidature and published in the Journal of Systems Research and Behavioural Science (129) (See Appendix A). The process was developed for a project called “Beyond the Bell” which sought to understand the drivers of low year 12 completion among the adolescent population in a regional Victorian community. The Beyond the Bell GMB process was designed by the candidate for use in a single setting, where the researchers were approached for assistance by a pre-existing and organised stakeholder group. This constituted a different setting from that of the present study and presented similar limitations (lengthy workshop session durations, and leveraging pre-existing community relationships) to those from the obesity-related GMB studies discussed in Chapter 2, Sections 2.2.5 and 2.2.6 above. Consequently, the process was substantially refined and redesigned into the format described below in order to meet the requirements of the multi-site, prevention focussed application described in Chapter 2.

The GMB process which was used in this study was conducted according to a facilitation manual which was developed by the candidate, and contained all information that the facilitation team required on the day to effectively negotiate the workshop tasks with participants. The document included agendas and task timings, along with the scripts that gave thorough descriptions of how each task was to be facilitated. The workshop manual is provided in Appendix C.
The process was also designed to be safe and inclusive for all participants. GMB is closely aligned with the core values of Action Research (130), which include the assumptions that all people are capable of drawing on their own lived experiences and worldviews to collaboratively address real life problems, that the quality of research is enhanced by the inclusion of multiple, diverse viewpoints, and that the inclusion of stakeholders gives voice to community members, building capacity and agency among participants (131). During the introduction to the workshops, participants were assured that their contributions would provide valuable information within the context of the research project, and were assured of the confidentiality of any information they shared. This was intended to assure participants that their participation in the workshops was both valuable for themselves and the community, and that they would not experience any harm as a result of their participation.

3.2.5.1 – Workshop Session One

The first workshop session began with a brief introductory presentation, describing the overall workshop process which participants would experience, as well as a basic overview of adolescent physical activity and nutrition behaviours, and the relationship of these risk factors to adolescent mental illness. Adolescent mental health was introduced as an issue to give impetus to the work of the sessions and the associations between mental health and diet and physical activity were described. The presentation concluded by encouraging participants to concentrate on adolescent diet and physical activity behaviours within their community as the focus of their work.
The first participatory exercise (called Behaviour over Time Graphs) invited participants to identify as many variables as they could in response to the prompt: “What things can you think of which affect or are affected by adolescents’ ability to eat healthily, or be physically active in the [community name] region.” The specific wording of the prompt was based on recommendations from the script literature (83) and other instructional material for conducting GMB in community settings (51). Participants filled in a template for each variable, requiring them to specify the name of the variable, along with their perceived trend in variable behaviour in the past, along with the “hoped” and “feared” trends into the future.

The behaviour over time exercise is designed to elicit a large number of variables that are causally related to the problem, over a short period of time at the beginning of the process. This is intended to minimise the chance that participants will forget or overlook a factor that they perceive to be important during later tasks. Requiring participants to plot the behaviour of each variable from past to future encourages participants to clarify the meaning behind the variable, and ensures that the variable is quantifiable and changes meaningfully over time. An example of a completed template is given in Figure 10.

Participants initially worked individually, before moving into small groups of 3-4 to share their behaviour over time graphs. In their small groups, participants identified 6-10 variables per group that they felt represented the “most important or influential” determinants of adolescent diet or physical activity. After this first round of shortlisting, the small groups then shared their highest priority variables with the entire participant group in a round-robin
fashion, until the 16 most important variables from the small groups had been shared. The prioritisation process was designed to isolate the variables that the group as a whole perceived to be the most important factors related to adolescent physical activity and diet behaviour. This ensured that these variables were included in the CLD, and provided a manageable starting place for the connection circle activity within the constraints of the modelling software used by the facilitation team. Throughout prioritisation, participants were reminded that they would have a chance to reintroduce variables that had not been included in the short list at a later stage.

Figure 10: Behaviour Over Time Graph Describing Adolescents Video Gaming/Screen Time Behaviour
The prioritised variables were projected onto a screen at the front of the room, using a computer-based Systems Dynamics modelling software package. Variables were displayed in a large, circular formation called a “connection circle.” Participants then began the connection circles activity in which they were asked to identify specific causal linkages between the shortlisted variables and describe whether these linkages represented positive or negative relationships. The task of specifying the causal linkages between variables captured individual causal relationships, but framed them within the context of a highly interconnected dynamic system. Each causally connected variable pair was also directly or indirectly related to various other causal relationships in the broader list of variables identified by participants.

Participants were also invited to suggest additional variables to be introduced into the connection circle, either from the full list of variables suggested in the first activity, or any that had come to mind during subsequent discussion. An example of a connection circle which was completed by one of the workshop groups is given in Figure 11, below. The workshop concluded with a discussion of the content of the second session and 5 minutes for questions from participants. Throughout the duration of the workshop session, note-takers recorded participants’ discussions for later reference.

3.2.5.2 – Offline Review One

The process used to revise and clarify the models produced by participants outside of the workshop setting is described here, and referred to henceforth as the “offline review” phase.
During the first workshop, variables were placed arbitrarily around the connection circle. This produced a large number of arrows that “crossed over” making the models visually busy and difficult to read. In order to align with the conventions of causal loop diagramming, which emphasises minimal crossing over of causal arrows (100), the connection circles were reconfigured. The reconfiguration was limited to the spatial rearrangement of variables and arrows, and no actual content was modified at this stage. Figure 12 shows the connection circle from Figure 11, rearranged into an initial CLD after offline review.
Following the construction of the initial CLD, note-takers accounts of the conversations were collaboratively reviewed by two researchers (the candidate and another member of the facilitation team) in order to identify any points of discussion which had not been captured during the workshop, or had been captured incorrectly. The two reviewers checked each line of the workshop notes. Where the reviewers agreed on a connection or variable that was missing or incorrect, the model was updated. Where agreement was not reached, the researchers conferred with other members of the facilitation team, in order to check their understanding of the context and meaning of the notes.
Any additions to the model were made using green connection arrows to enable participants to check the work in the second session. One researcher (the candidate) then made final amendments to the spatial arrangement of the diagrams for clarity of presentation. Variables were spatially rearranged in order to minimise the crossovers of causal arrows, and to maximise the visibility of feedback loops. Figure 13 shows the CLD from Figure 12 after it was subject to review of the written workshop notes.

Figure 13: Causal Loop Diagram After Offline Review

3.2.5.3 – Workshop Session Two

The second session of the workshop commenced with a brief reminder for participants of the purpose and structure of the workshop sessions, and the agenda for the day’s session. The offline review process was also explained to
participants. Particular care was taken to emphasise that the updated CLD was entirely derived from participants’ discussion, and that the content of the model had not been influenced by the researchers. The first participatory activity of the session consisted of a scripted activity where participants used “post-it” notes to provide feedback on the content of the CLD. Specific instruction was given to participants to give feedback indicating which variables, connections, or “parts” of the CLD they felt were correct, or represented something that the group had “gotten right”, as well as variables, connections or parts of the CLD that they felt were incorrect, either because they were irrelevant, had been represented incorrectly by the researchers, or were spaces where important variables or connections were missing from the CLD. Figure 14 shows the post it notes and new causal links which one group placed on a hard copy of the CLD.

This activity fed into the second participatory task of the second session, in which participants suggested amendments to the CLD, based on their written feedback from the first activity of the session. As with the connection circle activity, these changes were recorded and projected onto a screen in real time, with note takers recording the group discussions verbatim. An example of the CLD after participants had discussed their desired amendments is shown in Figure 15.
Figure 14: Causal Loop Diagram with Post-It Note Feedback

Figure 15: Revised Causal Loop Diagram with Participants Amendments
3.2.5.4 – Offline Review Two

Following the second workshop the offline review process was repeated based on the revised CLD and the written notes, to ensure that the map accurately reflected participants’ input, while minimising errors and redundancies. The final maps for each group were communicated back to participants at their home organisation via a short report, which described the overall workshop process, and presented the different stages of CLD development. Electronic and hard copies of the final CLD were also provided. The finalised CLDs from both workshops are presented in the article in Chapter 5, as well as the reports in the appendices. A flowchart of the overall CLD development process is shown in Figure 16.

3.2.5.5 – Social Network Analysis of CLDs

Social Network Analysis (SNA) was used to compare the two groups’ CLDs. The CLDs were treated as unweighted, directed networks, with variables as nodes and causal connections as edges. The CLDs from both groups were subsequently imported into the Gephi software package (Gephi Consortium, Paris) for SNA analyses, and Insight Maker (Scott Fortmann-Roe, San Francisco, CA) (132) for feedback loop Identification.

Gephi was used to report the total number of variables and causal connections in each model. ‘Average degree’ was then calculated, representing the mean number of causal connections per variable in the model. ‘Density’ was also calculated, representing the proportion of all possible causal connections that were actually in the model, ranging from 0 (no connections) to 1 (all possible connections).
Figure 16: Flowchart of the HAL Maps Workshop Stages and Outputs.
‘Out-degree’ and ‘betweenness centrality’ were also calculated in Gephi to identify influential variables in the CLDs. Within the context of CLDs, out-degree can be interpreted as a measure of the direct influence one variable may have over other variables in the CLD. Variables with higher out-degree may be important intervention targets due to their distributed and direct impact on a number of other elements within the system (107). Betweenness centrality indicates variables that act as mediator variables within the model. The betweenness centrality (referred to hereon as ‘betweenness’) of a variable is proportional to the number of shortest pathways between all other variable pairs that a given variable features in. Variables with high betweenness may therefore be interpreted as control variables within a network (133). Compared to out-degree, which only accounts for direct causal relationships, betweenness accounts for the position of a variable within an entire network, and is therefore a more refined measure of model influence. In order to enable easier comparison of variables’ relative influence, according to out-degree and betweenness, scores on both measures are normalised to a common scale, ranging 0 to 1.

The CLDs from both workshop groups were imported into Insight Maker (132), and the ‘identify loops’ function was used to generate a report of all feedback loops in the diagrams.

3.2.6 – Ethical Considerations

Ethical approval was granted by the Deakin University Faculty of Health Human Ethics Advisory Group (Application Number 198_2014), the Victorian Government Department of Education (Application Number 2014_002552) and
the Catholic Archdiocese of Melbourne. Informed consent was obtained from all participants using approved consent forms (Study approval letters, plain language statements and consent forms are provided in Appendix D). The consent forms contained an explanation of the study aims and methodology in simple language. In the case of student participants, the consent forms contained a space for signatures from both the participant and parent/guardian.

3.2.7 – Communication Strategy

The results of the study were communicated back to participants at their home organisations after the finalisation of the CLDs for both workshop groups. For each participant, a “report pack” was created, which included a written summary of the workshop activities they completed, and the outputs from each stage of the workshop (connection circle, initial CLD, finalised CLD), along with a printed copy of the CLD. At the suggestion of some of the teacher participants, students also received a certificate in recognition of their contribution to the project, and participation in extra-curricular activities. Finally, large A1 copies of the CLD were printed, and provided to the individual schools, health service providers, and the office where the local government personnel worked. These materials are included in the appendices at the end of this thesis, in Appendix E.
Chapter 4: Thesis Publication II “Lifestyle factors and adolescent depressive symptomology: Associations and effect sizes of diet, physical activity and sedentary behaviour”

This chapter contains the second paper of this thesis, an epidemiological study examining the associations between adolescent physical activity, sedentary, and diet behaviours, and their reported levels of depressive symptomology. Presented in this chapter is the authorship declaration, completed in accordance with Deakin University’s requirements for thesis by publication, followed by the current version of the article proof from the Journal.

This paper addresses RQ1 of this thesis: “What are the associations and effect sizes attributable to physical activity time, sedentary behaviour, and diet pattern, on depressive symptomology outcomes in a sample of Victorian secondary school students?”

This paper was published by the Australia and New Zealand Journal of Psychiatry in October 2016.
AUTHORSHIP STATEMENT

1. Details of publication and executive author

<table>
<thead>
<tr>
<th>Title of Publication</th>
<th>Publication details</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Name of executive author</th>
<th>School/Institute/Division if based at Deakin; Organisation and address if non-Deakin</th>
<th>Email or phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joshua Hayward</td>
<td>Global Obesity Centre, CPHR, Faculty of Health</td>
<td><a href="mailto:jnh@deakin.edu.au">jnh@deakin.edu.au</a></td>
</tr>
</tbody>
</table>

2. Inclusion of publication in a thesis

Is it intended to include this publication in a higher degree by research (HDR) thesis? Yes / No

If Yes, please complete Section 3 if No, go straight to Section 4.

3. HDR thesis author’s declaration

<table>
<thead>
<tr>
<th>Name of HDR thesis author if different from above. (If the same, write “as above”)</th>
<th>School/Institute/Division if based at Deakin</th>
<th>Thesis title</th>
</tr>
</thead>
<tbody>
<tr>
<td>As above</td>
<td>As above</td>
<td>Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants</td>
</tr>
</tbody>
</table>

If there are multiple authors, give a full description of HDR thesis author’s contribution to the publication (for example, how much did you contribute to the conception of the project, the design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)

JH conceived the paper, composed the initial drafts, oversaw drafting and editing of contributions from other authors, and managed the manuscript to submission. JH designed and conducted all statistical analyses, and assisted with the collection of data.

I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.

| Signature and date | 21/07/2016 |

4. Description of all author contributions

<table>
<thead>
<tr>
<th>Name and affiliation of author</th>
<th>Contribution(s) (for example, conception of the project, design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felice N Jacka</td>
<td>Contributed to drafts and provided expert knowledge in the field of common mental disorders prevention. Assisted with identification and critical review of relevant background CMD literature</td>
</tr>
<tr>
<td>Helen Skouteris</td>
<td>Contributed to drafts and provided expert knowledge in the field of adolescent lifestyle behaviours.</td>
</tr>
<tr>
<td>Name</td>
<td>Contribution</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lynne Millar</td>
<td>Contributed to drafts and provided expert knowledge in the field of adolescent lifestyle behaviours. Assisted with the construction of syntax for analyses.</td>
</tr>
<tr>
<td>Claudia Strugnell</td>
<td>Contributed to drafts and provided expert knowledge in the field of adolescent lifestyle behaviours. Oversaw collection of data.</td>
</tr>
<tr>
<td>Boyd A Swinburn</td>
<td>Contributed to drafts and provided expert knowledge in the field of adolescent lifestyle behaviour. Assisted with interpretation of findings and formulation of discussion.</td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Contributed to drafts and provided expert knowledge in the field of adolescent lifestyle behaviours. Assisted with design of statistical analyses.</td>
</tr>
</tbody>
</table>
5. Author Declarations
I agree to be named as one of the authors of this work, and confirm:
i. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,
ii. that there are no other authors according to these criteria,
iii. that the description in Section 4 of my contribution(s) to this publication is accurate,
iv. that the data on which these findings are based are stored as set out in Section 7 below.

If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further
v. consent to the incorporation of the publication into the candidate’s HDR thesis submitted to Deakin University and, if the higher degree is awarded, the subsequent publication of the thesis by the university (subject to relevant Copyright provisions).

<table>
<thead>
<tr>
<th>Name of author</th>
<th>Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Felice N Jacka</td>
<td>Signature Redacted by Library</td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Helen Skouteris</td>
<td>Signature Redacted by Library</td>
<td>01/08/2016</td>
</tr>
<tr>
<td>Lynne Millar</td>
<td>Signature Redacted by Library</td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Claudia Strugnell</td>
<td>Signature Redacted by Library</td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Boyd A Swinburn</td>
<td>Signature Redacted by Library</td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Signature Redacted by Library</td>
<td>25/07/2016</td>
</tr>
</tbody>
</table>

6. Other contributor declarations
I agree to be named as a non-author contributor to this work.

<table>
<thead>
<tr>
<th>Name and affiliation of contributor</th>
<th>Contribution</th>
<th>Signature* and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* If an author or contributor is unavailable or otherwise unable to sign the statement of authorship, the Head of Academic Unit may sign on their behalf, noting the reason for their unavailability, provided there is no evidence to suggest that the person would object to being named as author

7. Data storage
The original data for this project are stored in the following locations. (The locations must be within an appropriate institutional setting. If the executive author is a Deakin staff member and data are stored outside Deakin University, permission for this must be given by the Head of Academic Unit within which the executive author is based.)

<table>
<thead>
<tr>
<th>Data format</th>
<th>Storage Location</th>
<th>Date lodged</th>
<th>Name of custodian if other than the executive author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written survey &amp; Direct measure anthropometry</td>
<td>Locked storage cabinets, locked office. Global Obesity Centre Office [D1.101, Waterfront Campus]</td>
<td>2014</td>
<td>Claudia Strugnell</td>
</tr>
</tbody>
</table>
This form must be retained by the executive author, within the school or institute in which they are based. If the publication is to be included as part of an HDR thesis, a copy of this form must be included in the thesis with the publication.
Lifestyle factors and adolescent depressive symptomatology: Associations and effect sizes of diet, physical activity and sedentary behaviour

Joshua Hayward1, Felice N Jacka2,3, Helen Skouteris4, Lynne Millar1, Claudia Strugnell1, Boyd A Swinburn1,5 and Steven Allender1

Abstract

Objective: Depression affects many Australian adolescents. Research points to the potential of lifestyle improvement for the population-level prevention of mental disorders. However, most studies examine single relationships without considering the combined contribution of lifestyle factors to variance in depression. This study examined associations between adolescent diet, physical activity and screen time behaviours and depressive symptomatology.

Methods: A cross-sectional sample of year 8 and 10 students was recruited from 23 participating schools in 18 Victorian communities. Students were recruited using opt-out consent, resulting in 3295 participants from 4680 registered school enrolments (Participation Rate: 70.4%). Participants completed a supervised self-report questionnaire comprising Moods and Feelings Questionnaire–Short Form, an assessment of physical activity and sedentary behaviours during and outside school, and weekly food intake. Surveyed covariates included hours of sleep per night, age, socio-economic status and measured anthropometry. A hierarchical regression stratified by gender was conducted, with dichotomised Moods and Feelings Questionnaire–Short Form score as the outcome, and screen time, physical activity and dietary patterns as predictors. Nested regression analyses were then conducted to ascertain the variance in Moods and Feelings Questionnaire–Short Form score attributable to each significant predictor from the initial regression.

Results: Increased scores on an unhealthy dietary pattern (odds ratio = 1.18; 95% confidence interval = [1.07, 1.32]) and physical activity guideline attainment (0.91; [0.85, 0.97]) were associated with depressive symptomatology in males, while screen time guideline attainment (0.95; [0.91, 0.98]) was associated with depression in females. No association was observed between healthy diet pattern and Moods and Feelings Questionnaire–Short Form. Overall, effect sizes were generally small, and the regression model accounted for 5.22% of Moods and Feelings Questionnaire–Short Form variance.

Conclusion: Gender-specific associations were observed between physical activity and both sedentary and dietary behaviours and depressive symptomatology among adolescents, although reverse causality cannot be refuted at this stage. Lifestyle behaviours may represent a modifiable target for the prevention of depressive symptomatology in adolescents.

Keywords
Depressive symptomatology, adolescents, diet pattern, physical activity, screen time

1Global Obesity Centre, Centre for Population Health Research, Deakin University, Geelong, VIC, Australia
2Food & Mood Centre, Deakin University, Geelong, VIC, Australia
3IMPACT Strategic Research Centre, Deakin University, Geelong, VIC, Australia
4School of Psychology, Deakin University, Geelong, VIC, Australia
5School of Population Health, The University of Auckland, Auckland, New Zealand

Corresponding author:
Joshua Hayward, Global Obesity Centre, Centre for Population Health Research, Deakin University, 1 Gheringhap St, Geelong, VIC 3220, Australia. Email: jnh@deakin.edu.au
Introduction
Depressive disorders are responsible for 2.5% of global disease burden and are the fourth highest cause of disease burden in Australasia (Murray et al., 2012). One in six (15%) Australian adolescents reported symptoms of depression in 2007 (Slade et al., 2009). A South Australian study of adolescents reported that the prevalence of major depression increased between 1998 (7%) and 2008 (10%) (Goldney et al., 2010). Adolescence is a particularly important period for mental disorder onset; the average age of onset for depression may be as low as 13 years in Western populations (Merikangas et al., 2010), and half of all adult mental disorders have their onset during adolescence (Belfer, 2008).

Despite this, 16- to 24-year-olds are the least likely age group to access mental health services (Slade et al., 2009). Alcohol consumption, tobacco use, unhealthy diet and a lack of physical activity are all associated with and may increase the risk of adolescent depression (Cairns et al., 2014). Physical activity, sedentary behaviour and unhealthy diet are particularly promising targets (Jacka et al., 2013) amenable to large-scale population intervention (Hayward et al., 2014) and which have featured in recent clinical practice guidelines for the management of depression (Malhi et al., 2015).

Many studies have reported associations between either diet quality or physical activity/sedentary behaviour and depressive symptoms. One prospective study of 3040 Australian adolescents found that healthy diet was associated with better mental health and unhealthy diet with worse mental health cross-sectionally, while healthy diet also predicted better mental health over time (Jacka et al., 2011). A cross-sectional study of 1324 West Australian adolescents found that those with a healthy diet had better mental health using the Child Behaviour Checklist (Oddy et al., 2009). Similarly, the Australian Healthy Neighbourhoods Study found those reporting consistently healthy or unhealthy diet patterns reported more or less depressive symptoms, respectively, even after adjustment for a range of important familial factors (Jacka et al., 2010). The results of a systematic review support a relationship between unhealthy diet and depression in children and adolescents (O’Neil et al., 2014).

Evidence for the association between physical activity/ sedentary behaviour and reduced depressive symptoms in Australian adolescents has been supported by other studies. A study of over 8000 adolescents from Victoria, New South Wales and Queensland found meeting physical activity guidelines was associated with reduced depressive symptomatology (odds ratio OR = 0.62; 95% confidence interval [CI] = [0.44, 0.88]) as did attainment of the screen time (ST) guidelines among 12- to 14-year-old participants (OR = 0.77; 95% CI = [0.59, 0.99]) (Kremer et al., 2014).

While many studies have examined the diet–depression and physical activity/sedentary behaviour–depression associations, few have done so in the same analysis. Of those examining these relationships together, one study reported associations between sedentary time and depressive symptomatology in both male and female adolescents and between sweetened beverage consumption and depressive symptomatology in females (Hoare et al., 2014a). The lack of studies of Australian adolescents examining the possible contribution of physical activity and dietary patterns to the variance in depressive symptomatology simultaneously represents a gap in the literature. Thus, we aimed to establish the associations and relative contribution of each factor, singly and in combination, to the variance in depressive symptoms within a sample of male and female adolescents.

Methods
The methods are presented in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting on observational studies (von Elm et al., 2007).

Setting
Data for this study were drawn from the baseline assessment of adolescents participating in a cluster-randomised control trial on adolescent anthropometry and obesogenic behaviours (Strugnell et al., 2015). Participants were recruited from year 8 (aged 14–16) and 10 (aged 16–19) classes in consenting secondary schools and data collected during school term 3 (July–September) 2014. No significant differences were observed between intervention and comparison communities for body mass index (BMI) Z-score at baseline, allowing the data to be combined for cross-sectional analysis.

Participants and recruitment
Participants were 3295 year 8 and 10 secondary school students from 18 communities across Victoria, Australia. Within each community, secondary schools were randomised, and three were invited to participate. Where no schools agreed to participate, additional schools were invited in groups of three until a participant school consented. In total, 146 schools were invited and 23 schools accepted (school response rate of 16%).

All eligible students in each school were invited to participate. Opt-out consent was used and a letter containing the plain language statement and consent forms was sent home. Students were considered to have provided informed consent unless the student or their parent/guardian withdrew them from the study, and verbal consent was confirmed with students again at the time of measurement. Of 4680 students invited from consenting schools, 4127 consented to participate (relative risk [RR] = 88%). After absences, n = 3295 students were available on data collection days, with data collected from n = 1528 students from year 8 and n = 1767 students from year 10.
Measures

The dependent variable, depressive symptomatology, was measured using the Moods and Feelings Questionnaire—Short Form (SMFQ; Angold et al., 1995). The SMFQ has been used reliably in other community-based studies with adolescent populations (Chipman et al., 2007) and asks participants to endorse 13 symptoms of depression as ‘not true’ (coded 0), ‘sometimes true’ (coded 1) or ‘true’ (coded 2) for the last 2 weeks. Examples of individual symptoms include ‘I felt miserable or unhappy’, ‘I felt so tired I just sat around and did nothing’ and ‘I hated myself’. Possible scores range from 0 to 26, and the measure was dichotomised using a validated cut point of 8, indicating probable depression (referred to henceforth as ‘depressive symptomatology’) with a specificity of 60% and sensitivity of 85% for clinical depression in adolescent participants (Angold et al., 1995).

Dietary intake was measured using the Simple Dietary Questionnaire (SDQ; Parletta et al., unpublished). Items from this questionnaire were used to measure consumption of fruit, vegetable, takeaway, energy-dense nutrient-poor snack foods, sugar-sweetened beverages (SSBs), caffeinated beverages and sweetened and plain dairy foods. Up to 25 different food groups can be measured using the SDQ; however, the above categories were prioritised due to study constraints. Participants indicated the average number of fruit and vegetable servings they had consumed per day over the week preceding the survey. Possible responses range from none to more than seven serves per day. The SDQ has been tested in Australian adolescents and demonstrates good test–retest reliability over 1–2 weeks and good validity when assessed against a 24-hour food recall. Vegetable consumption demonstrated test–retest reliability of $r = 0.76$, $p < 0.05$ and validity of $r = 0.42$, $p < 0.05$; fruit consumption performed similarly: test–retest $r = 0.73$, $p < 0.05$; validity $r = 0.57$, $p < 0.05$ (Parletta et al., in press).

Moderate–vigorous physical activity (MVPA) time and ST were measured using an item from the Core Indicators and Measures of Youth Health Survey (Kroeker et al., 2012). Students responded to a 6-point scale for each of the 7 days preceding the survey representing total MVPA minutes. Options included none, 1–14 minutes, 15–29 minutes, 30–59 minutes, 1–2 hours and more than 2 hours. Test–retest reliability for this item was moderate overall, with responses for individual days ranging from $\kappa = 0.42$ (Friday) to 0.51 (Tuesday). The ST measure asked students to indicate screen-based ST for the 7 days preceding the survey on a 5-point scale for each day, with responses including none, less than 1 hour, 1–2 hours, 2–5 hours and more than 5 hours. Test–retest reliability for this item was moderate overall, $\kappa$ ranging from $= 0.43$ (Saturday) to 0.52 (Thursday/Sunday). Responses to these items were dichotomised according to whether the participant attained the Australian guideline for MVPA (>1 hour/day) (Commonwealth Department of Health, 2014) or ST (<2 hours/day) on each day, and categorical variables were generated to specify the number of days in the preceding week that the participant attained the MVPA and ST guidelines.

Covariates

Sleep was measured using a 9-point scale, with participants responding to the question ‘During the past 7 days, how much time did you usually spend sleeping per night?’ Possible responses began at ‘less than 5 hours’ and increased to ‘more than 12 hours’ in 1-hour increments. Previous research has shown sleep during adolescence to be associated with both physical activity and depression (Kredlow et al., 2015; Sivertsen et al., 2014). The item was written for this questionnaire and was constructed to capture self-reported sleep duration around US National Sleep Foundation recommendation of 8–10 hours per night for adolescents (Hirshkowitz et al., 2015). The question was time-bound to the preceding week to maximise accuracy in self-reporting (Matricciani, 2013).

Height and weight were measured by trained data collectors, using Charder HM200P stadiometers (Charder HM200P Portadal; Charder Electronic Co. Ltd, Taichung City, Taiwan) and A&D UC-321 scales (A&D Precision Scale UC-321; A7D Medical, San Jose, CA, USA). Height and weight were measured according to standardised procedures that have been described in previous publications (Strugnell et al., 2015). If results differed by more than 0.05 kg in weight, or 0.5 cm in height, a third measure was taken and the result averaged. Height and weight were used, in conjunction with age, to calculate BMI-for-age $Z$-score according to World Health Organization (WHO) growth references (De Onis et al., 2007).

Date of birth was collected to calculate age in years. Postcode was collected to identify economic advantage/disadvantage of the participants’ usual area of residence according to the Australian Bureau of Statistics’ Socio-Economic Index for Areas (SEIFA; Australian Bureau of Statistics, 2006). Participants’ SEIFA scores were divided by decile and used in all analyses as a categorical variable.

Ethical approval for this study was given by the Deakin University Human Research Ethics Committee (ref 2013_095), the Victorian Government Department of Education and Training (ref 2013_002013) and the Catholic Education Offices, Archdiocese of Melbourne, Ballarat, Sandhurst and Sale.

Statistical methods

Principal component analysis (PCA) was used in order to determine the underlying patterns in participants’ dietary
behaviour. Fruit and vegetable serves per day, frequency of consumption of takeaway foods, snack foods, SSBs and sweetened and unsweetened dairy foods were included in the analysis. The resulting components were subjected to an equamax rotation, and factors with loadings $\geq 0.3$ were retained. Based on the recommendations of Tabachnick and Fidell (2013), factors with an eigenvalue $\geq 1$ were retained in order to exclude components with less explanatory power than the individual dietary variables.

A hierarchical logistic regression was designed, with dichotomised SMFQ as the outcome. The regression was stratified by gender as previous studies have shown gender difference in the MVPA and physical activity/ST-depression associations (Hoare et al., 2014a). Model 1 was an unadjusted model with only the independent variables of physical activity and ST guideline attainment days, and diet pattern and the dependent variable – dichotomised SMFQ scores – entered into the model. Model 2 included Model 1 with the addition of age and SEIFA deciles. The final model, Model 3, was the fully adjusted model, which comprised Model 2 with the addition of sleep and BMI Z-scores.

Nested hierarchical regression models were used to observe the model $R^2$ attributable to each significant predictor of dichotomised SMFQ from the hierarchical regression model. The fully adjusted model was re-run once for each significant predictor, and the change in $R^2$ (referred to onwards as $\Delta R^2$) was observed after the predictor was removed from the model. Statistical significance was determined using likelihood ratio tests.

**Results**

**Descriptive statistics**

Students reported meeting the physical activity guidelines on average, 2.49 (standard deviation [SD] = 2.25) days out of the week preceding the survey, although year 8 students were slightly more active than year 10 students (year 8 $m = 2.62$ days, year 10 $m = 2.38$ days, $t = 3.06, p < 0.001$). Students reported meeting the ST guidelines on average, 3.55 (SD = 2.85) days out of the week preceding the survey, and again, year 8 students more frequently met the guidelines (year 8 $m = 3.81$ days, year 10 $m = 3.32$ days, $t = 4.94, p < 0.001$).

Attainment of the guidelines for at least two serves of fruit on a usual day was reported by 67% of students, with a small but significant difference by year level (year 8 = 70%, year 10 = 65%, $\chi^2 = 10.10, p < 0.01$). Attainment of the guidelines for at least five serves of vegetables on a usual day was reported by only 7% of students, with no significant difference by year level. When examined for attainment of both the fruit and vegetable intake guidelines, 6% of students met both guidelines simultaneously. Descriptive statistics for the broader set of study measures are provided in Table 1.

**PCA**

The PCA revealed three factors with an eigenvalue above 1.00, so the first three factors were investigated for use in the analysis. The PCA was then re-run specifying a three-factor solution, and the loadings of the individual dietary intake variables were examined in order to interpret the factors.

The first factor had strong positive loadings for consumption of takeaway foods, sweetened beverages, caffeinated beverages and energy drinks. The second factor had strong positive loadings on serves of fruits and vegetables per day. The third factor had strong positive loadings on consumption of snack foods, sweetened dairy and plain dairy foods. The first factor was labelled the ‘unhealthy’ diet pattern, the second factor the ‘healthy’ pattern and the third the ‘snacking’ pattern. Internal consistency within the factors ranged from 0.38 to 0.72, and the factors were weakly correlated (Table 2).

**Regression analysis**

The unadjusted regression model (Table 3) showed that for male participants, higher scores on the unhealthy diet pattern were associated with higher probability of an SMFQ score of 8 or more. Additionally, every additional day on which male participants attained the recommended guidelines for physical activity was associated with a reduction in the probability of an SMFQ score greater than 8. Among female participants, every additional day on which participants attained the recommended guidelines for screen time was associated with a reduction in the probability of depressive symptomatology. Healthy dietary pattern scores and the snacking dietary pattern scores were not significantly associated with SMFQ in either gender.

The significant associations from the unadjusted model remained significant after both the partial and full adjustment for the additional modifiable lifestyle-related factors, while healthy and snacking dietary pattern associations remained non-significant in all models. In both the partially and fully adjusted models, age and SEIFA decile were not significantly associated with SMFQ. In the fully adjusted model, however, both male and female participants who reported sleeping more hours on a usual night had a lower likelihood of depressive symptomatology. Increased BMI Z-score was associated with a higher likelihood of depressive symptomatology in female participants only.

$\Delta R^2$ analyses

The $\Delta R^2$ analyses (Table 4) found that the fully adjusted regression model accounted for 5.2% of the variance in the dichotomised SMFQ score for male participants and 6.0% of the variance for females. Table 4 presents the set of nested regression analyses, which tested the change in
**Table 1.** Descriptive statistics.

<table>
<thead>
<tr>
<th>Continuous variables</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>15.14</td>
<td>1.12</td>
</tr>
<tr>
<td>BMI Z-score</td>
<td>0.47</td>
<td>1.14</td>
</tr>
<tr>
<td>SMFQ</td>
<td>4.82</td>
<td>5.34</td>
</tr>
<tr>
<td>SEIFA</td>
<td>972.17</td>
<td>64.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Categorical variables</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity guideline attainment (days in last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>⩽4</td>
<td>2619</td>
<td>79.48</td>
</tr>
<tr>
<td>5–6</td>
<td>389</td>
<td>11.81</td>
</tr>
<tr>
<td>7</td>
<td>287</td>
<td>8.71</td>
</tr>
<tr>
<td>Screen time guideline attainment (days in last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>⩽4</td>
<td>1757</td>
<td>53.32</td>
</tr>
<tr>
<td>5–6</td>
<td>681</td>
<td>20.64</td>
</tr>
<tr>
<td>7</td>
<td>858</td>
<td>26.04</td>
</tr>
<tr>
<td>Veggie serves/day (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td>2985</td>
<td>92.44</td>
</tr>
<tr>
<td>5–6</td>
<td>180</td>
<td>5.58</td>
</tr>
<tr>
<td>7 or more</td>
<td>64</td>
<td>1.98</td>
</tr>
<tr>
<td>Fruit serves/day (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2</td>
<td>1029</td>
<td>31.77</td>
</tr>
<tr>
<td>2–4</td>
<td>1773</td>
<td>54.79</td>
</tr>
<tr>
<td>5 or more</td>
<td>435</td>
<td>13.44</td>
</tr>
<tr>
<td>Takeaway serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>2624</td>
<td>81.13</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>580</td>
<td>17.94</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>30</td>
<td>0.93</td>
</tr>
<tr>
<td>Sweetened beverage serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>1622</td>
<td>50.05</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>1148</td>
<td>35.39</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>472</td>
<td>14.56</td>
</tr>
<tr>
<td>Snack food serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>820</td>
<td>25.45</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>1382</td>
<td>42.86</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>1021</td>
<td>31.69</td>
</tr>
<tr>
<td>Caffeinated drink serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>2136</td>
<td>65.76</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>824</td>
<td>25.34</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>289</td>
<td>8.90</td>
</tr>
<tr>
<td>Energy drink serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>3051</td>
<td>93.96</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>150</td>
<td>4.62</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>46</td>
<td>1.42</td>
</tr>
<tr>
<td>Sweet dairy serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>2107</td>
<td>65.06</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>931</td>
<td>28.76</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>200</td>
<td>6.18</td>
</tr>
<tr>
<td>Plain dairy serves (last week)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never to once a week</td>
<td>810</td>
<td>25.05</td>
</tr>
<tr>
<td>Twice a week to daily</td>
<td>1546</td>
<td>47.77</td>
</tr>
<tr>
<td>Twice daily or more</td>
<td>879</td>
<td>27.18</td>
</tr>
<tr>
<td>Dichotomised SMFQ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No depressive symptomatology</td>
<td>2587</td>
<td>78.45</td>
</tr>
<tr>
<td>Depressive symptomatology</td>
<td>710</td>
<td>21.55</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1790</td>
<td>54.25</td>
</tr>
<tr>
<td>Female</td>
<td>1507</td>
<td>45.75</td>
</tr>
<tr>
<td>Sleep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>⩽6 hours</td>
<td>467</td>
<td>14.84</td>
</tr>
<tr>
<td>7–9 hours</td>
<td>2235</td>
<td>70.99</td>
</tr>
<tr>
<td>⩾10 hours</td>
<td>446</td>
<td>14.17</td>
</tr>
<tr>
<td>Weight status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underweight/normal</td>
<td>1991</td>
<td>68.92</td>
</tr>
<tr>
<td>Overweight</td>
<td>620</td>
<td>21.46</td>
</tr>
<tr>
<td>Obese</td>
<td>279</td>
<td>9.62</td>
</tr>
</tbody>
</table>

SD: standard deviation; BMI: body mass index; SMFQ: Moods and Feelings Questionnaire–Short Form; SEIFA: Socio-Economic Index for Areas.
explained SMFQ variance when a variable was removed from the fully adjusted model and subsequently re-entered. For each variable, the ‘Remove [variable]’ line shows the amount of variance explained by the model when the specified variable is not considered. The difference in model $R^2$ caused by the removal of that variable from the fully adjusted model is given in the $\Delta R^2$ column, along with the significance associated with that change. Only the significant associations from the fully adjusted model in each gender were tested.

Unhealthy dietary pattern scores and physical activity guideline attainment in males and ST guideline attainment and BMI $Z$-score in females all contributed a small but significant amount of explained variance in SMFQ scores in the model (<1.0%). Sleep, however, contributed a much larger share of variance explained in the adjusted model, explaining 1.9% of SMFQ variance in males and 3.4% in females.

Discussion

In this sample of Australian adolescents, multiple behavioural risk factors were associated with an increased probability of depressive symptomatology. Factors associated with increased odds of depressive symptomatology differed by gender. On average, male adolescents with unhealthy diet and low physical activity were more likely to experience depressive symptomatology. For males, a 1 SD increase in unhealthy dietary pattern was associated with an 18% increase in likelihood of depressive symptoms, while every day of physical activity guideline attainment was associated with a 9% decrease. Female adolescents of increased weight status and high levels of ST were also more likely to experience depressive symptoms. For females, every day of ST guideline attainment was associated with a 5% reduction in the probability for depressive symptomatology, while a 1-point increase in BMI $Z$-score was associated with a 20% increase in the likelihood of depressive symptomatology. Sleep was the only risk behaviour that was associated with depressive symptomatology in both genders, with both males and females who had more sleep less likely to experience depressive symptoms. For males, every additional hour of sleep per night was associated with a 22% reduction in the probability of depressive symptomatology, and in females, every additional hour reduced the odds by 26%.

The positive association among males between unhealthy dietary patterns and depressive symptomatology was consistent with previous findings (Jacka et al., 2010, 2011; Oddy et al., 2009). This appears to be a robust finding.
Hayward et al.

as different studies that have produced similar results have used a range of tools, including diet quality scores, frequency of consumption for specific food groups and food frequency questionnaires (O’Neil et al., 2014). The findings from this study add further support to the growing understanding of the role of nutrition in adolescent mental health (O’Neil et al., 2014).

Our finding of no association between healthy dietary patterns and depressive symptomatology is inconsistent with many previous findings. Studies have reported decreased likelihood of depressive symptomatology for adolescents reporting healthy dietary patterns (Jacka et al., 2010, 2011). In this study, only fruit and vegetable intake variables made up the healthy dietary factor score. Other studies with scores comprising more items capturing the intake of healthy foods, such as wholegrains, fish, legumes and so on, have consistently shown inverse relationships between healthy dietary patterns and depression. For example, several studies have reported that higher adherence to a ‘Mediterranean’ diet pattern is protective against depression (Psaltopoulou et al., 2013; Sánchez-Villegas et al., 2009). It may be the case that the lack of significant

Table 3. Regression model for diet pattern and physical activity/screen time on dichotomous SMFQ.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>Robust SE</td>
</tr>
<tr>
<td>Unadjusted model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unhealthy dietary pattern</td>
<td>1.25 0.06</td>
<td>[1.14, 1.37]</td>
</tr>
<tr>
<td>Healthy dietary pattern</td>
<td>1.03 0.07</td>
<td>[0.91, 1.18]</td>
</tr>
<tr>
<td>Snacking dietary pattern</td>
<td>0.89 0.07</td>
<td>[0.77, 1.04]</td>
</tr>
<tr>
<td>PA attainment days</td>
<td>0.92 0.03</td>
<td>[0.86, 0.99]</td>
</tr>
<tr>
<td>ST attainment days</td>
<td>0.96 0.02</td>
<td>[0.91, 1.00]</td>
</tr>
<tr>
<td>Partially adjusted model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unhealthy dietary pattern</td>
<td>1.23 0.06</td>
<td>[1.11, 1.35]</td>
</tr>
<tr>
<td>Healthy dietary pattern</td>
<td>1.01 0.06</td>
<td>[0.90, 1.14]</td>
</tr>
<tr>
<td>Snacking dietary pattern</td>
<td>0.90 0.07</td>
<td>[0.77, 1.06]</td>
</tr>
<tr>
<td>PA attainment days</td>
<td>0.92 0.03</td>
<td>[0.86, 0.99]</td>
</tr>
<tr>
<td>ST attainment days</td>
<td>0.96 0.02</td>
<td>[0.92, 1.01]</td>
</tr>
<tr>
<td>Age</td>
<td>1.05 0.08</td>
<td>[0.90, 1.22]</td>
</tr>
<tr>
<td>SEIFA decile</td>
<td>0.97 0.04</td>
<td>[0.89, 1.05]</td>
</tr>
<tr>
<td>Fully adjusted model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unhealthy dietary pattern</td>
<td>1.18 0.06</td>
<td>[1.07, 1.32]</td>
</tr>
<tr>
<td>Healthy dietary pattern</td>
<td>1.04 0.06</td>
<td>[0.93, 1.17]</td>
</tr>
<tr>
<td>Snacking dietary pattern</td>
<td>0.97 0.07</td>
<td>[0.83, 1.12]</td>
</tr>
<tr>
<td>PA attainment days</td>
<td>0.91 0.03</td>
<td>[0.85, 0.97]</td>
</tr>
<tr>
<td>ST attainment days</td>
<td>0.98 0.02</td>
<td>[0.93, 1.03]</td>
</tr>
<tr>
<td>Age</td>
<td>1.04 0.08</td>
<td>[0.90, 1.21]</td>
</tr>
<tr>
<td>SEIFA decile</td>
<td>0.95 0.04</td>
<td>[0.86, 1.04]</td>
</tr>
<tr>
<td>Sleep (hours/night)</td>
<td>0.78 0.04</td>
<td>[0.70, 0.87]</td>
</tr>
<tr>
<td>BMI-Z</td>
<td>1.08 0.07</td>
<td>[0.96, 1.22]</td>
</tr>
</tbody>
</table>

SMFQ: Moods and Feelings Questionnaire–Short Form; SE: standard error; OR: odds ratio; CI: confidence interval; PA: physical activity; ST: screen time; SEIFA: Socio-Economic Index for Areas; BMI: body mass index.
Table 4. Examination of $R^2$ change in depressive symptomatology attributable to dietary patterns, physical activity, screen time, sleep and BMI-Z

<table>
<thead>
<tr>
<th>Model</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model $R^2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>p</td>
<td>$\Delta R^2$</td>
</tr>
<tr>
<td>Adjusted regression model – $R^2$ total</td>
<td>0.0522</td>
<td>&lt;0.0190</td>
</tr>
<tr>
<td>Remove unhealthy diet</td>
<td>0.0427</td>
<td>0.0095</td>
</tr>
<tr>
<td>Remove PA attainment</td>
<td>0.0458</td>
<td>0.0064</td>
</tr>
<tr>
<td>Remove ST attainment</td>
<td>n/s</td>
<td>&lt;0.0190</td>
</tr>
<tr>
<td>Remove sleep</td>
<td>0.0332</td>
<td>0.0035</td>
</tr>
<tr>
<td>Remove BMI Z-score</td>
<td>n/s</td>
<td>0.0060</td>
</tr>
</tbody>
</table>

BMI: body mass index; PA: physical activity; ST: screen time.

association between healthy diet and depressive symptoms in this study is attributable to the use of a less sophisticated dietary measurement tool than previous studies.

The association between ST guideline attainment and depressive symptomatology was partially consistent with a previous Australian study (Hoare et al., 2014a), which found that exceeding the guidelines of 2 hours of ST per day increased the odds of depressive symptomatology for both males and females, but found no association between physical activity and depressive symptomatology. These differences may be attributable to the measurement tools used, as physical activity was classified as low, moderate or high based on the previous day’s activity, and ST attainment was estimated based on the preceding weekday and weekend, while this study asked participants to recall each of the last 7 days.

Consistent with our findings, Kremer et al. (2014) observed a significant association between self-reported physical activity and reduced likelihood of depressive symptomatology, yet they found no support for the ST association. That analysis, however, used a single survey item to ask participants to estimate their daily physical activity and ST behaviour in a ‘normal’ week, and also did not stratify the analyses by gender, which may have masked the significance of the ST association in girls, if a true gender difference does exist in this association.

The analysis regarding depressive symptom variance attributable to the significant predictors identified that unhealthy dietary patterns and physical activity guideline attainment in males and ST guideline attainment and BMI Z-score in females were responsible for a small proportion of the variance in SMFQ scores. While the sleep association was significant in both genders, and explained a moderate proportion of model variance (1.90% in males, 3.41% in females), the overall effect remained small. Individual studies have reported significant, but often small effects for many risk factors, including socio-economic and community factors (Stirling et al., 2015), family structure and self-perception (Klasen et al., 2015) and modifiable lifestyle behaviours including drug use, sexual behaviours, religious practices, sleep, weight and many others (Cairns et al., 2014). There appears to be a broad base of small, yet important modifiable risk factors that may expose the adolescent population to increased depressive symptomatology risk. Although the proportion of variance explained is small, given the high prevalence of depression in the population, poor diet, reduced physical activity, increased sedentary behaviour, inadequate sleep and high BMI-Z may translate to a significant burden at the population level.

These data were drawn from a large, population-based sample spanning broad geographical and demographic areas across Victoria. The sample for this study was recruited using an opt-out recruitment process, which was the first of its kind for a population-based study of adolescents in Victoria. Opt-out consent did not appear to place participants at risk of adverse outcomes (Lacy et al., 2012), and no formal complaints were raised by participants during this study. Opt-out consent also greatly ameliorated the poor opt-in response rate observed in the pilot for this study, which was around 10%. Response rate at the school level remained low at 16%. This may have biased the sample at the school level if non-participation was caused by non-random factors (i.e. non-participation due to time/resource constraints); however, reasons for non-participation were not assessed.

In interpreting these results, it should be considered that the measures for physical activity, ST, diet behaviours, depressive symptomatology and all covariates (with the exclusion of direct-measured anthropometry) were self-reported. Self-report can be subject to respondent bias and recall errors (affecting, for example, estimation of portion sizes). In a study with such a large sample as this, however, the use of more direct measures for these behaviours (i.e. accelerometry, food diaries, etc.) would have created prohibitive logistical and cost burden. Data on other possible effect modifiers were not collected in this sample (e.g. body image, social support and anxiety).
These data are cross-sectional and longitudinal data would be needed to infer causal relationships between the health behaviours examined and depressive symptomatology. One risk is potential reverse causality in the diet–depressive symptom relationship (Jacka et al., 2015), although this has been extensively investigated in many of the prospective studies in the adult literature and the data do not support this as an explanation for the relationships observed (e.g. Jacka et al., 2015). A recent systematic review of the sedentary behaviour–depressive symptomatology relationship suggests that current evidence is thus far inadequate for inferring causality (Hoare et al., 2014b).

The evidence points to the potential for prevention (Jacka et al., 2012), and next steps should include randomised controlled trials of behaviour change interventions targeting sedentary and dietary behaviours to alleviate depressive symptomatology among adolescents. These results also suggest that mental health outcomes should be more widely incorporated into the evaluation of large, population-based health promotion activities. This study supports small but important associations between lifestyle behaviours and depressive symptomatology. This is positive news, given that previous interventions in other lifestyle-related disease prevention fields have successfully modified these behaviours in children and adolescents (Waters et al., 2011).

Conclusion

Meeting the physical activity guidelines on fewer days per week and adhering more closely to an unhealthy diet pattern were associated with greater risk of displaying significant depressive symptomatology for males in this study. Females who met the ST guidelines on fewer days and who had higher BMI-Z were also at greater risk, as were any adolescents who reported sleeping fewer hours per night regardless of their gender.

Acknowledgements

Allender, Millar and Strugnell are researchers within a National Health and Medical Research Council (NHMRC) Centre for Research Excellence in Obesity Policy and Food Systems (APP1041020). Felice Jacka has received Grant/Research support from the Brain and Behaviour Research Institute, the NHMRC, Australian Rotary Health, the Goolongong Medical Research Foundation, the Ian Potter Foundation, Eli Lilly, the Meat and Livestock Board, Woolworths Limited and The University of Melbourne and has received speakers honoraria from Sanofi-Synthelabo, Janssen Cilag, Servier, Pfizer, Health Ed, Network Nutrition, Angelini Farmaceutica, and Eli Lilly. She is the president of the International Society for Nutritional Psychiatry Research (ISNPR) and the Alliance for the Prevention of Mental Disorders. She is supported by an NHMRC Career Development Fellowship (2) (11108125). Allender is supported by funding from an Australian NHMRC/Australian National Heart Foundation Career Development Fellowship (APP1045836). Allender is supported by US National Institutes of Health grant titled Systems Science to Guide Whole-of-Community Childhood Obesity Interventions (1R01HL115485-01A1). Jacka is supported by an NHMRC Career Development Fellowship (APP108125). Millar is supported by an Alfred Deakin Postdoctoral Fellowship. We would like to acknowledge the support from the Victorian Department of Health and the Victorian Department of Education and Early Childhood Development.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

This work was supported by the Australian National Health and Medical Research Council (NHMRC)/Australian National Heart Foundation (grant number APP1045836), the NHMRC (grant number APP1041020), the US National Institutes of Health (grant number 1R01HL115485-01A1) and the National Heart Foundation (grant number 100259) and Deakin University.

References


Chipman P, Jorm AF, Priest M, et al. (2007) No interaction between the serotonin transporter polymorphism (5-HTTLPR) and childhood adversity or recent stressful life events on symptoms of depression: Results from two community surveys. American Journal of Medical Genetics, Part B: Neuropsychiatric Genetics 144: 561–565.


Hoare E, Millar L, Fuller-Tyszkiewicz M, et al. (2014a) Associations between obesogenic risk and depressive symptomatology in Australian adolescents who reported sleeping fewer hours per night regardless of their gender.


Parletta N, Fresnham L, Peters J, O’Dea K, Hsiaoopoulos C. Validation of a Simple Dietary Questionnaire with adolescents in an Australian population, unpublished.


This chapter contains the third paper of this thesis, reporting on the development of a specially tailored group model building process, designed to capture community perspectives on the complex determinants of adolescent lifestyle. Presented in this chapter is the authorship declaration, completed in accordance with Deakin University’s requirements for thesis by publication, followed by the manuscript itself.

This is the first of two manuscripts which address RQ2 of this thesis, which asks: “What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?”

This paper describes the GMB workshop process which was designed to capture community perceptions of the complex causes of adolescent physical activity and diet behaviours, and overcome the limitations of previously reported GMB processes from the literature (see Section 2.2.6). The manuscript specifically addresses RQ2.1 of this thesis, which asks: “Does the use of a rapid approach to GMB produce complex representations of the community-level determinants of adolescent physical activity and diet behaviours?”

At the time of submission this paper was under peer review at the journal of Systems Research and Behavioural Science.
AUTHORSHIP STATEMENT

1. Details of publication and executive author

<table>
<thead>
<tr>
<th>Title of Publication</th>
<th>Publication details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of executive author</td>
<td></td>
</tr>
<tr>
<td>School/Institute/Division if based at Deakin, Organisation and address if non-Deakin</td>
<td>Email or phone</td>
</tr>
<tr>
<td>Joshua Hayward</td>
<td></td>
</tr>
<tr>
<td>Global Obesity Centre, CPHR, Faculty of Health</td>
<td><a href="mailto:jnh@deakin.edu.au">jnh@deakin.edu.au</a></td>
</tr>
</tbody>
</table>

2. Inclusion of publication in a thesis

| Is it intended to include this publication in a higher degree by research (HDR) thesis? | Yes / No | If Yes, please complete Section 3 if No, go straight to Section 4. |

3. HDR thesis author’s declaration

<table>
<thead>
<tr>
<th>Name of HDR thesis author if different from above. (If the same, write “as above”)</th>
<th>School/Institute/Division if based at Deakin</th>
<th>Thesis title</th>
</tr>
</thead>
<tbody>
<tr>
<td>As above</td>
<td>As above</td>
<td>Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants</td>
</tr>
</tbody>
</table>

If there are multiple authors, give a full description of HDR thesis author’s contribution to the publication (for example, how much did you contribute to the conception of the project, the design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)

JH conceived the paper, composed the initial drafts, oversaw drafting and editing of contributions from other authors, and managed the manuscript to submission. JH designed the methodology and led data collection team, and performed all analyses.

I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.

| Signature and date | 21/07/2016 |

4. Description of all author contributions

<table>
<thead>
<tr>
<th>Name and affiliation of author</th>
<th>Contribution(s) (for example, conception of the project, design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Brown</td>
<td>Assisted with study design, execution of workshops and critical feedback on manuscript.</td>
</tr>
<tr>
<td>Jaimie McGlashan</td>
<td>Assisted with execution of workshops and critical feedback on manuscript. Assisted with execution of analyses</td>
</tr>
<tr>
<td>Brynle Owen</td>
<td>Assisted with execution of workshops and critical feedback on manuscript.</td>
</tr>
<tr>
<td>Felice Jacka</td>
<td>Critical feedback and development of manuscript.</td>
</tr>
<tr>
<td>Helen Skouteris</td>
<td>Critical feedback and development of manuscript.</td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Assisted with project conception, critical feedback and development of manuscript.</td>
</tr>
</tbody>
</table>
5. Author Declarations

I agree to be named as one of the authors of this work, and confirm:

i. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,

ii. that there are no other authors according to these criteria,

iii. that the description in Section 4 of my contribution(s) to this publication is accurate,

iv. that the data on which these findings are based are stored as set out in Section 7 below.

If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further

v. consent to the incorporation of the publication into the candidate’s HDR thesis submitted to Deakin University and, if the higher degree is awarded, the subsequent publication of the thesis by the university (subject to relevant Copyright provisions).

<table>
<thead>
<tr>
<th>Name of author</th>
<th>Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Brown</td>
<td></td>
<td>25/07/2016</td>
</tr>
<tr>
<td>Jaimie McGlashan</td>
<td></td>
<td>25/07/2016</td>
</tr>
<tr>
<td>Brynle Owen</td>
<td></td>
<td>25/07/2016</td>
</tr>
<tr>
<td>Felice Jacka</td>
<td></td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Helen Skouteris</td>
<td></td>
<td>01/08/2016</td>
</tr>
<tr>
<td>Steven Allender</td>
<td></td>
<td>25/07/2016</td>
</tr>
</tbody>
</table>

Signature Redacted by Library

6. Other contributor declarations

I agree to be named as a non-author contributor to this work.

<table>
<thead>
<tr>
<th>Name and affiliation of contributor</th>
<th>Contribution</th>
<th>Signature* and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*If an author or contributor is unavailable or otherwise unable to sign the statement of authorship, the Head of Academic Unit may sign on their behalf, noting the reason for their unavailability, provided there is no evidence to suggest that the person would object to being named as author.

7. Data storage

The original data for this project are stored in the following locations. (The locations must be within an appropriate institutional setting. If the executive author is a Deakin staff member and data are stored outside Deakin University, permission for this must be given by the Head of Academic Unit within which the executive author is based.)

<table>
<thead>
<tr>
<th>Data format</th>
<th>Storage Location</th>
<th>Date lodged</th>
<th>Name of custodian if other than the executive author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper outputs (printed workshop materials)</td>
<td>Locked storage cabinets, locked office. Global Obesity Centre</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>Electronic data (causal maps in SD software)</td>
<td>Office (D1.101, Waterfront Campus)</td>
<td>Home directory, secure server. Deakin University</td>
<td>2015</td>
</tr>
</tbody>
</table>

This form must be retained by the executive author, within the school or institute in which they are based.

If the publication is to be included as part of an HDR thesis, a copy of this form must be included in the thesis with the publication.
A Rapid Group Model Building Process for Understanding Determinants of Adolescent Lifestyle

<table>
<thead>
<tr>
<th>Journal:</th>
<th>Systems Research and Behavioral Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuscript ID</td>
<td>Draft</td>
</tr>
<tr>
<td>Wiley - Manuscript type:</td>
<td>Research Paper</td>
</tr>
<tr>
<td>Keywords:</td>
<td>Group Model Building, Prevention, Adolescent, Diet, Physical Activity</td>
</tr>
</tbody>
</table>

http://mc.manuscriptcentral.com/srbs
Title: A Rapid Group Model Building Process for Understanding Determinants of Adolescent Lifestyle.

Keywords:

Group Model Building, Prevention, Adolescent, Diet, Physical activity.
Abstract:

**Introduction:** Group Model Building (GMB) is a promising tool for creating shared understandings of lifestyle determinants to support community-based interventions. This paper reports a rapid GMB process tailored to minimise barriers to the implementation of GMB in community settings.

**Methods:** Two participant “streams” (n=13 & n=14) comprised of local government personnel, health service providers and secondary schools teachers and students participated in two 90-minute workshops, and produced CLDs of the community-level drivers of adolescent lifestyle behaviours.

**Results:** Both streams created “connection circles” during the first session, which were developed into CLDs and revised in session two. Participants identified feedback loops with causal pathways to tangible diet and physical activity-related outcomes.

**Conclusions:** Small groups were able to create CLDs that contained potential leverage points for intervention, and participation appeared to promote community capacity. This process may support and help communities to engage with the design of complex lifestyle interventions.

http://mc.manuscriptcentral.com/srbs
**Introduction:**

Diet and physical activity are risk factors for several diseases including obesity and metabolic syndrome (Nisanc-Kln and Cagdas, 2013), some cancers (Heinen et al., 2011), cardiovascular heart disease (Fernandes et al., 2013) and, more recently, depressive symptoms among adolescents (Bursnall, 2014; O’Neil et al., 2014). The recent evidence that diet and physical activity influence mental health reinforces the importance of these behaviours as lifestyle-based disease prevention targets. The development of prevention strategies for depressive symptoms is particularly important, given that unipolar depressive disorders are now the leading cause of disability adjusted life-years (DALYs) among 10-24 year olds worldwide, with 9.9% of global DALYs in this age-group attributable to unipolar depression (Gore et al., 2011).

The complex nature of diet and physical activity determinants presents major challenges to the modification of diet and physical activity at the population level (Hayward et al., 2014). Systems Dynamics (SD) is a theoretical perspective that generates insight into the complex drivers of population health problems through the identification of feedback mechanisms and non-linear causal pathways (Richardson, 2011). The identification of these system-level characteristics are considered important for the development of more effective population health interventions (Wang et al., 2014; Meadows, 1997). Group Model Building (GMB), a participatory modelling methodology from the SD literature (Hovmand et al., 2012), is a process for constructing qualitative SD
models (known as Causal Loop Diagrams (CLDs)) based on the knowledge and understanding of key informants and problem stakeholders.

The use of GMB is emerging in a diverse range of population health research applications. Allender et al, (Allender et al., 2015) created a CLD of the causes of childhood obesity in a project that recruited more than 150 local community members to work together over several hours. More recently, Moreland reported on a similar GMB process conducted in Denver, Colorado (Moreland, 2015) which led to the development of several intervention strategies that aimed to improve safety and access around public parks.

While studies such as these report successful implementation of GMB in single settings, studies are yet to examine how GMB might be applied in larger, multi-setting prevention programmes. Current best practise recommendations state that interventions targeting diet and physical activity should be guided by complex frameworks such as the socioecological model (Waters et al., 2011), target multiple settings and employ multiple intervention strategies (Hayward et al., 2014; Jacka et al., 2013) acknowledge the role of environments and health settings in determining health behaviours (Waters et al., 2011), and build capacity, problem ownership and willingness to respond to the problem at a community level (Millar et al., 2013).

Group Model Building is well-placed to meet these needs, as SD models are appropriate for problems with large numbers of determinants, across varying organizational levels (Luke and Stamatakis, 2012). The inclusion of community
stakeholders also provides an opportunity to capture insights at the community or settings level (Hovmand, 2014), and to increase participants capacity to understand complexity, and respond to complex problems (Scott et al., 2016).

No studies thus far have reported this application of GMB, however Brennan et al’s (Brennan et al., 2015) study of childhood obesity determinants in 49 communities, reports a conceptually similar project. Brennan et al used a series of half-day GMB workshops to evaluate policy changes following a 7-year, multi-site intervention programme. The approach successfully implemented GMB workshops across multiple settings, however the context of Brennan et al’s study as an evaluation programme means that it may not directly translate to the goal of informing intervention design.

Brennan et al’s (Brennan et al., 2015) evaluation process was conducted under the banner of a large intervention programme, and was able to leverage existing relationships between the researchers and community stakeholders to recruit participants into the GMB workshops. The use of GMB to inform intervention design would necessitate the recruitment of stakeholders with whom researchers have little or no existing relationship. In the absence of pre-existing participant-researcher relationships, time commitment is a significant barrier to participation (Krueger and Casey, 2014), and >10 hours of pre-workshop engagement may be required to generate sufficient “buy-in” to ensure adequate levels of participation (Hovmand, 2014). For many multi-setting intervention programmes, such a requirement would be unfeasible due to the substantial time and resource costs. This suggests that a GMB approach that minimises the time

http://mc.manuscriptcentral.com/srbs
burden of participation is required. Previous research experience suggests that a specific aspect of the time commitment barrier which prevents participation is longer, unbroken session durations, particularly among participants in senior organizational positions.

This study therefore demonstrates a rapid approach to GMB. The process reported in this study is based on the use of shorter, repeated GMB sessions designed to reduce participant’s time-commitment in individual sessions. The use of a rapid, segmented approach to GMB aims to produce CLDs of the community-level determinants of adolescent physical activity and diet behaviours, while avoiding lengthy individual sessions for participants and reducing the need for intensive engagement strategies.

**Methods:**

Two 90-minute workshops, held on separate days were designed using the GMB script literature (Hovmand et al., 2012). Participants were recruited from a community in Victoria, Australia.

**Participants**

Participants were recruited from three key stakeholder groups, chosen as their occupations and lived experience necessitated knowledge of adolescent lifestyle behaviours and their causes.
The community’s Local Government (LG) contained an active health promotion team, which was funded by a large, whole-of-population preventative health initiative targeting healthy diet and physical activity behaviours among adolescents. Secondary schools were also a population of interest, as a contact point for secondary school teaching staff, who have daily contact with adolescents, and secondary school students themselves with lived experience. The third stakeholder group were health service providers situated within the community, whose client base included adolescents. This group was targeted for its exposure, working directly with adolescents beyond the school setting.

Recruitment began with purposive recruitment within the LG health promotion group, who were subsequently asked to recommended contacts in the remaining two stakeholder groups. Health promotion officers from the LG group provided contact details for 15 individuals, which led to the recruitment of 13 LG staff (two were unable to participate due to work commitments), comprising the health promotion team leader, project support officer, and several health promotion officers and interns. The health promotion team recommended a further eight secondary schools and 11 health service providers for invitation.

Of the eight invited schools, four schools accepted the invitation. Two schools were located in or close to the centre of the community, while one sat within the wider suburban area, and one was located in a small satellite community nearby. Three out of four were girls’ schools, and enrolments ranged from ~700 – 1400 students. Three of four schools were of approximately average socioeconomic advantage/disadvantage (within 0.25 standard deviation), and one
was comparatively advantaged (0.85 standard deviation above average) according to publicly available school-level data (Victorian State Government Department of Education and Training, 2016). Of the four schools who did not accept, one was a boys’ school, one was a girls’ school, and all were located in the suburban area surrounding the community centre. Enrolments ranged from ~500 – 2000 students, and schools were comparatively more disadvantaged. One school was marginally above-average (<0.25 standard deviations above state average), two schools were between 0.5 and 1.0 standard deviations below state average and one school was more than 1.0 standard deviation below state average.

Schools who accepted the invitation identified one teacher and up to four students to participate. Students in leadership positions were recommended to the schools as ideal candidates. Four teaching staff and nine students were ultimately recruited. Of the schools who did not participate, two expressed a lack of available personnel to attend, and two did not respond to the invitations.

Of the 11 invited health service providers, four accepted the invitation to participate. Represented organisations included a youth counselling service, a family health service for disadvantaged groups, a health insurer, and a large regional health organisation with research, primary care, and service delivery divisions. Of those who did not accept the invitation, three individuals had conflicting work commitments, one did not work with adolescents, and one worked in a different town. A further two did not respond.
A total of 30 participants were ultimately recruited. Previous publications describe the optimum stakeholder group size for GMB sessions as between 5 and 17 (Hovmand, 2014; Yalom, 1995). The initial group was therefore split into two groups, to enable effective facilitation, and participants were allocated into one of two workshop “streams” however some participants indicated availability for both times, allowing some reallocation between streams to create groups of roughly equal size. The composition of the streams by participant organization are shown in Table 1, below.

Informed consent was obtained from all participants under full ethics committee approval; Deakin University approved consent forms (Ref: HEAG-H 189_2014), with ethics clearance from the Victorian Government Department of Education and Training (Ref: 2014_002552), and the Catholic Education Office Archdiocese of Melbourne (Ref: 2124).

Workshop Session 1

Workshop one began with an overview of current evidence regarding adolescent physical activity and nutrition behaviours and their association with adolescent depression. Participants were introduced to the research team which included two note-takers who recorded discussion throughout both sessions.

In the first activity participants identified variables which they understood to cause, or be affected by adolescents’ diet and physical activity behaviours. Participants worked in small groups create a shortlist of these variables. The
whole group then agreed on a starting list of 16 variables, which seeded the discussion for a “connection circles” activity.

The starting list of variables were displayed arranged in a circle on a large screen via projectors. Participants identified causal linkages between the variables, specifying whether the relationships were positive or negative. New variables were introduced throughout the activity as they became relevant. An example connection circle is presented below, in Figure 1. The session concluded with a short overview of the next session, and questions from participants.

Following the first session, the research team conducted an “offline review”, to develop the connection circle into an initial CLD. Notes from the session were simultaneously reviewed by two researchers, and where there was agreement that the notes identified a missing or incorrect connection or variable, the model was updated. Where consensus was not reached, the broader research team was consulted for clarification.

**Workshop Session 2**

Workshop two commenced with a session overview and explanation of the offline review process. In the first activity of the session, participants reviewed the initial CLD, with a focus on correcting aspects of the model that were incorrect (either irrelevant or represented incorrectly by the researchers). This activity served as a triangulation, or respondent validation of the CLD, confirming that the diagram was a faithful representation of participants’ perceptions, while highlighting areas for further development. Participants also noted feedback
loops. In the second activity, participants discussed the CLD, and amendments which were made in real time on a projector screen. Following the workshop, a second offline review was conducted to finalise the CLD.

**Results:**

**Stream 1**

Session one was attended by 13 individuals, as one participant was absent from the first session due to work commitments. Participants identified a total of 23 causes or effects of diet and physical activity behaviours among adolescents, including “cost of healthy foods,” “time pressure for families,” “understanding of future [health] consequences,” and “screen time.” During the connection circle activity, 36 connections were identified. Following offline review, the connection circle contained 31 variables and 54 connections.

Session two was attended by 6 participants, with 7 unable to attend due to work commitments. Feedback on the CLD focussed primarily on the role of adolescent social and physical development. Participants felt that the model did not adequately represent the influence of the media and celebrities on healthy adolescent peer culture. Participants also saw a need for greater detail around the role of bullying and puberty on body image, and subsequent impacts on dietary and physical activity behaviours. The role of schools was also discussed as an effective, but resource constrained avenue for students to gain understanding and knowledge of healthy nutrition.

http://mc.manuscriptcentral.com/srbs
Following discussion of these concepts, and revision to the CLD, the diagram contained 39 variables and 86 connections. Offline review resulted in the addition of one variable and three connections. The final version of the stream 1 CLD is shown in Figure 2.

Participants identified several examples of feedback in the model, many of which centred on technology use, exposure to advertising, and celebrity influence. An example of one of these loops, labelled the “Celebrity culture and media” loop is given in Figure 3. In this feedback loop, participants described a scenario where recreational technology use contributed to total technology use time. As overall technology use increased, so did exposure to marketing and advertising messages for unhealthy foods which were often associated with celebrity personalities. As the influence of celebrities increased, this negatively influenced peer culture, by encouraging adolescents to engage in more technology use. This loop was a driver of physical activity, via the variable “time pressure for young people”. Participants reflected that time available for physical activity was displaced by the use of technology in adolescents’ leisure time.

Stream 2

Session one was attended by 14 individuals, with two absences from the first session (one due to illness and one to work commitments). Twenty-five causes and effects of diet and physical activity behaviours were identified by participants including “Affordability of fresh fruit and veg,” “pressure of studies,” “knowledge of Australian physical activity guidelines,” and “technology use”. Fifty-two connections were specified by participants in the connection circles

http://mc.manuscriptcentral.com/srbs
exercise. Following offline review, the connection circle contained 30 variables and 57 connections.

Session two was attended by 13 individuals, as 1 participant from workshop 1 was unable to attend due to working commitments. Feedback on the CLD focused on the role of time pressure, knowledge of how to budget effectively, and the amount of fresh food that is consumed in the home setting. Community involvement was also added to the model as a variable which influenced community safety and use of active transport. One variable focusing on “seeking alternative or unusual physical activity opportunities” was removed as it was deemed by participants to not be relevant. Following group discussion of this feedback, the diagram contained 39 variables and 99 connections. Offline review identified no missing or incorrect content. The final version of the stream 2 CLD is shown in Figure 4.

Several feedback loops were identified in the stream 2 CLD. Feedback loops were found to influence a range of variables including technology use, food and cooking skills, and sports participation. One example of a feedback loop, labelled the “Marketing and peer influence” loop, is given in Figure 5.

In this loop, participants described that declining food-related skills meant that adolescents encountered fewer healthy marketing messages, as adolescents who had poor food skills were not “marketing” healthy messages to their peers (“marketing” was defined by the group as referring not only to media-based marketing, but also to the behavioural messaging that occurs within peer groups).
Less exposure to healthy messaging subsequently increased the proportion of unhealthy messages that adolescents encountered. As exposure to unhealthy messaging increased, there was a concordant reduction in the degree to which “cool” behaviours or trends among adolescents would be health-promoting. This in turn further reduced adolescents’ knowledge and skills regarding food. This loop was a driver of fresh food consumption in families, as poor food knowledge and skills reduced the ability to budget for, and afford healthy meals and foods.

**Discussion:**

The GMB process described in this paper generated CLDs of community-level causes of adolescent physical activity and diet behaviours.

The process was efficient, and was able to be completed across two 90-minute sessions, minimising the time-commitment on a given day for participants, and restricting the overall time-burden of the GMB to three hours. The study successfully recruited participants from a range of settings, including some in senior organizational positions who have been difficult to recruit in previous research.

Feedback loops are a key factor in the utility of GMB as a tool for intervention design as they provide the means to identify elements of policy resistance often caused by feedback processes whereby systems to self-correct, or “push back” against interventions (Meadows, 2009). Participants in this study identified multiple feedback loops during the second workshop sessions.
Meaningful causal chains could be traced from the feedback loops through to tangible outcomes such as participation in physical activity, and the consumption of fruit and vegetables within the family setting.

Increases in problem awareness, ownership at high organisational levels, and drive to respond to a problem have previously been identified as components of community capacity, which is associated with intervention success among adolescents (Millar et al., 2013). Participant reflections during the sessions suggested that some of these aspects of community capacity were being improved by the workshop process. Strong positive endorsements were expressed by participants throughout the sessions, and a group of participants with significant remit and capacity to influence adolescent health within the community have since asked the research team to replicate the approach within their own organisation.

The GMB “script” approach strengthens this approach as it increases consistency between workshops, assists in planning and structuring workshop activities and allows for the easy translation of successful strategies into other projects (Hovmand et al., 2012). The use of scripts also supports facilitator training in techniques that are designed to minimise power dynamics, and create an environment which is inclusive for diverse participant groups.

Although some of the health service providers worked with LGBTI, disadvantaged, homeless and otherwise at-risk or minority adolescent groups, there was no direct representation of these groups. Future GMB projects that
focus on drivers of adolescent lifestyle behaviours should engage with these groups where possible. Participation at followup was also comparatively low in stream 1, with only 46% of participants returning to the second session, as opposed to 93% in stream 2. It is likely that this biased the content of the stream 1 CLD towards the perspective of the participants who returned, however it also highlights the advantage of the 90-minute session structure. Of the 27 participants who attended at least one workshop, 19 went on to attend both sessions, including all school participants, and the team leader and project support officer from the LG group. Only eight individuals were unable to attend session two. Had the first session required participants to commit to the entire 180 minutes on one day, it is likely that participation rates would have been lower.

Further research should investigate means to compare the CLDs created by the two workshop streams. One promising approach is to consider the CLD as a form of directed social network and apply, and to apply Social Network Analysis techniques to compare the structural characteristics and influential variables in the two diagrams. Such investigation may give insight into the differences in perceived drivers of adolescent lifestyle behaviours between similar groups. This may help illustrate whether similar participant groups perceive systems in comparable ways, or whether broader engagement is warranted.

Implications of this research include that GMB workshops can be tailored to a low participant-burden approach, which demonstrates good engagement among the examined stakeholder groups, while reducing the need for resource intensive engagement. This study suggests that the approach may be a viable
method for gathering useful information about the complex drivers of population health problems prior to multi-setting interventions, however a larger trial of the approach in multiple groups will be required to confirm that it is translatable between different stakeholder groups and settings. The approach may also be beneficial for promoting a sense of ownership among stakeholders over the causes of population health problems, as well as their potential solutions, prior to an intervention programme.

**Conclusion:**

This study describes a GMB process which can be used to rapidly generate participant-led, respondent validated representations of the complex, community-level drivers of population health problems. Participants created detailed maps of the determinants of adolescent physical activity and diet behaviours over two 90-minute sessions, which contained clear examples of feedback loops, and which show promise as both intervention planning resources, and tools for building community capacity around forthcoming intervention activity.
References:


http://mc.manuscriptcentral.com/srbs


http://mc.manuscriptcentral.com/srbs


Figure 1: Example Connection Circle from Session 1 of HAL Maps process.
Figure 2: Causal Loop Diagram of Adolescent Diet and Physical Activity from HAL Workshop Stream 1.

Figure 2
103x71mm (600 x 600 DPI)
Figure 3: Celebrity culture and media feedback loop, and connection to physical activity behaviour from stream 1 CLD.

40x22mm (600 x 600 DPI)
Figure 4: Causal Loop Diagram of Adolescent Diet and Physical Activity from HAL Workshop Stream 2.

http://mc.manuscriptcentral.com/srbs
Figure 5: Marketing & peer influence feedback loop, and connection to fresh food consumption from stream 2 CLD.

http://mc.manuscriptcentral.com/srbs
Chapter 6: Thesis Publication IV “Comparing Multiple Stakeholder Perspectives on Complex Determinants of Adolescent Lifestyle Risk”

This chapter contains the fourth paper of this thesis, reporting on the quantitative analysis of causal loop diagrams describing the community level determinants of adolescent diet and physical activity behaviours. Presented in this chapter is the authorship declaration, completed in accordance with Deakin University’s requirements for thesis by publication, followed by the manuscript itself.

This is the second of two manuscripts which address RQ2 of this thesis, which asks: “What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?”

This paper describes the results of a quantitative analysis and comparison of the two adolescent lifestyle CLDs created by participants, and presented in Chapter 5, above. The manuscript specifically addresses RQ2.2 of this thesis, which asks: “What similarities or differences can be observed in CLDs constructed by independent groups from a repeat-methods GMB workshop, regarding the perceived drivers of community-level adolescent diet and physical activity?”

At the time of submission this paper was under peer review at the journal of Systems Research and Behavioural Science.
AUTHORSHIP STATEMENT

1. Details of publication and executive author

<table>
<thead>
<tr>
<th>Title of Publication</th>
<th>Publication details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparing Multiple Stakeholder Perspectives on Complex Determinants of Adolescent Lifestyle Risk</td>
<td>Under Review with Journal of Systems Science and Behavioural Research</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of executive author</th>
<th>School/Institute/Division if based at Deakin; Organisation and address if non-Deakin</th>
<th>Email or phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joshua Hayward</td>
<td>Global Obesity Centre, CPHR, Faculty of Health</td>
<td><a href="mailto:jnh@deakin.edu.au">jnh@deakin.edu.au</a></td>
</tr>
</tbody>
</table>

2. Inclusion of publication in a thesis

<table>
<thead>
<tr>
<th>Is it intended to include this publication in a higher degree by research (HDR) thesis?</th>
<th>Yes / No</th>
<th>If Yes, please complete Section 3 if No, go straight to Section 4.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. HDR thesis author’s declaration

<table>
<thead>
<tr>
<th>Name of HDR thesis author if different from above. (If the same, write “as above”)</th>
<th>School/Institute/Division if based at Deakin</th>
<th>Thesis title</th>
</tr>
</thead>
<tbody>
<tr>
<td>As above</td>
<td>As above</td>
<td>Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants</td>
</tr>
</tbody>
</table>

If there are multiple authors, give a full description of HDR thesis author’s contribution to the publication (for example, how much did you contribute to the conception of the project, the design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)

JH conceived the paper, composed the initial drafts, oversaw drafting and editing of contributions from other authors, and managed the manuscript to submission. JH designed the methodology and led data collection team, and performed all analyses.

I declare that the above is an accurate description of my contribution to this paper, and the contributions of other authors are as described below.

<table>
<thead>
<tr>
<th>Signature and date</th>
<th>21/07/2016</th>
</tr>
</thead>
</table>

4. Description of all author contributions

<table>
<thead>
<tr>
<th>Name and affiliation of author</th>
<th>Contribution(s) (for example, conception of the project, design of methodology or experimental protocol, data collection, analysis, drafting the manuscript, revising it critically for important intellectual content, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Brown</td>
<td>Assisted with study design, execution of workshops and critical feedback on manuscript.</td>
</tr>
<tr>
<td>Jaimie McGlashan</td>
<td>Assisted with execution of workshops and critical feedback on manuscript. Assisted with execution of analyses</td>
</tr>
<tr>
<td>Brynie Owen</td>
<td>Assisted with execution of workshops and critical feedback on manuscript.</td>
</tr>
<tr>
<td>Felice Jacka</td>
<td>Critical feedback and development of manuscript.</td>
</tr>
<tr>
<td>Helen Skouteris</td>
<td>Critical feedback and development of manuscript.</td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Assisted with project conception, critical feedback and development of manuscript.</td>
</tr>
</tbody>
</table>
5. Author Declarations

I agree to be named as one of the authors of this work, and confirm:

i. that I have met the authorship criteria set out in the Deakin University Research Conduct Policy,
ii. that there are no other authors according to these criteria,
iii. that the description in Section 4 of my contribution(s) to this publication is accurate,
iv. that the data on which these findings are based are stored as set out in Section 7 below.

If this work is to form part of an HDR thesis as described in Sections 2 and 3, I further consent to the incorporation of the publication into the candidate’s HDR thesis submitted to Deakin University and, if the higher degree is awarded, the subsequent publication of the thesis by the university (subject to relevant Copyright provisions).

<table>
<thead>
<tr>
<th>Name of author</th>
<th>Signature*</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrew Brown</td>
<td>Signature Redacted by Library</td>
<td>25/07/2016</td>
</tr>
<tr>
<td>Jaimie McGlashan</td>
<td>Signature Redacted by Library</td>
<td>25/07/2016</td>
</tr>
<tr>
<td>Brynle Owen</td>
<td>Signature Redacted by Library</td>
<td>25/07/2016</td>
</tr>
<tr>
<td>Felice Jacka</td>
<td>Signature Redacted by Library</td>
<td>29/07/2016</td>
</tr>
<tr>
<td>Helen Skouteris</td>
<td>Signature Redacted by Library</td>
<td>01/08/2016</td>
</tr>
<tr>
<td>Steven Allender</td>
<td>Signature Redacted by Library</td>
<td>25/07/2016</td>
</tr>
</tbody>
</table>

6. Other contributor declarations

I agree to be named as a non-author contributor to this work.

<table>
<thead>
<tr>
<th>Name and affiliation of contributor</th>
<th>Contribution</th>
<th>Signature* and date</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* If an author or contributor is unavailable or otherwise unable to sign the statement of authorship, the Head of Academic Unit may sign on their behalf, noting the reason for their unavailability, provided there is no evidence to suggest that the person would object to being named as author

7. Data storage

The original data for this project are stored in the following locations. (The locations must be within an appropriate institutional setting. If the executive author is a Deakin staff member and data are stored outside Deakin University, permission for this must be given by the Head of Academic Unit within which the executive author is based.)

<table>
<thead>
<tr>
<th>Data format</th>
<th>Storage Location</th>
<th>Date lodged</th>
<th>Name of custodian if other than the executive author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper outputs (printed workshop materials)</td>
<td>Locked storage cabinets, locked office. Global Obesity Centre</td>
<td>2015</td>
<td></td>
</tr>
<tr>
<td>Electronic data (causal maps in SD software)</td>
<td>Office (D1.101, Waterfront Campus)</td>
<td>Home directory, secure server. Deakin University</td>
<td>2015</td>
</tr>
</tbody>
</table>

This form must be retained by the executive author, within the school or institute in which they are based.

If the publication is to be included as part of an HDR thesis, a copy of this form must be included in the thesis with the publication.
Comparing Multiple Stakeholder Perspectives on Complex Determinants of Adolescent Lifestyle Risk

<table>
<thead>
<tr>
<th>Journal:</th>
<th>Systems Research and Behavioral Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuscript ID</td>
<td>Draft</td>
</tr>
<tr>
<td>Wiley - Manuscript type:</td>
<td>Research Paper</td>
</tr>
<tr>
<td>Keywords:</td>
<td>Group Model Building, Prevention, Adolescent, Diet, Physical Activity</td>
</tr>
</tbody>
</table>
Title: Comparing Multiple Stakeholder Perspectives on Complex Determinants of Adolescent Lifestyle Risk

Keywords: Group Model Building, Prevention, Adolescent, Diet, Physical activity.
Abstract:

Introduction: A challenge for Group Model Building (GMB) is the translation of Causal Loop Diagrams (CLDs), created by few participants, to represent community-level perceptions. This study aimed to apply network analyses methods to explore the effect of participant group on GMB products.

Methods: Two independent groups participated in repeat-methods GMB workshops. Over two sessions, each group developed CLDs of adolescent lifestyle behaviours in their community. Model density, out-degree and betweenness-centrality were used to quantify and contrast CLDs.

Results: The CLDs demonstrated similar quantifiable characteristics. Model density appeared similar, and similar socio-cultural drivers were ranked highly by out-degree and betweenness-centrality. Differences between the CLDs were observed in feedback loop frequency.

Conclusions: Independent groups created comparable models showing a densely interconnected system driving adolescent physical activity and diet behaviour. This process of developing CLDs can create comparable generalised models of complexity to support intervention design, implementation and evaluation for complex problems.


Introduction:

The Foresight obesity model (Butland et al., 2007) brought the use of causal loop diagrams, as a means of representing complexity, to the public health literature. Several authors have pointed to the potential benefits of viewing health problems through a complex lens in a range of problems including maternal and child health (Kroeling et al., 2014), urban health (Tozan and Ompad, 2015), health disparities (Roux, 2011), school-based health promotion (Rosas, 2015) and other areas. A systems perspective represents a range of approaches from many different intellectual traditions providing means to understand and address the drivers of complex problems (Ison, 2008). Systems science provides a range of tools which specifically aim to investigate nonlinearity, unintended consequences and feedback as important elements of complex problems (Morecroft, 2015). Previous discussion of traditional reductionist approaches suggest that the failure to account for these characteristics has previously led to sub-optimal intervention efforts in population health promotion (Mabry et al., 2008).

System Dynamics (SD) is one methodology for understanding and engaging with complex population health problems (Homer and Hirsch, 2006); it is primarily concerned with the identification of the multiple drivers of a problem and their causal interrelationships (Richardson, 2011). The SD perspective contends that the behaviour of a system arises from the interconnections between the drivers within the system (Morecroft, 2015), particularly where closed chains of causally-related variables form “feedback loops” which drive system behaviour over time (Kampmann, 2012). System Dynamics modelling employs graphical

http://mc.manuscriptcentral.com/srbs
modelling techniques to expose feedback structures, which can be used to explain unintended consequences of action, non-linear change in outcomes over time (i.e. exponential growth or fluctuation) and how causes and effects may be separated by both time and geographical space (Morecroft, 2009). Feedback loops are often cited as high-value leverage points for intervention in complex systems (Meadows, 1997; Wang et al., 2014), and are a primary focus of SD.

Within SD, a participatory approach known as Group Model Building (GMB) allows stakeholders to be actively involved in the development of SD models (commonly referred to as Causal Loop Diagrams (CLDs)) of complex problems (Hovmand et al., 2012). Recent applications of the GMB process to population health problems includes CLDs of the drivers of obesity (Allender et al., 2015), patient flows through primary health care (Pieters et al., 2011), and access to community recreation and park spaces (Moreland, 2015).

Currently GMB is a “small-group” process; with an optimal group size of between 5 and 17 participants (Hovmand, 2014). In previous studies such groups have created models aiming to represent perceived drivers of health problems within whole communities (Allender et al., 2015; Moreland, 2015). However, low participant numbers in this process challenge the representativeness and generalisability of the outcomes beyond the small number of participants who are in the room when the map was created. This issue has been raised as a limitation in both applied GMB studies (Allender et al., 2015), and in theoretical discussions (Zagonel, 2002). Further work is needed to examine the influence of this “participant group effect” on the outputs of GMB projects.
To date there has been one study proposing a methodology for directly comparing CLDs (Scholz et al., 2015). The approach employed Venn Diagrams to show common variables between CLDs and provided a relative comparison of the variables within the model. However, there is still a gap in our knowledge regarding methods to quantify the direction and strength of relationships between variables in multiple CLDs attempting to understand the complexity of problems from multiple points of view.

Social Network Analysis techniques and recent advances in computing power now make it possible to quantify the contents and structure of CLDs. These techniques provide the means to further analyse, compare and understand similarities and differences in CLDs created by multiple independent groups considering the same problem, such as those recently conducted for the Healthy Adolescent Lifestyle (HAL) Maps project. In the HAL Maps project a series of workshops were conducted using the same approach in order to understand multiple viewpoints of the complex drivers of adolescent health-related lifestyle behaviours in Victoria Australia. The overall aim of this study was thus to address the research question: What similarities or differences can be observed in CLDs, constructed by independent groups from the HAL Maps GMB workshops, regarding the perceived drivers, and causal structure of the community-level adolescent diet and physical activity system, in Victoria, Australia?

**Methods:**

http://mc.manuscriptcentral.com/srbs
The HAL Maps project was a series of GMB workshops, conducted in a community in Victoria, Australia. Two independent groups were recruited, each of which developed a Causal Loop Diagram (CLD) describing the perceived drivers of adolescent diet and physical activity behaviours in their community. The methods are described in detail in the companion piece to this article (also included in this issue) and are summarised below.

**Group Model Building workshops**

The workshops were conducted by trained facilitators with prior experience in GMB delivery. Participants initially identified a list of causes and effects of adolescent diet and physical activity behaviours and prioritised the “most important” 16 variables. These variables were projected onto a screen at the front of the room and participants identified causal linkages between them, adding new variables as required. Note-takers took written accounts of the discussions throughout. Following the first workshop, the research team revised the connection circle into an initial CLD, visually clarifying the diagram, and removing errors and redundancies based on the workshop notes.

In the second workshop participants provided written feedback on the initial CLD, highlighting errors and omissions. Proposed amendments were discussed and made in real time. Following the workshop, the researchers once again reviewed the model, based on note-takers accounts.

**Participants**

http://mc.manuscriptcentral.com/srbs
A purposive sampling approach was used to recruit health promotion personnel from Local Government (LG) who subsequently recommended potential participants from other target groups, representing a snowball sampling approach. Additional participants were drawn from health services and also included secondary school teachers and students.

Of the 15 LG personnel identified and invited to participate, 13 were recruited into the study (two withdrew due to conflicting work commitments). The LG group recommended a total of eight secondary schools and 11 health service staff for invitation, which led to the recruitment of four teaching staff, nine students, and four health service providers, for a total of 30 participants. The group was divided into two independent groups; 14 participants were placed into Group 1, and 16 into Group 2. The results from these two independent groups represent the data comprising the basis of this paper.

Informed consent was obtained from all participants using Deakin University approved consent forms (Ref: HEAG-H 189_2014), Victorian Government Department of Education and Training (Ref: 2014_002552), and the Catholic Education Office Archdiocese of Melbourne (Ref: 2124). Consent forms contained an explanation of the study aims and methodology in simple language. For student participants, consent was sought from both the participant and a parent/guardian.

Analysis
Social Network Analyses (SNA) were used to compare the independent diagrams. Each CLD was treated as an unweighted, directed network, with variables as nodes and causal connections as edges. The CLDs from both groups were subsequently imported into the Gephi software package (Gephi Consortium, Paris) for SNA analyses, and Insight Maker (Scott Fortmann-Roe, San Francisco, CA) (Fortmann-Roe, 2014) for feedback loop Identification.

*Model-level SNA*

Gephi was used to report the total number of variables and causal connections in each model. `Average degree` was then calculated, representing the mean number of causal connections per variable in the model. `Density` was also calculated, representing the proportion of all possible causal connections that were actually in the model, ranging from 0 (no connections) to 1 (all possible connections).

*Variable-level SNA*

`Out-degree` and `betweenness centrality` were also calculated in Gephi to identify influential variables in the CLDs. Within the context of CLDs, out-degree can be interpreted as a measure of the direct influence one variable may have over other variables in the CLD. Variables with higher out-degree may be important intervention targets due to their direct impact on a number of other elements within the system (McGlashan et al., 2016). Betweenness centrality indicates variables that act as mediator variables within the model. The betweenness centrality (referred to hereon as `betweenness`) of a variable is proportional to the
number of shortest pathways between all other variable pairs that a given variable features in. Variables with high betweenness may therefore be interpreted as control variables within a network (Freeman, 1979). Compared to out-degree, which only accounts for direct causal relationships, betweenness accounts for the position of a variable within an entire network, and is therefore a more refined measure of model influence. In order to enable easier comparison of variables’ relative influence, according to out-degree and betweenness, scores on both measures are normalised to a common scale, ranging 0 to 1.

*Feedback loop identification*

The CLDs from both workshop groups were imported into Insight Maker (Fortmann-Roe, 2014), and the ‘identify loops’ function was used to generate a report of all feedback loops in the diagrams.

**Results:**

**Model-level SNA results**

The Group 1 CLD comprised 40 variables and 89 connections, while the Group 2 CLD comprised 38 variables and 98 connections. Average degree was 2.2 connections per variable in the Group 1 CLD, and 2.6 connections per variable in the Group 2 CLD. Density, which was proportional to the number of variables and connections, was also similar at 0.06 (meaning that 6% of all possible causal connections were present in the CLD) for Group 1, and 0.07 for Group 2.
Variable-level SNA results

In the Group 1 CLD, out-degree scores ranged from 0 to 5. Three variables, ‘Healthy peer culture/social influence’, ‘Screen time’, and ‘Puberty’ had the maximum out degree, meaning that these variables had each been specified by participants as causally affecting five other variables. Other high out-degree variables included ‘Technology use’ (out-degree = 4) and ‘Knowledge and education’ (out-degree = 4).

In Group 1, betweenness scores ranged from 0 to 111.30, with ‘Healthy peer culture/social influence’ scoring highest on the scale (betweenness = 111.33), meaning that this variable featured on many of the causal pathways that connected other variable pairs, and had a role in connecting potential themes or clusters in the CLD. Other high betweenness-centrality variables included ‘Exposure to advertising/marketing of unhealthy foods’ (betweenness = 94.33), and ‘Technology use’ (betweenness = 86.00).

The 10 highest ranked variables, by normalised out-degree and betweenness, from the Group 1 CLD are shown in figure 1. ‘Healthy peer culture/social influence’ ranked highest on both measures, indicating important direct effects on other model variables and mediating position within the model. Notably, ‘Puberty’ and ‘Time pressure for families’ ranked highly on out-degree, but had zero betweenness, indicating that these variables were important causes in the model, but were not causally affected by other model variables. ‘Exposure to
advertising’ had lower out-degree, but was the second highest ranked mediator variable.

In Group 2, out-degree scores ranged from 0 to 8. The variable ‘Technology use’ had the highest out-degree, meaning participants specified it as a causal factor for eight other variables in the CLD. Other high out-degree variables included ‘Pressure of studies’ (out-degree = 7), and ‘Healthy marketing messages’ (out-degree = 5).

In Group 2, betweenness scores ranged from 0 to 343.70, with ‘Involvement in sport’ scoring highest on the scale, meaning that the variable featured in causals chains connecting many other variable pairs in the CLD. Other high-betweenness variables included ‘Technology use’ (betweenness = 277.08), and ‘Family eating of fresh food’ (betweenness = 269.07).

The 10 highest ranked variables by normalised out-degree and betweenness centrality from the Group 2 CLD are shown in figure 2. ‘Technology use’ scored highly on both measures, indicating that it had significant direct effects on other model variables, while also being an important mediator. ‘Government/private sector funding’, ‘Community involvement’, and ‘Whole community education in physical activity and healthy foods’ each ranked highly on out-degree but did not mediate any causal pathways within the model. ‘Involvement in sports’ and ‘Family eating of fresh food’ ranked more highly on betweenness than out-degree, indicating fewer direct effects, but a strong mediator position in the model.
Feedback loops

We identified 14 feedback loops in the Group 1 CLD, ranging from 2 to 7 variables in length. Examination of the variables included in the feedback loops revealed that the majority of loops comprised variables pertaining to technology use, peer culture, and celebrity influence. For example, a four-variable feedback loop from Group 1 explained that the use of recreational technology increased total technology usage time, which strengthened the influence of unhealthy ‘Celebrity culture’ on adolescents and their peers. This reduced the ‘Healthiness’ of peer culture by preoccupying adolescents with celebrity news, which required more recreational technology use to consume. This feedback loop is shown in figure 3.

The Group 2 CLD contained 383 feedback loops, ranging from 2 to 17 variables in length. Examination of variables included in the feedback loops revealed a broad range of variables, with a greater proportion of model variables represented in at least one loop. An example of a four-variable feedback loop from Group 2 showed that adolescents’ skills and knowledge regarding healthy food increased their ability to successfully budget for healthy food options, which improved the affordability of healthy foods. This led to consumption of fresh foods in the family setting, which in turn reinforced adolescents’ food and cooking knowledge and skills. This feedback loop is shown in figure 4.

Model contrasts
Group 1 included a cluster of variables reflecting the influence of puberty, celebrity influence, body image, bullying and mental health. Group 1 participants suggested that adolescents with low self-esteem (at least partially driven by pubertal development and celebrity influences) would be much less motivated to exercise due to negative feelings about their bodies, or due to desires to avoid bullying. Review of the session notes confirmed that these concepts were not discussed by Group 2.

The Group 2 CLD included variables describing students’ knowledge of physical activity guidelines, and stress and injury. Participants suggested that adolescents with better comprehension of the physical activity guidelines may dedicate more time to sports, and that physical injuries or mental distress decreased adolescents’ ability to engage in physical activity. Review of the session notes again confirmed that these concepts were not raised by Group 1.

**Discussion:**

The two workshop groups created diagrams with similar numbers of variables and causal connections, and similar overall network density, suggesting that the groups perceived the determinants of adolescent physical activity and diet behaviours to be highly interconnected. Further agreement was observed after ranking influential variables quantified within the SNA. A group of socio-cultural variables concerning adolescents’ technology use, peer cultural influences, family food environments and media/marketing messages featured among the influential
variables from both CLDs. These variables also appeared in feedback loops (see figures 3 & 4), further supporting their influence in the CLDs (Meadows, 1997). These results support the argument that groups shared perceptions that the adolescent physical activity and diet behaviour system in their community was heavily influenced by socio-cultural factors.

While there was strong evidence of agreement, differences were observed in the number and frequency of feedback loops in the CLDs. Other studies have reported a similarly wide range of feedback loop frequency in CLDs, from the 10’s (Wittenborn et al., 2015) into the 100’s (Forrester, 1982). High numbers of feedback loops may, however, indicate the presence of “dependent” feedback loops within an SD model (Kampmann, 2012). Dependant loops are feedback loops that are similar to each other in terms of the variables that comprise them and the subsequent effects that they have on the behaviour of the system. Where dependant loops exist within a CLD, several feedback loops, which appear to be otherwise discrete, may actually be redundant representations of the same ‘real world’ loop – re-routed multiple times through conceptually similar variables. This may be an explanation for the large number of loops in the Group 2 CLD, as a number of the loops were identical, apart from one or two variables.

Group 1 included a unique cluster of variables related to pubertal/psychosocial development, bullying and self-esteem. Group 2 included variables pertaining to knowledge of recommended physical activity behaviours, and the role of injury and mental distress as barriers to physical activity participation. These concepts arose from participants’ reflections on parallels
between personal experiences and the content of the CLDs. This was an example of participants’ mental models influencing the diagrams. CLDs produced by group processes are interpreted as a aggregation of participants’ mental models (Kim, 2009), which are internally held, incomplete representations of systems that are influenced by social and context-specific experiences (Doyle and Ford, 1998). Although the CLDs indicated agreement regarding overall structure and important variables, individuals’ lived experiences led to some differences in the CLDs between the two groups.

The apparent shared perceptions regarding the importance of socio-cultural drivers of physical activity and diet between the two groups highlights the potential for this approach to community-led SD modelling to inform intervention design. The CLDs produced by the two groups are consistent with previous evaluation studies that have described socio-cultural influences as having a ‘pervasive’ effect on physical activity and diet behaviours (McCabe et al., 2011). Socio-cultural influences have been historically difficult to overcome in the intervention setting and are considered critical barriers to intervention success (Watson et al., 2015; Brennan et al., 2012; Goh et al., 2009). The groups in this study both identified the importance of these factors, and were able to locate them within a broader complex system of lifestyle determinants, while previous linear approaches have failed to do so (Atun, 2012; Mabry et al., 2008). This approach provides promise towards identifying logic models for interventions subject to socio-cultural drivers prior to intervention.
The use of GMB scripts in the design of this study engendered greater consistency between sessions, and leveraged the collaborative development of GMB by many groups over time (Hovmand et al., 2012). The inclusion of adolescents within the sample overcomes limitations of previous studies, which have aimed to investigate adolescent health issues but have not recruited adolescent participants. The use of a community-based, ‘bottom up’ approach also overcomes the limitations of previous “top down” SD models of adolescent health, which have defined models based on expert perspective and literature. These ‘top down’ models have previously overlooked many of the socio-cultural factors observed in this study (Butland et al., 2007; Abidin et al., 2014).

This study is limited in the representativeness of the included participant sample. Several minority groups for whom physical activity and diet behaviours determinants are known to differ from the general population (i.e. Aboriginal or Torres Strait Islanders (Ricciardelli et al., 2012; Stronach et al., 2016), or the Lesbian, Gay, Bisexual, Transgender and Intersex community (Hadland et al., 2014; Mereish and Poteat, 2015)), were not directly represented, although recruitment for the latter would provide difficult due to ethical limitations in recruiting on the basis of sexuality. In light of these limitations, the diagrams developed in this study should not be generalised to groups not represented by this sample. The use of purposive and snowball sampling also led to the recruitment of a somewhat homogenous sample, relative to the wider community. Adult participants were comparatively well-educated and had considerable experience working in fields related to adolescent lifestyle health, which may have biased the
content of the model. Only three professional groups were represented, and perspectives from other important groups were not captured (i.e. clinicians, parents, or counsellors). The majority of student participants attended schools in areas of above-average socioeconomic advantage.

Future research should investigate alternative methods to quantify and compare CLDs to test the repeatability of the agreement observed in this study. The role of the facilitation teams in influencing CLD content should also be investigated, as this may have affected the content analysed here. The effect of a ‘broad’ rather than ‘deep’ sampling frame is a further area for exploration – whereas this study included many participants from few contextual settings, representation from a broader base of community settings may yield different CLDs. Finally, research could investigate archetypal structures, which may help to understand drivers of adolescent lifestyle common to multiple communities or settings. Archetypal structures are a set of fundamental models that may be used to explain any dynamic problem over time and provide guidance on possible problem solutions (Wolstenholme, 2003). Using archetypes to characterise lifestyle behaviours may help identify common system elements, and therefore common intervention strategies, which could be tested in multiple sites.

**Conclusion:**

Two independent participant groups created CLDs of the perceived community-level drivers of adolescent physical activity and diet behaviours,
demonstrating agreement in identifying that these disease risks were densely interconnected and heavily influenced by socio-cultural variables. This finding represents a step forward for bringing together multiple stakeholder views of the complex drivers of disease to inform intervention design, implementation and evaluation.
References:


Participative Inquiry and Practice. 2nd ed. London, UK: Sage

Publications, 139-158.


http://mc.manuscriptcentral.com/srbs


Figure 1: Influential Variables from Group 1 CLD, by Normalised Out-Degree and Betweenness Centrality Score.

http://mc.manuscriptcentral.com/srbs
Figure 2: Influential Variables from Group 2 CLD, by Normalised Out-Degree and Betweenness Centrality Score.
figure 2
44x28mm (600 x 600 DPI)
Figure 3: Example Feedback Loop from Group 1.
Figure 4: Example Feedback Loop from Group 2.
Chapter 7: Discussion

This chapter presents the main findings of the research, the strengths and limitations, contributions to knowledge, and implications for future research and practice. The section concludes by identifying unanswered questions and suggested future research directions.

7.1 – Main Findings

7.1.1 – Thesis RQ1 Findings:

*RQ1: What are the associations and effect sizes attributable to physical activity time, sedentary behaviour, and diet pattern, on depressive symptomology outcomes in a sample of Victorian secondary school students?*

Findings supported the existence of associations between physical activity, screen-based sedentary behaviour and diet pattern, and the likelihood of self-reported depressive symptomology among Victorian adolescents. Among a large sample with a high response rate the study found that more than one in five adolescents reported a level of depressive symptomology, indicative of major depression.

Stratification by gender showed different effects for male and female participants. Among male participants, attainment of the recommended moderate to vigorous physical activity guidelines of more than one hour per day was associated with a reduced likelihood of depressive symptomology. Also for male participants, adherence to an unhealthy diet, characterised by greater consumption
of takeaway foods, sweetened beverages, caffeinated beverages, and energy
drinks, was associated with a greater likelihood of depressive symptomology.

Among female participants, exceeding the screen-based sedentary
behaviour recommendations of less than two hours per day was associated with an
increased likelihood of reporting depressive symptomology. Having a higher
BMI-for-age Z-score was also associated with increased likelihood of depressive
symptomology in females.

Although significant, the effect sizes of the associations for both male and
female participants were small. The findings were broadly consistent with
previous literature, and the few inconsistencies appeared largely attributable to
measurement tools.

The findings affirmed that both dietary and physical activity/sedentary
behaviours are independently associated with depressive symptomology, and do
not represent mediating variables on a common causal pathway with a third
variable not measured by this study. Further, these findings are based on an
observational sample drawn from the Victorian adolescent population, for whom
there were previously no comparable findings in the literature.

The individual effect sizes observed in the study were consistent in size
with the large number of factors understood from the literature to increase
depression risk, most of which contribute small effect sizes (134). This finding
extends upon previous understanding by identifying that adolescents' physical
activity/sedentary behaviours, and diet patterns are independently associated with
depressive symptomology among Victorian adolescents, and that the effect
strengths of these lifestyle behaviours on depressive symptomology are comparable in magnitude to many other generally accepted intervention targets, including socio-economic and community factors (135), family structure & self-perception (134), and other modifiable risk behaviours including drug use, sexual behaviours, and religious practises (23).

7.1.2 – Thesis RQ2 Findings:

RQ2: What are the perceived community-level drivers, and feedback processes affecting adolescents’ diet and physical activity behaviours, from the perspective of adolescents and other community representatives in Victoria?

In answering the second research question two “sub-questions” were addressed. Answering RQ2 necessitated the formulation of a GMB workshop methodology. Given the focus of this thesis on population-level prevention, which requires a low-burden approach suitable for use in multiple settings or locations, a new process was needed that could overcome some of the barriers to implementation in previous approaches. The first sub-question, RQ2.1, addressed the design and implementation of this process. The second sub-question, RQ2.2, addressed the analysis of the causal diagrams produced by the GMB process, and directly addressed RQ2.

RQ2.1: Does the use of a rapid approach to GMB produce complex representations of the community-level determinants of adolescent physical activity and diet behaviours?

This study found that a “rapid” GMB process was effective for engaging community-based stakeholders in the process of creating a CLD of the drivers of
adolescent physical activity and diet behaviours. The process was designed to overcome the time burden attributable to recruitment and pre-workshop engagement required in “usual practise” GMB. The division of the workshop into a 2x90minute session structure successfully reduced these burdens. The study engaged a group of 30 participants, divided into two independent workshop groups, allowing a “repeat measures” GMB project to be undertaken.

Both groups were able to identify numerous determinants of adolescent physical activity and diet, and causal relationships between these determinants. The study found that participant groups constructed CLDs in a similar fashion, with comparable numbers of variables and causal connections identified at each workshop stage. Participants created and were able to identify feedback loops within their own diagrams, which was a critical indicator of the success of the process, given the importance of feedback loops to the system dynamics perspective (52).

In reflecting on their experience throughout the workshop sessions, participants were positive in their appraisal of the process, although this was not formally evaluated. One group of participants formally requested that the research team conduct the workshop process at their organisation on a related health issue. It is suggested that this is at least an indirect indication that participants found the problem a novel and useful way of conceptualising a complex issue, and at best a demonstration of the process as building participant capacity to appreciate the role of complexity in providing insight into health-related problems.
RQ2.2: What similarities or differences can be observed in CLDs constructed by independent groups from a repeat-methods GMB workshop, regarding the perceived drivers of community-level adolescent diet and physical activity?

This RQ, following from the development of the independent CLDs reported in Chapter 5, employed SNA techniques to identify prominent variables within, as well as the structural characteristics of each CLD. Feedback loops within the CLDs were also identified and compared between workshop groups. In addition to addressing RQ2.2 these analyses also directly addressed RQ2, as the findings highlighted feedback loops, and individual variables of influence, representing potential intervention targets for adolescent physical activity and healthy diet promotion.

Quantified network analyses of the two CLDs allowed for comparison of the content and characteristics of the two diagrams. The “small-group” nature of GMB (optimally between 12 and 17 participants), has led some authors to argue that it is difficult to generalise the output of a GMB process beyond the people who were “in the room” for the sessions (93). This is the first study to quantitatively compare GMB outputs created by independent groups.

Analysis of the two CLDs found that adolescent physical activity and dietary behaviour were strongly influenced by peer culture and social norms, technology use, individual level knowledge and education, time pressure, study pressures and engagement in school. Numerous feedback loops were identified in both CLDs, and several of the influential drivers listed above were components
within those feedback loops. The number of feedback loops present in each of the CLDs was consistent with previous System Dynamics modelling studies (136, 137), although the number of feedback loops in one CLD greatly exceeded the other. Feedback loops from the CLDs described various feedback processes and two examples presented in Chapter 6 included the reinforcing effect of celebrity culture on technology use and peer culture, and the reinforcing effect of the home food environment on adolescents cooking and meal preparation skills.

By contrasting the results of the network analysis, this study was able to conduct an initial investigation of the effect of group composition on the content and structure of CLDs. This initial investigation represents a first step in addressing the concerns regarding the representativeness of GMB outputs. Comparison of the influential variables within each model, as well as the structural characteristics of the two CLDs, found generally good agreement between the two workshop groups. Both groups created models with similar overall structural characteristics, and some overlap was observed in the list of diet and physical activity determinants ranked most influential by the network analyses. Alongside the observed agreement in the models, subtle differences were detected, reinforcing the need for a broad sampling approach, with representation from a range of community settings.
7.2 – Strengths & Limitations

7.2.1 – Study Strengths

The data which were collected and analysed under RQ1 are of a high quality. The study employed an opt-out consent process, which was the first of its kind for a population-level observational study in Victoria. The use of opt-out consent produced a very high response rate (88%) that minimised the risk of response bias. Standardised tools were used in the measurement of survey data, and anthropometry data were directly measured by trained data collectors. Taken in combination, the tools which were used in the collection of data were of a high quality, and the high response rate indicates that the study sample is representative of the invited population of year 8 and 10 students in the participating schools.

The methodologies which were employed for RQ2 come from established practices in engineering and business that are finding new applications in the population health sphere. The GMB scripts which were used to design the workshop approach presented in this thesis represent the codification of a long tradition of largely undocumented research experience by experts in GMB. Scripts are based on best-practise recommendations and are highly structured, providing workshop frameworks which are repeatable, methodologically rigorous, and transparent.

7.2.2 – Study Limitations

Although the tools used in the analysis of RQ1 were all standardised measures, they are less accurate than direct and objective measures for behaviours such as physical activity and diet composition. Direct measurements such as
accelerometry for physical activity/sedentary behaviour measurement, and food
diaries for diet pattern measurement avoid the need to rely on participants’
potentially incorrect recollections. Such measures have been shown to more
accurately capture actual behaviour in the case of physical activity/sedentary
behaviour (138), although the evidence is less conclusive for food diaries as
compared to food frequency questionnaires (139, 140). More objective measures
here would have minimised the risk of various biases, including recall and social
desirability bias, although to engage with more direct measurements would have
significantly increased the cost and resource burden of the study, and greatly
reduced the number of participants able to be recruited into the study.

The CLDs developed under RQ2 are limited in that they are qualitative
models, and represent only the perceptions of the determinants of adolescent
lifestyle behaviours, from the perspective of the participants. The models should
not be interpreted as representing the “true” system of adolescent lifestyle causes.
As introduced in Chapter 2, Doyle and Ford argue that participant-informed CLDs
represent the participants’ internally held representations of the perceived
structure of external systems (80). In this context, Doyle and Fords definition
could be applied to view the CLDs as an aggregate representation of the
knowledge or beliefs of the study participants regarding what drives adolescent
lifestyle behaviours in their community.

The group of stakeholders that created the model also lacked explicit
representation from a number of population groups, including economically
disadvantaged populations, LGBTI students or Indigenous Australian students.
The student and Local Government participants were also primarily female. In
light of the Doyle and Ford definition – it is reasonable to assume that these
different groups may have different knowledge and beliefs regarding the causes of
adolescent lifestyle behaviour - and so the CLDs should be interpreted with
cautions when considering generalisability, or the application of its findings to
more diverse adolescent populations.

The study in Chapter 6 went some way towards addressing the concerns
regarding the “representativeness” of the CLD of broader community perceptions,
however this finding should be considered preliminary. The two participant
groups whose models were compared in this study were reasonably homogenous,
being of a similar gender breakdown, similar educational levels, and representing
organisations from areas of above-average socio-economic advantage. That the
diagrams were found to align in various ways rejects the argument that GMB
outputs are so variable that vastly different results are likely, even among similar
participant groups. The findings cannot, however, reject the argument that any
study sample from the same target population will produce different CLDs – this
requires further investigation.

7.3 – Contribution to Knowledge

This thesis aimed to understand the associations between the adolescent
lifestyle risk behaviours (physical activity, sedentary behaviour and diet pattern)
and depressive symptomology within the Victorian adolescent population, and to
test whether a participatory approach could be used to generate insight into the
complex determinants of those behaviours in a community setting. The thesis
presents these insights as potential intervention points, and proposes the GMB approach as one which would be appropriate for the generation of comparable insights in other problem domains where community-led population-level prevention is required.

This thesis contributes to knowledge in several domains:

1) New epidemiological evidence on the associations between lifestyle risk factors and adolescent depression in the Victorian population, and the effect strength of these associations relative to other lifestyle-based intervention targets.

2) The formulation of a novel methodological approach to understanding the causes of complex lifestyle behaviours.

3) The presentation of specific, novel insights regarding the complex causes of adolescent lifestyle health in a community in Victoria.

These contributions are outlined in detail in the following paragraphs.

Chapter 4 of this thesis presents the first study to demonstrate an association between adolescents’ lifestyle risk behaviours, and depressive symptomology outcomes in a sample of Victorian adolescents. This finding addressed a critical gap in knowledge describing the health status of Victorian adolescents. Further, this was the first study in the Australian context to use an opt-out consent process to examine associations between lifestyle behaviours, and mental health outcome, which contributes robust epidemiological findings to the literature, both in the reported associations, and the observed prevalence of health behaviours and depressive symptomology outcomes. The successful
implementation of an opt-out consent process in a population-level study within Victoria also strengthens the case for the feasibility and safety of large-scale “data monitoring” programs in Victoria, which are critical for strengthening population-level prevention strategies (141).

Chapter 5 demonstrates a low-burden method for conceptualising the causes of complex health problems prior to intervention. The process was applied to the adolescent lifestyle risk behaviours investigated in Chapter 4. The results of this study contributes the first example in the Australian literature of how the complex determinants of adolescent physical activity and nutrition behaviours may be conceptualised based on the perspectives of a community stakeholder group which includes the target population of adolescents.

Additionally, Chapter 6 presents insights from the GMB workshops, demonstrating the feedback loops and influential system-level variables that represent potential intervention points in the CLDs of adolescent diet and physical activity behaviour causes. In identifying these features, the outputs of the GMB workshops represent an initial resource that could be further refined and developed by the community into a suite of options for community-based lifestyle health promotion. The final contribution of the thesis is therefore the initial step in a roadmap towards the development of a community-led lifestyle-health intervention, which is grounded in complexity and System Dynamics theory, and which is scalable to multiple other settings.

This represents the overall significance of this thesis. The GMB approach outlined in this thesis provides a method for conceptualising the dynamic
complexity of adolescents’ modifiable lifestyle risk factors. The approach builds a
shared representation of this complexity, based on the contributions of
community-based participants, using an established methodology which is
believed to build participants’ capacity to appreciate and respond to complexity
(62). The design is also purposefully designed to be scalable and easily
implemented in multiple communities and settings at a lower burden, to both
facilitator and participant, than previously approaches reported in the GMB
literature.

In the longer term – this approach is a key step towards the development
of dynamic simulation models, which can be constructed where sufficient, high
quality evidence exists to inform and validate the simulation (50). This thesis has
also demonstrated the feasibility of a large, high response rate data collection
program, which took place across a number of Victorian communities. Such data
collection programmes could be leveraged in future research to collect the data
required to move CLDs such as the ones developed in the HAL Maps workshops
from qualitative diagrams into quantified simulation models. This would afford
the opportunity for “in-silico” development and testing of lifestyle-targeted
intervention strategies for specific communities.

7.4 – Study Implications

The findings of the research presented in this thesis have several
implications for policy and practice. The finding that adolescent physical
activity/sedentary behaviour and diet are associated with depressive
symptomology strengthens the case for these behaviours to be considered as lifestyle-related targets for the prevention of depressive symptoms at a population level. The finding that more than one in five of the Victorian adolescents surveyed in this research report levels of depressive symptomology demonstrates the scope and importance of this issue. Despite the apparently small effect of physical activity, sedentary behaviour and diet on depressive symptomology, most factors which are accepted as legitimate intervention targets for depression treatment are similarly effectual (134), and even small changes in disease risk across entire populations has the potential to create significant offset of disease cost and morbidity at the population level (142). The population-level prevention of depressive symptomology among adolescents, using lifestyle-based behaviour modification targets should therefore be considered a policy priority – especially considering the current lack of prevention activity for mental disorders when compared to more “visible” disease outcomes such as obesity (38).

Considering the community-level drivers of adolescent physical activity and diet behaviours, the GMB workshops identified a number of complex causes of adolescent physical activity and diet behaviours, as perceived by a group of Victorian community-based stakeholders. Alongside established intervention points such as the costs and availability of healthy foods and screen time, these included non-traditional points of intervention like popularity of cooking subjects, enrolment numbers in schools, and exposure to current affairs and news programmes.

The outcomes of the GMB workshops may guide future research into the complex drivers of adolescent health in this community, as the study identified a
group of socio-cultural factors that were particularly important in perpetuating adolescent lifestyle behaviours. Further, the GMB workshops demonstrated a process for conceptualising the complex determinants of lifestyle-related health, which is appropriate for use in community settings, and should be extended to other communities.

The CLDs produced by the GMB workshop process also provide a clear demonstration of the value of seeking a complex perspective on the causes of health-related issues. Following the publication of the Foresight obesity model the observation was made that, due to the highly interconnected system of obesity determinants, interventions were never well placed to modify health behaviours as they did not account for these complex interdependencies in their intervention design (96, 97). This point is driven home once more by variables which participants specified in the CLDs reported in this thesis that in some cases were reinforced by feedback loops, and subject to eight or more interconnected causal inputs.

The workshops also have implications for the methodological GMB literature. The process demonstrated in this thesis took a rapid approach to the development of qualitative community-led CLDs. This represents a trade-off of the more traditional and intensive participant engagement process against a reduction in barriers to participation for community members. In the context of community-based work with complex health issues, it may be the case that the relative loss of deep engagement with community stakeholders may be countered by the ability to more quickly establish a rapid GMB process, and engage a number of community stakeholders at a lower burden to both participant and
researcher. Additionally, the rapid process enables a faster overall progression from initial engagement to the creation of CLD outputs.

7.5 – Unanswered questions and future research directions

The study under RQ1 observed associations between the lifestyle risk factors, physical activity/sedentary behaviour and diet, and depressive symptomology. While this study contributed new insights into the drivers of mental wellbeing in the Victorian adolescent population, these findings are not adequate to infer causality. Indeed, the broader literature on lifestyle associations with depression and depressive symptoms is currently insufficient to infer causality (143, 144), although some evidence exists that suggests that it is likely (37). Future research should observe adolescents’ physical activity/sedentary and diet behaviours, and depressive outcomes longitudinally in order to shed further light on this question.

The GMB study under RQ2 reported community perspectives on the causes of physical activity and dietary behaviours among adolescents. While this research demonstrated important causal drivers of these behaviours, and identified various feedback loops which may be perpetuating the problem of poor lifestyle in adolescence, future work is required to guide action planning. Currently, the literature around GMB scripts provides a structured and rigorous approach to guiding a group of participants from a position of uncoordinated, individual mental models, to a shared conceptualisation of a complex system. However, there is no comparable process to guide participants through the identification and
prioritisation of actionable plans on the basis of the System Dynamics model they
created (with the exception of simulation model development, which has a high
barrier to entry for reasons identified above). Future research could leverage the
“script” framework to extend the GMB process past model development and into
an “action planning” phase. Incorporating formal evaluations of community
capacity into this process would also clarify the role of GMB and action planning
in strengthening community capacity, and contribute to the GMB evaluation
literature, which is still in its infancy (62).

On the question of the validity of GMB outputs, the findings from this
study suggest that comparable groups located within the same setting share some
perceptions around the complex drivers of adolescent lifestyle. More work is
required, however, to compare these perceptions among larger, and more diverse
population groups. To this end, development of the GMB process might explore
how the process can be modified to include more stakeholders than the “5-17”
guideline (51) which has been followed in this research. Similarly, because the
GMB is typically a “face-to-face” process, it will be difficult to implement for
health problems that affect geographically isolated or dispersed groups or
individuals, or individuals who have difficulty travelling to attend workshops.
Modifications to the GMB process that facilitate greater accessibility for these
individuals should be explored – particularly approaches which allow for remote
or computer-assisted participation in GMB.

At a broad level, this thesis recommends that the quantitative data
collection program and GMB process, having been demonstrated in this research,
be expanded to support a multi-setting, community-led prevention project. The
GMB process described in this research could be implemented across a number of community settings to identify targets for adolescent lifestyle-based behaviour modification, and communities could be supported to translate GMB insights into action plans for community-led intervention efforts. Opt-out data monitoring within those communities could run parallel to the complex, community-based intervention to gather high quality, representative data on changes in health behaviours and outcomes as a result of prevention activity. Revision and iteration of the community-led System Dynamics models over time could also provide process evaluation, tracking changes in the adolescent lifestyle health system over time, and the changes in system structure which are contemporaneous with prevention activity. Identification of influential variables and feedback loops within the System Dynamics models would also provide guidance on what data to collect through the data monitoring programme in order to enable the development of the qualitative community-led CLDs into fully quantified simulation models. Over the longer term, the creation of a simulation model would enable the development and testing of more sophisticated prevention strategies.
Chapter 8: Conclusion

This thesis has presented new evidence for gender-specific associations between physical activity, screen-based sedentary behaviour and diet pattern, and the likelihood of self-reported depressive symptomology among Victorian adolescents. The thesis also presents the first example of a rapid group model building study, tailored for engagement with community-based stakeholders in multiple settings, which found that adolescent physical activity and dietary behaviour were strongly influenced by peer culture and social norms, technology use, individual level knowledge and education, time pressure, study pressures and engagement in school.

These findings represent new epidemiological evidence regarding lifestyle behaviours and their associations with mental health among the Victorian adolescent population, as well as a novel, complex conceptualisation of the causes of adolescent lifestyle behaviours in the community setting. This research has affirmed the important role of lifestyle in the future prevention of depression symptoms in adolescence, and demonstrated a process that engages communities in generating insights into the complex drivers of lifestyle behaviour. Further, the process used in this thesis aligns with current best practice for population-level, lifestyle-based prevention, and can be used to identify community-specific intervention targets.
References


130. Scholl HJ. Action research and system dynamics: can they benefit from each other? 37th Annual Hawaii International Conference on System Sciences Proceedings; Jan2004. p. 11.


Adolescent Lifestyle and Depressive Symptoms: Associations and Complex Community Determinants

APPENDICES

by

Joshua N. Hayward
(B.Psych (Hons))

Submitted in fulfilment of the requirements for the degree of:

Doctor of Philosophy

Deakin University

October 2016
Contents:

Appendix A: Beyond the Bell Report “A Community-based Complex Systems Approach to High School Completion” ......................................................... 3

Appendix B – Recruitment .................................................................................... 13
  B.1 - HTCE Principal Information Letter .......................................................... 13
  B.2 - HAL LGA Information Package ............................................................... 15
  B.3 - HAL Principal Information Letter ............................................................ 24

Appendix C – Tools ............................................................................................... 25
  C.1 - HTCE Questionnaire ................................................................................. 25
  C.2 - HTCE Anthropometry Data Collection Sheet .......................................... 37
  C.3 - HTCE Data Collector Training Manual .................................................... 38
  C.4 - HAL Facilitation Manual .......................................................................... 70

Appendix D: Study Ethics Clearances ................................................................. 90
  D.1 - HTCE Ethics Approval – Deakin University ........................................... 90
  D.2 - HTCE Ethics Approval – Department of Education and Early Childhood Development ......................................................................................... 91
  D.3 - HTCE Ethics Approval – Catholic Education Office Melbourne ............ 93
  D.4 - HTCE Ethics Approval – Catholic Education Office Ballarat .................. 95
  D.5 - HTCE Ethics Approval – Catholic Education Office Sandhurst .............. 96
  D.6 - HTCE Ethics Approval – Catholic Education Office Sale ....................... 97
  D.7 - HTCE Plain Language Statement & Consent Form ................................. 99
APPENDICES

D.8 - HAL Ethics Approval – Deakin University ........................................... 106
D.9 - HAL Ethics Approval – Department of Education and Early Childhood Development .................................................................................................... 108
D.10 - HAL Ethics Approval – Catholic Education Office Melbourne ........... 110
D.11 - HAL Plain Language Statement & Consent Form (LGA Personnel & Health Service Staff Version) .......................................................................... 112
D.12 - HAL Plain Language Statement & Consent Form (Student & Parent/Guardian Version) ................................................................................ 117
D.13 - HAL Plain Language Statement & Consent Form (Teacher Version). 123
Appendix E – Outputs.......................................................................................... 128
E.1 - HAL School Report – Stream 1 .............................................................. 128
E.2 - HAL School Report – Stream 2 .............................................................. 145
E.3 - HAL Final CLD – Stream 1 ................................................................. 162
E.4 - HAL Final CLD – Stream 2 ................................................................. 163
E.5 - HAL Student Participation Certificate.................................................... 164
High school completion, like many educational phenomena, is the result of processes that, when taken together, constitute a complex system. In this paper, we describe the innovative use of group model building (GMB) as an entry point for complex systems analysis of educational processes that collectively determine high school completion. GMB exercises were conducted in a community in the state of Victoria in Australia. GMB brought together stakeholders from around the community and encouraged them to view high school completion from a complex systems perspective. Not only were participants able to use their experience to create an action plan to increase high school graduation rates but they also provided researchers with valuable information that can be used as input into rigorous, quantitative models of high school completion. Copyright © 2016 John Wiley & Sons, Ltd.

Keywords complex systems; education; high school completion; group model building

INTRODUCTION

Education is a highly complex landscape, situated at the intersection of a number of interests, institutions and cultural influences. Education is typically classified as a ‘mixed good’, with both public and private aspects. Students and their families have an interest in pursuing educational attainment in order to reap the many benefits associated with it, which prominently include advantages in the labour market. Similarly, governments, communities and businesses are all strongly affected by the amount and form of education that individuals with whom they interact receive.

In many places, the completion of high school has historically been an important milestone from the standpoint of individuals, institutions and society. It represents the transition from societal to individual control and responsibility. Prior to the completion of high school, governmental agencies primarily determine the form that education will take, from facilities to personnel to curricula. Access to this education is universal and is paid for with public funds. After the completion of high school, control and responsibility devolves to individuals, who can select from a large array of options including no further education; vocational education; and undergraduate, professional and graduate degrees in a large
number of fields, available at a variety of different types of postsecondary institutions. Individuals are primarily responsible for procuring education beyond high school completion. As a result of the important liminal status of high school completion, it is expected to serve multiple purposes. A high school degree indicates that a government has discharged its obligation to provide a 'sound basic education (Duncombe et al., 2004). It also is intended to serve as a signal of an individual’s readiness to competently serve in the military, participate in the labour market or continue into postsecondary education and is used as a prerequisite (to a greater or lesser extent) for each of these.

There are thus not only a number of different stakeholders invested in determining how many students and who completes high school but those who also have different priorities when they exert their influence to affect what graduation from high school entails (Labaree, 1997). At any point in time, overall distributions of high school completion represent a delicate and dynamic balance of interests. Interventions that are intended to have a specific effect on high school completion are likely to alter this balance in ways that generate resistance or adaptation that thwarts the intended effect. However, approaching high school completion from a complex systems perspective offers the potential to obtain powerful insights about why interventions have the overall effects that they do and how to select alternative mixes of policies to obtain different outcomes (Maroulis et al., 2010; Bruch & Atwell, 2015; Hammond, 2015). High school completion, like many educational outcomes, is the result of processes that manifest each of the properties mentioned previously. Changes in policies can have disparate impacts on graduation rates across students based on a number of observable attributes including racial or ethnic group, socioeconomic status, educational aptitude or achievement and geographic location (Rumberger, 1987).

High school completion can be expected to display interconnectedness in multiple ways. Perhaps most importantly, students are socially situated; one student’s decision to complete high school despite challenges or to leave school can have a substantial effect on subsequent decisions made by his or her peers. There can be important feedback effects. For example, effectively increasing graduation rates by a substantial amount might create either social (e.g. through changing norms) or economic (e.g. through labour market disadvantages for those without high school degrees) incentives that encourage further increases. Finally, individuals and institutions with an interest in high school completion can adapt over time in response to changes in the educational environment. For example, if requirements for graduation are substantially loosened, businesses or colleges might begin utilizing additional certifications to supplement a high school degree when assessing candidates.

In order to conduct meaningful analyses of a complex system, it is first necessary to understand the structure of the system and how it can
best be characterized in an analytic framework. In order to do this, we must identify the educational environment where we are interested in exploring high school completion; determine who the relevant actors, institutions and stakeholders are; and explore how these elements interact with one another. There are many different ways to approach this task. It can be carried out with empirical evidence, theory or consultation with experts in the field or practitioners (Hammond, 2015). In addition, GMB represents a powerful tool that can be used to understand a complex system, either on its own or in conjunction with other sources.

METHOD: GROUP MODEL BUILDING

Rationale

During the development of municipal health promotion strategies, a regional community in Victoria, Australia, identified low rates of high school completion as a high-priority concern for their local population. Some members of the municipal council had participated in previous GMB projects in the region and determined that something similar would be a fruitful approach to this problem (Allender et al., 2015). In order to aid this community in developing a strategy for improving high school completion, we employed workshop sessions grounded in the GMB research approach, bringing together stakeholder groups from various community organizations and settings for the purpose of creating a representation of the dynamic system under investigation (Andersen and Richardson, 1997; Hovmand et al., 2012; Hovmand 2014). The approach facilitates the exchange and sharing of knowledge among participants, building understanding and shared conceptualization of this problem while also creating a product that participants, policymakers or other stakeholders could draw from when designing responses to increase high school completion rates (Richardson and Andersen, 1995; Andersen et al., 1997).

Group model building is scientifically appropriate for conceptualizing complex systems within community settings (Hovmand, 2014). At the community level, there are a number of interdependent and interacting actors dispersed across different organizations or community contexts who have some influence over the educational system. Despite the importance of each of these individual actors within this system, the complexity of the educational system and the physical and mental demands placed on many of these actors can preclude them from engaging in meaningful collaboration. Individuals tend to have a strong understanding of the sections of the system in which they operate but have a less clear picture about the system as a whole (Hovmand et al., 2012). However, if given the opportunity to bring together their separate perceptions, they can develop a rich map that describes how different sections of the system interact with one another over time (Hovmand et al., 2012; Scott et al., 2013).

The use of the GMB methodology had a second, desirable outcome of fostering community ownership of, and responsibility for, the educational attainment issue. A central tenet of the GMB approach is its ‘bottom up’ approach, whereby the content and structure of the model and workshop outputs are provided by the participants rather than the researchers. Thus, findings tend to be highly responsive to and reflective of local contexts and are ‘owned’ by the stakeholder group that produced them (Thomas and Reilly, 2015). This ownership is intended to empower participants and build motivation to continue working together to design and implement effective changes in their community (Allender et al., 2015).

Planning/Design

Three researchers with experience and training in GMB, group facilitation and community action planning were approached by representatives of a community coalition to design and facilitate a series of workshops to explore local barriers to high school attainment. Following consultation with local government and community stakeholders, each member of the ‘core modelling team’ (JH, CB, BO, AK, MM) reached a consensus that the aim of the
workshops was to visually represent barriers to high school attainment via a causal loop diagram (CLD). The design of the sessions was developed using GMB scripts, from the ‘Scriptapedia’ database (Hovmand et al., 2012), and followed a two-workshop structure, with an initial 3-h session, followed by a follow-up validation session approximately 2 weeks after.

**Execution**

**Workshop Session 1**

At the commencement of the first session, participants received an overview of the best available data describing the issue at a community level, describing the percentage of adolescents completing year 12 in the community, compared with the surrounding regions, and Victoria as a whole. Participants were then prompted to think about high school attainment as a dynamic problem and identify as many variables as possible that have affected or been affected by high school attainment in their community over time. This activity generated a community-identified list of the top 12–15 most important determinants of educational attainment in the community. The second exercise involved a facilitated group discussion of these variables, referred to as the ‘connection circle’ exercise, throughout which a second facilitator, acting as a ‘modeller’, recorded each variable using a system dynamics computer software package (Vensim, Ventana Systems, Harvard MA, USA). As the primary facilitator led the discussion, the modeller updated the emerging causal diagram in real time on the computer software, which was projected for participants to see. Participants identified which of these variables were causally connected, as well as the ‘polarity’ of the connection. The polarities were denoted either positive (signifying a positive correlation between the connected variables) or negative (signifying an inverse correlation). Participants were urged to add, remove or modify variables and their connections continuously throughout the exercise, and note takers captured the discussions as close to verbatim as was practicable.

Following the first session, the initial diagram that had been constructed by participants was developed into a formal CLD that includes both positive and negative causal linkages between system elements and identifies both reinforcing and balancing feedback loops. This task was completed by the two members of the core modelling team who had acted as the facilitator and modeller in the first session (JH, BO). Each of the three sets of notes that captured participants’ discussion from session 1 was reviewed alongside the initial diagram to corroborate the variables and connections that were specified in the computer software. Other variables and connections that had been captured in the notes but had not been included in the model were added at this stage. All available notes on each causal connection or variable in the CLD were discussed collaboratively between JH and BO to ensure agreement. Clusters of variables were then identified and organized according to the emergent themes.

**Workshop Session 2**

In the ‘model validation’ session, the formalized causal loop diagram was presented to community stakeholders, with the key domains highlighted (school settings and resources, local opportunities and messages, support services and resources, mental health and wellbeing and access to education/ geography). At the beginning of the session, the purpose and scope of the activity were reiterated to participants, and the work of the first session was presented to participants as a ‘refresher’ of the initial session. Participants were then given time to read and consider the updated CLD and to provide written feedback on the diagram, chiefly regarding positive comments (to validate elements of the model that were ‘correct’ from the communities perspective), general comments (to encourage engagement with and ownership of the model) and negative comments (to identify ‘gaps’ or areas that could be improved with further development of the CLD). Comments were attached to the CLD using colour-coded post-it notes. Positive or confirmatory comments were placed on
green post-its—general on yellow and negative comments on red post-its.

RESULTS

Throughout the two sessions, the participatory GMB methodology that was employed was successful in engaging the stakeholder group to create a CLD of the drivers of high school completion. The outputs of the workshop at several key workshop stages are described in detail in the following.

Session 1

During the initial discussion of determinants of high school completion within the target community, and the subsequent connection circles exercise, participants recognized multiple levels of facilitators and barriers to high school attainment. Examples of facilitators identified by the group included ‘parent attitudes toward education’, ‘educational and community resources’, ‘access to education’ and ‘cultural safety and inclusion’. Examples of barriers included ‘bullying (social media)’, ‘alcohol/other drug use’, ‘dependence on support services’ and ‘geographic distribution’. Throughout the discussion, participants were able to identify many causal linkages between the identified determinants. Figure 1 displays the CLD, as it appeared following the construction of the initial diagram in the connection circles exercise and the review of the notes from the first session. Two examples of feedback loops (discussed in detail in the following) are highlighted in red and green.

Session 2

In the second session, participants were given an opportunity to provide written feedback on the model, validating parts of the model that were correct, from their perspective, and identifying areas of the model that were problematic or could be developed further at a later stage.

Positive feedback confirmed variable names and causal links between variables across the CLD. For example, each of the working groups had given written feedback that validated the model as an accurate representation of their perceptions, with notes distributed evenly across the CLD. Participants typically provided positive comments by placing a blank or ticked/check marked green post-it notes next to variables that agreed with. Other confirmatory comments were typified by a general but positive comment. For example, one participant placed a green post-it next to the variable ‘School Participation’ with the comment ‘Key strength’. General commentary was also evenly dispersed across all groups and was frequently used when participants wished to append some additional information to a variable. In one example, a yellow post-it was attached to the variable ‘ATAR-Centric thinking’ with the comment ‘lack of support for VCAL programme’. Negative feedback tended to provide more detailed and specific commentary on the CLD. One participant appended a red post-it with the comment ‘Knowledge of scholarships’ to the variable ‘Financial support for programmes’. This comment indicated a gap in the model, whereby the financial support available to support adolescents taking part in specific educational programmes was an incomplete description of how the participant saw this determinant. The participant indicated that it was not only availability of financial support that was important but also the awareness in the community of what support might be available. Another negative comment appended to the variable ‘Availability of students desired subjects/courses’ was ‘School students not funded to do TAFE (Technical And Further Education) programs’, indicating a gap in the model around how funding for a specific school programme affects student decisions to complete high school. A final example of a negative comment was ‘limited opportunities for

---

1 ATAR, Australian Tertiary Admission Rank. ATAR is the scoring system used to rank students’ academic performance on completion of their year 12 studies and is the primary selection criteria for tertiary education courses in Australian universities.

2 VCAL, Victorian Certificate of Applied Learning. VCAL is an alternative study pathway for students during the later years of high school. Participating students can complete ‘certificates’ in applied learning areas in place of the more typical year 12 subjects.
traineeships/apprenticeships’, which was attached next to the variable ‘perceived pressure to finish year 12’. This comment indicated a gap in the model, whereby the perceived pressure to finish year 12 was an incomplete description of how the participant saw this determinant. The participant indicated that this perceived pressure was important but that the model did not as yet include the capacity of local industry to offer trade-based training (i.e. electrician, plumbing, building apprenticeships, etc.) as an alternative to year 12 studies, as something which increased the perceptions of pressure to complete year 12.

Overall, participants provided mostly confirmatory feedback indicating that the CLD was a valid representation of their perceptions of the drivers of high school completion in their community. In addition, participants provided general commentary, giving some minor additional detail to existing variables in the CLD and suggesting areas for minor potential improvement of the CLD. The working groups that provided the most written feedback of the three groups provided a total of >20 confirmatory notes, ~10 general comments and 4 comments indicating problems in the CLD.

### Causal Loop Diagram Insights

**Feedback Loops**

Throughout the workshop sessions, participants located several feedback loops, both reinforcing and balancing. Examination of the CLD using the Vensim computer software identified in excess of 40 feedback loops across the CLD, varying in length from 3 to 10+ variables.

Although there is much feedback in the model, the following examples reflect key feedback mechanisms both within the model and as revealed through confirmatory conversations. Participants identified a reinforcing loop, labelled ‘low parent capacity reducing service engagement’. Participants were able to use this loop to describe the scenario whereby low parent capacity within the community was driving poorer...
parental attitudes towards education. Where these attitudes were poor, parents were less likely to engage with support services regarding their children’s education, which decreased the overall effectiveness or quality of educational services for family and youth in the region. Low-quality services were seen as a potential cause of poorer mental health in the region, which contributed to the overall disability burden within the community, which further reduced parent capacity. This feedback loop is highlighted in red in Figure 1.

A further example of a feedback loop in the diagram is labelled ‘poor cultural inclusion reducing confidence to seek support’. Using this loop, participants described how poor cultural safety and inclusion in the community were driving low self-efficacy, particularly among cultural minority groups in the region. Low self-efficacy was seen to reduce community members’ preparedness to admit to, or ‘own up to’, issues regarding education, and thus, willingness to engage with support services was reduced. Low engagement with support services, as with the first loop, led to poor quality support service provision to family and youth in the region, which was a driver of poor parental attitudes towards education. Finally, poor parental attitudes towards education reinforced the poor sense of cultural safety and inclusion of minority cultural groups. This feedback loop is highlighted in green in Figure 1.

Themes
We conduct a final qualitative analysis by reducing the CLD to an ‘abbreviated form’, an approach that has been used successfully by Finegood et al. (2010) to assess the relative size and interconnectedness of major themes that emerged from the diagram. Each of the theme clusters in the CLD (Figure 1) was collapsed and represented as a single box in Figure 2. In this figure, each box represents a thematic cluster from the CLD, and the line weight of the box outline represents the relative size (i.e. the total number of variables included in the cluster) of that cluster from the CLD. The arrows connecting the cluster names represent the relative number of causal connections that connected variables from one cluster to another.

There was a considerable range in the size of the themes. The smallest thematic cluster was ‘Access to education/geography’, which contained only seven variables, and the largest was ‘Mental health & wellbeing’ with 33 variables. ‘School settings & resources’ was the second largest cluster, containing 25 variables, and ‘Support services & resources’ and ‘Local opportunities & messages’ were similarly sized with 17 and 18 variables, respectively. Causal connections bridging the different clusters were much more consistent, with a minimum of one connection (‘Access to education/geography’ to ‘Local opportunities & messages’ and vice versa) and a maximum of four connections from variables in the ‘Support services & resources’ cluster to the ‘Mental health & wellbeing’ cluster.

Overall, the examination of the thematic clustering of the CLD seems to suggest that many of the determinants of high school completion may be described as being related to school settings and resources and mental health and wellbeing, with a particularly prominent focus on the latter. Determinants relevant to adolescents’ mental health and wellbeing also appear to be heavily influenced by the availability of support services and resources within the community, as well as the availability of local employment opportunities and the messages about those opportunities that are communicated within the community.

DISCUSSION

Direct Effects

The project successfully generated a CLD of local barriers to high school attainment via a complex
systems lens. Community coalition members were able to describe the system that drives high school completion by identifying specific, key causal variables and explaining the manner in which these variables interact. Participants successfully identified positive and negative feedback loops and discussed the dynamics that affect their operation. Participants then had an opportunity to reengage with the model for validation purposes; this not only provided researchers with additional, nuanced information but it also gave participants valuable, hands-on experience iteratively improving upon a model of a complex system.

The GMB process fostered multilayered discussions about the complexity of barriers to high school attainment in the community that would otherwise have been challenging to engage in. During the course of engaging in GMB activities, we observed community members first learning about and then internalizing complex systems thinking in ways that we believe enhanced their understanding of the problem and the potential effectiveness of the interventions that they might deploy. As we progressed through each iterative step of the GMB process, participants’ discussions made it clear that they were moving from an understanding of education in their community as a limited set of cause-and-effect relationships that they took part in or observed to a deeper understanding of the education system as an interconnected whole.

Discussion of feedback loops appears to have played a vital role in fostering systems perspectives. Participants first successfully identified and discussed variables driving the problem and the causal linkages between them. Then, group members effectively delineated feedback loops and demonstrated an understanding of nonlinearity through discussions of reinforcing or balancing effects of feedback loops on the system. Feedback structures in the CLD were a focus when the group began initial discussions of intervention targets and actions. For this phase of the workshop, participants were divided into subgroups and selected action areas based on their interest or role in the community. Feedback loops within the CLD were used as a frame of reference for discussion within these subgroups, with the CLD serving as a prominent visual aid and feedback loops used as springboards for brainstorming potential actions. We believe that participants focused their attention on these feedback loops because the insights that they provided were both powerful and, as they were only apparent after creating and inspecting the CLD, novel. Although we have not yet reviewed a finalized version of an action plan created by the stakeholder group and other community members, our observations give us confidence that this plan benefits from stakeholders’ participation in the GMB process.

Group model building is inherently participatory and democratic: participants ranging from school principals to indigenous community representatives were asked to work together to act as a modelling team to create a shared consensus about the system that drives high school completion in their community. Overall, the successful implementation of GMB in this community had three key, direct effects:

1. Community members representing different groups and organizations engaged with one another, forming meaningful connections.
2. Participants were empowered and encouraged to view problems from a complex systems perspective and thus will formulate interventions and communicate the problem and potential solutions to other members of the community through this lens.
3. Each participant has a sense of investment in and ownership of the products that were created (e.g. the CLD). Thus, participants are motivated to use this tool and to cooperate with one another and recruit additional community members as needed to design and implement effective changes as part of an action plan to increase high school graduation rates in their community.

Research Implications

There is a growing belief among educational researchers that complex systems research can...
supplement traditional quantitative analysis approaches to produce powerful insights into educational processes and policies, helping to answer questions about why particular outcomes are observed and how effective policies can be crafted, and this belief has translated into increased use of these approaches to study educational problems (Maroulis et al., 2010). Researchers have already been able to satisfactorily employ complex systems approaches to begin answering important and interesting educational policy questions (Montes, 2012; Kasman, 2014; Maroulis et al., 2014; Salgado et al., 2014). The current body of research on high school completion reveals a consensus that it exhibits complex system properties, with heterogeneous policy effects, interconnectedness and adaptation (Rumberger, 1987; Labaree, 1997; Bradley & Renzulli, 2011; Harris & Kiyama, 2013). However, we have not encountered any extant complex systems models of high school completion.

When approaching a complex system for the first time, the initial and most substantial challenge faced by researchers is determining how to characterize a complex system in a way that elegantly captures all of its essential elements and relationships within a tool that can be used as a ‘virtual laboratory’ where hypotheses about mechanisms and policy changes can be explored. GMB offers a way to kickstart the model design process by providing important information from the collective observations of a range of stakeholders who are most intimately familiar with a given system. Thus, the products and observations generated by the GMB project are not only immediately useful for generating action but also represent important inputs into a potential next phase of this project. This effort would attempt to create a rigorous, quantitative complex systems model (e.g. a system dynamics model or agent-based model) of high school completion. Once this model is designed using GMB input, it can then be calibrated using data from the community and finally used as a test bed to generate important insights about policy effects in this context. In turn, both these findings and the underlying model can be used to inform policy changes and formal modelling efforts in other communities.

CONCLUSION

In this paper, we explore high school completion using a complex systems framework. We first identify elements of the overlapping processes that affect high school graduation that make it an appropriate focus of complex systems analytic approaches. We then describe the deployment of GMB to study this phenomenon in a specific context in Victoria, Australia. Although we have not seen the secondary results of the GMB process (e.g. a finalized action plan or implementation effects), we look forward to exploring these in future research. Beyond the immediate implications for the featured community, we suggest that this descriptive paper provides benefits that are twofold. Firstly, the GMB process can be replicated in other communities to bring together stakeholders from different community groups to create consensuses about the forces that hinder graduation rates and, using these insights, craft interventions that these stakeholders believe have high potential for positive effects. Secondly, products created during this and other GMB processes can be used as the basis for quantitative complex systems models (e.g. agent-based models or system dynamics models) that can be used to prospectively explore the efficacy of a large number of interventions, possibly across a number of different communities. Because designing and implementing interventions—especially interventions that address phenomena influenced by complex systems—can be expensive in terms of resources, capacity, motivation and opportunity, uncertainty about expected effects can be daunting; both of the benefits that we posit represent ways to increase the ability of researchers, policymakers and community stakeholders to confidently craft interventions that can effectively and meaningfully increase high school completion rates.

REFERENCES


Maroulis S, Bakshy E, Gomez L, Wilensky U. 2014. Modeling the transition to public school choice. *Journal of Artificial Societies and Social Simulation* 17(2). Available at: http://jasss.soc.surrey.ac.uk/admin/about.html


Appendix B – Recruitment

B.1 - HTCE Principal Information Letter

The Principal (Insert Name)
School Name
School Address
Victoria

Date: xx/xx/xxxx

Dear Insert Name,

We are writing to you to invite your school to participate in the ‘Healthy Together Children’s Evaluation’ (HTCE). The HTCE aims to evaluate long-term changes in healthy weight and associated behaviours among school children in Years 4, 6, 8 and 10 in your community. In recent years, several initiatives have been implemented to reduce chronic disease and improve the health of the Victorian population. These have included a particular focus on encouraging healthy eating and physical activity, and reducing overweight and obesity in children and young people; however, little empirical information exists on the effectiveness of these programs. The HTCE aims to examine changes in healthy weight and related behaviours among Victorian school children on an annual basis in Term 4 in the years 2013, 2014 and 2015. We are inviting your school to participate in the 2014 evaluation.

This study has strong support from the Victorian Department of Health and Deakin University. The information from this study may be used to inform policy and practice at the community, state and federal levels on approaches to promote healthy weight among school children.

Should you consent for your school to participate, all students in two year levels in your school comprising either Years 4 and 6 OR 8 and 10 will be invited to participate in the study. Participation is voluntary and we plan to recruit students from each of these year levels across several local councils in Victoria throughout Term 3, 2014 (a minimum of 2600 students in total will be recruited). With your cooperation we plan to collect the following information from students who return a signed consent form (attached). All data collection will be conducted during normal class times:

a) **Complete a 10-page self-report recall survey** regarding participation in physical activity and sedentary behaviour, dietary intake, perceived quality of life (all participants) and aspects of mental health (Years 8 and 10 only) (35min).

b) **Have measurements taken** of their height, weight and waist circumference and a small sample of students will be fitted with a small activity monitor (like a pedometer) (5 min per child).

We have ethics approval from the Victorian Department of Education and Early Childhood Development, the Catholic Education Office Archdiocese (Melbourne, Sandhurst, Ballarat and Sale) and Deakin University’s Human Research Ethics Committee (DU-HREC). We have funding to conduct this study and support from the Victorian Department of Health and the Centre of Excellence in Intervention and Prevention Sciences. There are no financial or other rewards/incentives offered to schools or students to participate in this study. This study employs an OPT-OUT consent process...
(similar to NAPLAN), whereby only students who do not wish to participate return the signed plain language statement and OPT-OUT consent form.

We understand there are enormous time and curriculum constraints for Victorian Schools which is why we have designed this study to keep the disruption to school functioning to a minimum. A team of trained data collectors from Deakin University with current Victorian Working with Children's Checks will attend your school on data collection days and every effort will be made to reduce the time children are not in class. Experience suggests that liaising with your Health or Wellbeing coordinator within your school is the most efficient way for our researchers to discuss times and dates for data collection. It is envisaged that a maximum of two visits to your school would be required. The first visit will be to hand out the Plain Language Statements and consent forms and to inform and discuss the study with students (this could be done through a year-level assembly or morning roll call and will take <5 minutes). The second visit would be to conduct the survey and take anthropometric measurements among school children (this could be done during a Physical Education, Health or Science class or at a specified time during the school day). A third visit may be scheduled to pick up the activity monitor (1-2 minutes), although these can be returned using the provided reply paid envelope.

We would greatly appreciate you taking the time to read the attached paperwork and consider your participation in the study. We are happy to address any concerns you may have about your schools’ potential involvement so please do not hesitate to contact us for further information. Members from Deakin University will contact you via telephone within 2-3 days upon receipt of this information to answer any questions you may have and to garner your support.

Kind regards,

[Signatures]

Dr Claudia Strugnell
Research Fellow
World Health Organization
Collaborating Centre for Obesity Prevention, Deakin Population
Strategic Research Centre
Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8483
claudia.strugnell@deakin.edu.au

Dr Lynne Millar
Research Fellow
World Health Organization
Collaborating Centre for Obesity Prevention, Deakin Population
Strategic Research Centre
Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8483
lynn.millar@deakin.edu.au

Professor Steven Allender
Co-Director
World Health Organization Collaborating Centre for Obesity Prevention, Professor of
Population Health, Deakin Population
Strategic Research Centre
Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305
steven.allender@deakin.edu.au

Please find attached a copy of the Plain language statement and consent form for parents and students and the proposed questionnaires for students to complete.
Healthy Adolescent Lifestyle (HAL) Mapping Project

Understanding Physical Activity and Diet Behaviours in Victoria, Australia

Project Overview
2015
Executive Summary:

The purpose of this project is to gather key stakeholders within two Local Government Areas to engage in workshops to develop a “map” that represents the determinants of healthy adolescent physical activity and diet behaviours within specific regions of Victoria.

A group of key community stakeholders will be identified, which includes staff from selected Local Government agencies, as well as teachers and students from schools within the local area. These stakeholders will participate in two facilitated participatory workshop sessions of 90 minutes each. The first of these sessions will produce an initial map of adolescent diet and physical activity determinants. After an interval of approximately 2 weeks, during which time the outputs of the first workshop are revised, participants return for a second workshop. In this second session, participants are guided through activities to review and confirm the model. After the second workshop, participants’ feedback and comments are incorporated into the model to produce a “finalised map” which is communicated back to participants in their home organization or setting.

This project will result in benefits to the participating organizations and individuals by building shared consensus around the determinants of healthy physical activity and diet behaviours among adolescents in their community. Schools will benefit from an increased understanding of the various factors at the school and community level which influence the health behaviours of their students. This will result in greater knowledge of determinants which operate within the school environment, as well as greater awareness and understanding of the determinants which influence their students from the broader community setting. The workshop process will further highlight the complex and interconnected nature of these determinants.
## Table of Contents

- Executive Summary: ................................................................. 2
- Aims of the Project: .............................................................. 4
- Study Design and Workshop Structure: .................................... 4
- Overview of Workshop Sessions: ............................................. 4
- Participant Group: ................................................................. 6
- Recruitment Process: ............................................................ 7
- Consent and Data Storage: ...................................................... 7
- Participant Benefits & Risk Management: ................................. 8
- Further Information: ............................................................... 9
Aims of the Project:

The purpose of this project is to gather key stakeholders within two Local Government Areas to engage in a series of two 90-minute workshops to develop a “map” that represents the determinants of healthy adolescent physical activity and diet behaviours within their region.

Study Design and Workshop Structure:

Within each community, two separate groups will be convened, for a total of four groups across the entire project (See Figure 1 for research design overview). This design allows the researchers to achieve one of the main objectives of this study: Through this research, we hope to examine the kinds of similarities and differences between maps produced by this workshop process, when the same workshop structure is used in different groups and different locations.

Figure 1: HAL Maps Research Design Overview

The workshops designed for this project are based on a novel workshop methodology. This approach guides each stakeholder group through a series of structured participatory tasks to examine participants’ mental models (their individual perspective of “how the world works”) of a given situation or problem.

Overview of Workshop Sessions:

An initial session will be conducted for 90 minutes with each group to produce an initial map of adolescent physical activity and diet behaviour. The first session is facilitated by two or three research staff, and up to three “recorders” who take notes throughout the session. The output at the end of the first session is described as a “spaghetti map” (see Figure 2 for
example), and is revised significantly between the first and second workshops by the research staff, using the notes taken by the recorders. This process ensures that any discussion points which are not captured during the initial in-workshop modelling can be retrospectively added into the map.

**Figure 2:** Example of typical “spaghetti map” diagram (Actual variable names removed)

After an interval of approximately 2 weeks, participants return for a second workshop, where the revised map is presented (see Figure 3 for example). Participants are led through a second set of facilitated activities to review and confirm the model. The session is facilitated by the same team as the first session. During this session, participants actively reflect on the map, providing comments and feedback on its accuracy – modifying, adding or deleting from the map as they feel is necessary. The output of this session is a revised map, with extensive participant feedback, which is given a second round of development.

**Figure 3:** Example of a typical “revised map” (Actual variable names removed)
After the model has been further revised after the second workshop, it is in its final version, and is communicated back to the participants for their own interest, or use in their organization. A summary of the overall workshop format is displayed in Figure 4, below.

**Participant Group:**

The participant group will consist of community stakeholders from Local Government, as well as secondary schools from the area. The secondary school participant group will involve teacher and student representation.

Within each community, the project plans to recruit a group of up to 32 participants. The breakdown of a participant group will be approximately as follows: up to 16 stakeholders from within the LGA (e.g. health promotion officers, project support officers, etc); and up to 8 teacher-student pairs from secondary schools within the community. (N.B. teachers and students are being recruited as pairs specifically to satisfy schools legal requirements around student supervision – if a teacher withdraws from the study and a replacement teacher from the school cannot be found, then the student will be automatically withdrawn).

Once the participant pool has been established, all LGA staff and student-teacher pairs will be randomised into one of the two workshop groups for that particular community. Randomization will be conducted in such a way that each group is made up of 50% LGA staff and 50% student-teacher pairs.
Recruitment Process:

Participants will be recruited via purposive sampling. If working relationships exist between LGA staff and key secondary school contacts, the assistance of LGA staff will be sought to assist with the recruitment of secondary schools.

Secondary schools will be contacted by phone and/or email, and asked to identify one teacher representative and one year 10 student representative (approximately 16 years of age) to participate in the workshops. Mail correspondence and contact via phone will aim to liaise directly with the school principal at first, with the goal of identifying a participant teacher who will then become the liaison for the duration of the project.

Consent and Data Storage:

Once the group of 16 LGA staff have been identified, plain language statements and consent forms will be distributed to these participants. For school participants (teachers and students) once a school has been invited to participate, a package containing information about the study, as well as teacher and student plain language statements and consent forms will be forwarded to the school by mail or email.

If practicable, consent forms will be collected prior to the workshop taking place, however consent forms may be produced on the day of the workshop. School teachers and local government participants who attend on the day, but have not provided a consent form will be required to complete one prior to the workshop commencing. School student participants who attend without a consent form will only be allowed to participate if a parent or guardian can be reached by phone to provide verbal consent. Where a school teacher withdraws consent, the student participant from that school will also be withdrawn.

The data stored will be non-identifiable, and will not be re-identifiable. Map outputs will be primarily electronic in nature, however some hard-copy outputs will be produced including workshop notes taken by the investigators, and some written descriptions of variables produced by the participants. Electronic outputs will be stored on secure Deakin servers for five years after the final publication of the research outcomes, and hard-copy outputs will be stored for the same time period in locked storage within the WHO Collaborating Centre for
Obesity Prevention at Deakin University Waterfront Campus. After this time, electronic data will be destroyed by file deletion, and physical materials will be shredded by a secure document disposal service. Throughout the research, participants will not be asked to disclose any information which is specific to any person. Publications will not disclose or imply any participant information.

**Participant Benefits & Risk Management:**

The purpose of this project is to guide key stakeholders within a specified community through a facilitated group process. These workshops are used to develop models of the determinants of physical activity and diet behaviours within their region. Mapping the physical activity and diet behaviour system using this technique helps identify system elements that may be potential targets for disease prevention intervention efforts.

This project will have community benefits as the project will foster greater understanding of the systemic causes of adolescent physical activity and diet at the community level. This will be of particular benefit to participants from each LGA, who may find this insight useful in their health promotion activities. Similarly, school staff who participate may find the insights useful for work in the education setting.

The proposed workshop process asks participants to discuss health risks and associated health issues related to adolescent physical activity and diet behaviour at a regional/societal level but at no time will participants be asked to discuss personal information. This project does not require participants to talk about their own personal diseases or health problems, nor will any participants be identified in any manner. The workshops discuss in general the influences on physical activity and dietary intake within their community.

The research project is interested in societal and system level determinants of adolescent physical activity and diet behaviours. To this end it is appropriate that adolescents should be included in the research. While the participants, including those aged under 18, will be subject to the full consent process including the plain language statement and signed consent form (with parent/guardian consent where necessary), the data collected during the research process relates to participants perceptions of societal causes of disease. No personal data will
be identified and there is very low risk of any sensitive personal information being divulged. The research team have been closely involved in previous community based prevention interventions among adolescents, and have all undertaken ethics training and advanced training in facilitation techniques to ensure that participants are given equal voice within sessions and that personal data are not shared. To give a sense of the nature of data collected similar process have generated variables such ‘time to prepare food’, ‘water quality’ and ‘school curriculum’ as possible drivers of dietary patterns in one community.

Further Information:

Thank you for taking the time to read this study brief regarding the HAL Maps project.

If you have any further questions about the study, or the content of this document, please do not hesitate to contact Joshua Hayward at one of the following addresses:

Joshua Hayward
WHO Collaborating Centre for Obesity Prevention
Deakin University Waterfront Campus
1 Gheringhap Street, Geelong, Victoria 3220
Ph. 0437 029 030
Email: jnh@deakin.edu.au
Dear Principal or School Representative,

Your school is cordially invited to take part in the Healthy Adolescent Lifestyles Community Mapping (HAL Maps) Project. This project aims to bring together students, teachers, and health promotion professionals from Greater Geelong to build a collaborative picture of the determinants of physical activity and healthy diet for adolescents in the Geelong community.

This workshop is based on a new approach to thinking about the causes of health behaviours. Diet and physical activity are often described as “complex”– they have many causes and effects, and these are often inter-related. Over two 90-minute sessions, one year 10 student and one teacher from your school will join a wider group of around 20 participants to build a diagram of these causes and effects, and the various connections between them. Only one “teacher-student” pair will be required to attend the sessions from your school.

Participating in this workshop may benefit your school in a few key areas. Teaching staff who attend will be part of an informative discussion of determinants of adolescent health, working alongside other secondary teachers and health professionals from around the Geelong area. Students are expected to benefit from the workshop by contributing to, and learning from, a discussion of the health of their peers. There is also potential for leadership development as participating students will be acting as representatives for students from their school, and the wider community. Finally, the map which is produced as a result of the workshop is expected to be of value to the school as a tool for planning internal health promotion activities. It is my hope that following your involvement in the workshop, the map may begin conversations and prompt new ways of thinking about adolescent health promotion.

Thank you for taking the time to read this brief study introduction. If you have any questions, or for more detailed information, please feel free to contact me via the details at the top of the page.

Regards,

Josh Hayward

B.3 - HAL Principal Information Letter
# Healthy Together Children’s Evaluation (HTCE)

## Grade 8 & 10 Student Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Name</td>
<td>[ ]</td>
</tr>
<tr>
<td>Surname</td>
<td>[ ]</td>
</tr>
<tr>
<td>Date of birth</td>
<td>[ ] D D / M M / Y Y</td>
</tr>
<tr>
<td>School</td>
<td>[ ]</td>
</tr>
<tr>
<td>Which suburb do you usually live in?</td>
<td>[ ]</td>
</tr>
<tr>
<td>Postcode</td>
<td>[ ]</td>
</tr>
<tr>
<td>Are you a boy or girl?</td>
<td>[ ] Boy</td>
</tr>
<tr>
<td>[ ] Girl</td>
<td>[ ]</td>
</tr>
<tr>
<td>Are you an Aboriginal or Torres Strait Islander?</td>
<td>[ ] No</td>
</tr>
<tr>
<td>[ ] Yes, Aboriginal</td>
<td>[ ] Yes, Torres Strait Islander</td>
</tr>
<tr>
<td>[ ] Don’t Know</td>
<td>[ ]</td>
</tr>
<tr>
<td>Do you speak a language other than English at home?</td>
<td>[ ] No, English only</td>
</tr>
<tr>
<td>[ ] Yes, Italian</td>
<td>[ ] Yes, Greek</td>
</tr>
<tr>
<td>[ ] Yes, Cantonese</td>
<td>[ ] Yes, Arabic</td>
</tr>
<tr>
<td>[ ] Yes, Arabic</td>
<td>[ ] Yes, Mandarin</td>
</tr>
<tr>
<td>[ ] Yes, Vietnamese</td>
<td>[ ] Yes, other – please specify</td>
</tr>
<tr>
<td>In which country were you born?</td>
<td>[ ] Australia</td>
</tr>
<tr>
<td>[ ] England</td>
<td>[ ] New Zealand</td>
</tr>
<tr>
<td>[ ] Italy</td>
<td>[ ] Vietnam</td>
</tr>
<tr>
<td>[ ] India</td>
<td>[ ] Scotland</td>
</tr>
<tr>
<td>[ ] Other- please specify</td>
<td>[ ]</td>
</tr>
<tr>
<td>What is your ancestry? (select up to two ancestries)</td>
<td>[ ] English</td>
</tr>
<tr>
<td>[ ] German</td>
<td>[ ] Irish</td>
</tr>
<tr>
<td>[ ] Chinese</td>
<td>[ ] Scottish</td>
</tr>
<tr>
<td>[ ] Australian</td>
<td>[ ] Italian</td>
</tr>
<tr>
<td>[ ] Other – please specify</td>
<td>[ ]</td>
</tr>
</tbody>
</table>
8. Mark how many minutes of physical activity you did on each of the past 7 days. Include physical activity during physical education class, lunch, after school, evenings, and spare time. Physical activities include skating, bike riding, running, skateboarding/rollerblading and any other physical activities that make you sweat, breathe harder or be “out of breath”.

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>1 to 14 minutes</th>
<th>15 to 29 minutes</th>
<th>30 to 59 minutes</th>
<th>1 to 2 hours</th>
<th>More than 2 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tuesday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Wednesday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Thursday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Friday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Saturday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sunday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

9. For each of the past 7 days, mark how many hours (outside of school) did you spent sitting or lying down looking at a screen. Think about the time you spent watching TV and movies, playing video games, video chatting, text messaging, or surfing internet sites like Twitter or YouTube, for example.

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Less than 1 hour a day</th>
<th>1 to 2 hours a day</th>
<th>More than 2 hours but less than 5 hours a day</th>
<th>5 or more hours a day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Tuesday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Wednesday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Thursday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Friday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Saturday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Sunday</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

10. Do you have a TV in your bedroom?
- ☐ Yes
- ☐ No

11. How many TV’s are there in your house?
- ☐ None
- ☐ 1 TV
- ☐ 2 TV’s
- ☐ 3 TV’s
- ☐ 4 TV’s
- ☐ 5 or more TV’s

12. Do you have a computer or electronic games console in your bedroom? (e.g. Nintendo, PlayStation, Xbox, Wii)
- ☐ Yes
- ☐ No
13. During the past 7 days, how did you usually get to and from school? (If you use two or more modes of travel, choose the one that you spend most time doing)

<table>
<thead>
<tr>
<th>To School</th>
<th>From school</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ Car</td>
<td>○ Car</td>
</tr>
<tr>
<td>○ School bus</td>
<td>○ School bus</td>
</tr>
<tr>
<td>○ Public bus, Train or Tram</td>
<td>○ Public bus, Train or Tram</td>
</tr>
<tr>
<td>○ Walking</td>
<td>○ Walking</td>
</tr>
<tr>
<td>○ Cycling</td>
<td>○ Cycling</td>
</tr>
<tr>
<td>○ Other active</td>
<td>○ Other active</td>
</tr>
<tr>
<td>○ Other inactive</td>
<td>○ Other inactive</td>
</tr>
</tbody>
</table>

14. Did your activities over the past 7 days represent a typical week for you?
○ Yes
○ No

15. During the past 7 days, how much time did you usually spend sleeping per night?
○ less than 5 hours
○ 5 hours
○ 6 hours
○ 7 hours
○ 8 hours
○ 9 hours
○ 10 hours
○ 11 hours
○ more than 12 hours

16. How tall are you without your shoes on?
“My height is ____________________________”

17. How much do you weigh without your shoes on?
“My weight is ____________________________”

18. In a typical Physical Education class, how much time are you actually active?
○ I am not taking a physical education class
○ less than 15 minutes
○ 15 to 30 minutes
○ 31 to 45 minutes
○ 46 to 60 minutes
○ more than 1 hour

19. How many Physical Education classes did you have in the last 7 days?
○ 0 classes
○ 1 classes
○ 2 classes
○ 3 classes
○ 4 classes
○ 5 classes

20. Do you consider yourself:
○ Very overweight
○ Slightly overweight
○ About the right weight
○ Slightly underweight
○ Very underweight

21. When did you last have your height and/or weight measured?
○ Today
○ less than 3 months ago
○ 3 to 6 months ago
○ 6 to 12 months ago
○ More than 12 months
○ Don’t Know
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>22. How physically active do you consider your father (or male caregiver) to be?</td>
<td>Active, Somewhat active, Inactive, I don’t know</td>
</tr>
<tr>
<td>23. How physically active do you consider your mother (or female caregiver) to be?</td>
<td>Active, Somewhat active, Inactive, I don’t know</td>
</tr>
<tr>
<td>24. In general, compared to other people your age, how would you rate your athletic ability?</td>
<td>Excellent, Good, Fair, Poor</td>
</tr>
<tr>
<td>25. How much do your parent(s) or guardian(s) encourage you to be physically active?</td>
<td>Strongly encourage, Encourage, Do not encourage or discourage, Discourage, Strongly discourage</td>
</tr>
<tr>
<td>26. How much do your parent(s) or guardian(s) support you to be physically active? (e.g. driving you to team games, buying you sporting equipment, etc.)</td>
<td>Very supportive, Supportive, Unsupportive, Very unsupportive</td>
</tr>
</tbody>
</table>
Simple Dietary Questionnaire

1. **How many serves of vegetables do you usually eat EACH DAY?**

   (A ‘serve’ or ‘portion’ is ½ cup cooked vegetables or 1 cup salad vegetables. Tick one box)

   - Don’t eat vegetables / none
   - ½ serve per day
   - 1 serve per day
   - 1 ½ serves per day
   - 2 serves per day
   - 2½ serves per day
   - 3 serves per day
   - 3½ serves per day
   - 4 serves per day
   - 4½ serves per day
   - 5 serves per day
   - 5½ serves per day
   - 6 serves per day
   - 6½ serves per day
   - 7 or more serves per day

2. **How many serves of fruit do you usually eat EACH DAY?**

   (A ‘serve’ or ‘portion’ is 1 medium piece or 2 small pieces of fruit – tick one box)

   - Don’t eat vegetables / none
   - ½ serve per day
   - 1 serve per day
   - 1 ½ serves per day
   - 2 serves per day
   - 2½ serves per day
   - 3 serves per day
   - 3½ serves per day
   - 4 serves per day
   - 4½ serves per day
   - 5 serves per day
   - 5½ serves per day
   - 6 serves per day
   - 6½ serves per day
   - 7 or more serves per day
3. **HOW OFTEN** do you usually eat the take-away food below as a meal? (tick one box)

- Every meal
- More than once a day
- Every day
- Almost every day
- 2-4 times a week
- Once a week
- Once a fortnight
- Rarely or never

4. **Which type do you eat most of?** Tick all that apply

- McDonalds
- Hungry Jacks
- Red Rooster
- Fish and chips
- Hamburger
- Chicko roll
- Chinese food
- Thai take-away
- Potato cakes
- Pizza
- Pie/Pasty/Sausage roll
- KFC
- Hot dog
- Other (please specify)
- Hot chips/French fries/Wedges

5. **HOW OFTEN** do you eat snacks such as packet potato chips, biscuits (sweet or savoury), chocolate, lollies, cakes and sweet pastry? (tick one box)

- 3 or more times a day
- 2 times per day
- 1 time per day
- Almost every day
- Every second day
- Once a week
- Once a fortnight
- Rarely or never
6. **HOW OFTEN** do you drink soft drinks, cordial, fruit or sports drinks? (tick one box)

- 3 or more times a day
- 2 times per day
- 1 time per day
- Almost every day
- Every second day
- Once a week
- Once a fortnight
- Rarely or never

7. **HOW OFTEN** do you drink soft drinks that contain caffeine? (i.e. Coke, Pepsi, Mountain Dew) (tick one box)

- 3 or more times a day
- 2 times per day
- 1 time per day
- Almost every day
- Every second day
- Once a week
- Once a fortnight
- Rarely or never
8. **HOW OFTEN do you drink energy drinks?** (i.e. Red Bull, V, Mother) (tick one box)

- 3 or more times a day
- 2 times per day
- 1 time per day
- Almost every day
- Every second day
- Once a week
- Once a fortnight
- Rarely or never

9. **Have you experienced the following symptoms after consuming one or more energy drink(s) in the LAST 2 WEEKS?** Tick all that apply.

<table>
<thead>
<tr>
<th></th>
<th>Racing heart/ heart palpitations</th>
<th>Upset stomach</th>
<th>Anxiety/agitation/ nervousness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>❑ Never</td>
<td>❑ Never</td>
<td>❑ Never</td>
</tr>
<tr>
<td>Almost Never</td>
<td>❑ Almost Never</td>
<td>❑ Almost Never</td>
<td>❑ Almost Never</td>
</tr>
<tr>
<td>Sometimes</td>
<td>❑ Sometimes</td>
<td>❑ Sometimes</td>
<td>❑ Sometimes</td>
</tr>
<tr>
<td>Often</td>
<td>❑ Often</td>
<td>❑ Often</td>
<td>❑ Often</td>
</tr>
<tr>
<td>Almost Always</td>
<td>❑ Almost Always</td>
<td>❑ Almost Always</td>
<td>❑ Almost Always</td>
</tr>
</tbody>
</table>

10. **HOW OFTEN do you usually drink flavoured milk/eat ice-cream or sweetened yoghurt?** (tick one box)

- 3 or more times a day
- 2 times per day
- 1 time per day
- Almost every day
- Every second day
- Once a week
- Once a fortnight
- Rarely or never
11. **HOW OFTEN** do you usually drink plain milk or eat cheese or plain yoghurt? (tick one box)

- 3 or more times a day
- 2 times per day
- 1 time per day
- Almost every day
- Every second day
- Once a week
- Once a Fortnight
- Rarely or never

12. **How many glasses of water do you usually drink EACH DAY?** (tick one box – note 1 glass = 250ml, a typical bottle is 600ml or just over 2 glasses)

- None
- 1-2 glasses a day
- 3-4 glasses a day
- 5-6 glasses a day
- 7-8 glasses a day
- More than 8 glasses a day
**PedsQL™**
Paediatric Quality of Life Inventory

Version 4.0 – Australian English

**TEENAGER REPORT** (ages 13-18)

**DIRECTIONS**

On the following page is a list of things that might be a problem for you. Please tell us how much of a problem each one has been for you in the **LAST MONTH** by circling:

- 0 if it is *never* a problem
- 1 if it is *almost never* a problem
- 2 if it is *sometimes* a problem
- 3 if it is *often* a problem
- 4 if it is *almost always* a problem

There are no right or wrong answers. If you do not understand a question, please ask for help.
In the **LAST MONTH**, how much of a **problem** has this been for you …

<table>
<thead>
<tr>
<th>ABOUT MY HEALTH AND ACTIVITIES (problems with…)</th>
<th>Never</th>
<th>Almost</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is difficult for me to walk more than 100 metres</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2. It is difficult for me to run</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3. It is difficult for me to play sport or do exercise</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4. It is difficult for me to lift something heavy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5. It is difficult for me to have a bath or shower by myself</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6. It is difficult for me to help around the house</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>7. I get aches and pains</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>8. I have low energy</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ABOUT MY FEELINGS (problems with…)</th>
<th>Never</th>
<th>Almost</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I feel afraid or scared</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2. I feel sad</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3. I feel angry</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4. I have trouble sleeping</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5. I worry about what will happen to me</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HOW I GET ALONG WITH OTHERS (problems with…)</th>
<th>Never</th>
<th>Almost</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have trouble getting along with other teenagers</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2. Other teenagers do not want to be my friend</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3. Other teenagers tease me</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4. I cannot do things that other people my age can do</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5. It is hard to keep up with other teenagers</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ABOUT SCHOOL (problems with…)</th>
<th>Never</th>
<th>Almost</th>
<th>Sometimes</th>
<th>Often</th>
<th>Almost</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is hard to pay attention in class</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2. I forget things</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3. I have trouble keeping up with my school work</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4. I am away from school because I feel sick</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5. I am away from school to go to the doctor or hospital</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
# Mood and Feelings Questionnaire: Short Version

This form is about how you might have been feeling or acting recently.

For each question, please check (√) how you have been feeling or acting in the past two weeks.

If a sentence was not true about you, check NOT TRUE.
If a sentence was only sometimes true, check SOMETIMES.
If a sentence was true about you most of the time, check TRUE.

Score the MFQ as follows:
NOT TRUE = 0
SOMETIMES = 1
TRUE = 2

<table>
<thead>
<tr>
<th>Statement</th>
<th>NOT TRUE</th>
<th>SOMETIMES</th>
<th>TRUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I felt miserable or unhappy.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I didn't enjoy anything at all.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I felt so tired I just sat around and did nothing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I was very restless.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I felt I was no good anymore.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I cried a lot.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I found it hard to think properly or concentrate.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I hated myself.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I was a bad person.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I felt lonely.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I thought nobody really loved me.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I thought I could never be as good as other kids.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I did everything wrong.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Copyright Adrian Angold & Elizabeth J. Costello, 1987; Developmental Epidemiology Program; Duke University
# HTCE Anthropometry Measurements

<table>
<thead>
<tr>
<th>Student Name</th>
<th>Accelerometer Number</th>
<th>Consent Form (Y/N)</th>
<th>Date of Birth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RA1 initials ______ RA2 initials ______ RA3 initials ______

<table>
<thead>
<tr>
<th>Measure 1</th>
<th>Measure 2</th>
<th>Measure 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>_ _ _ _ cm</td>
<td>_ _ _ _ cm</td>
</tr>
<tr>
<td>Weight</td>
<td>_ _ _ _ kg</td>
<td>_ _ _ _ kg</td>
</tr>
<tr>
<td>Waist</td>
<td>_ _ _ cm</td>
<td>_ _ _ cm</td>
</tr>
</tbody>
</table>

Notes

_____________________________________________
_____________________________________________
_____________________________________________
Healthy Together Children’s Evaluation (HTCE)

Data collector training manual for the evaluation of changes in healthy weight among Victorian schoolchildren in selected regions

Claudia Strugnell, Lynne Millar, Josh Hayward, Erin Hoare, Kyle Turner, Steven Allender
# Table of Contents

List of Tables ........................................................................................................................................... 3

List of Figures ........................................................................................................................................... 3

A bit about the project................................................................................................................................. 4

Study design and sample .......................................................................................................................... 4

Overview of measures and procedure ..................................................................................................... 4

Possible benefits ....................................................................................................................................... 6

Who has approved this study? Ethical approval and funding ............................................................... 6

What is involved for participants? The complete detail .......................................................................... 7

Data collector training ............................................................................................................................... 8

Preparation Prior to School Visit ............................................................................................................ 10

School Visit ............................................................................................................................................... 10

Anthropometry (Height, weight and waist circumference) ......................................................................... 13

Physical activity and sedentary behaviour (Questionnaire) ..................................................................... 19

Diet quality (Food Frequency Questionnaire) .......................................................................................... 21

Emotional wellbeing (Questionnaire) Grade 8 & 10 only ...................................................................... 23

Quality of Life (Questionnaire) ............................................................................................................... 25

Obesogenic school environments ........................................................................................................... 27

Data Entry, Cleaning and Analysis Overview ........................................................................................ 28

Issues with Data entry and cleaning ....................................................................................................... 29

References ............................................................................................................................................... 30

Appendix ............................................................................................................................................... 32

Appendix 1. Testing day checklist ........................................................................................................ 32

Appendix 2. Anthropometry data entry sheet ......................................................................................... 33
List of Tables

Table 1  Primary and secondary outcomes of interests and proposed instrument/measure ...............7
Table 2 Deakin University Pay Calendar 2013 ........................................................................................ 8

List of Figures

Figure 1 The Frankfurt plane* ..............................................................................................................15
Figure 2 Waist circumference measurement site ................................................................................ 17
A bit about the project...

In recent years, several initiatives have been implemented to reduce chronic disease and improve the health of the Victorian population. These have included a particular focus on encouraging healthy eating and physical activity, and reducing overweight and obesity in children and young people; however, little empirical information exists on the effectiveness of these programs. The Healthy Together Children’s Evaluation (HTCE) aims to examine changes in healthy weight and related behaviours among Victorian school children on an annual basis in Term 4 in the years 2013, 2014 and 2015. A random sample of primary and secondary schools located across Victoria will be invited to participate. Information deriving from this study may be used to inform policy and practice at the community, state and federal levels on approaches to promote healthy weight among school children.

Study design and sample

The HTCE aims to examine changes in healthy weight using a repeat cross-sectional study design among school children from 2013 to 2015. Several LGA’s have been identified as evaluation areas based on their previous history of prevention initiatives. A random sample of three primary and three secondary schools within each LGA will be invited to participate with the hope that one of each school type will consent (33% response rate). All students within either Grade 4 & 6 or Grade 8 & 10 at each school will be invited to participate in the study. Sample size calculations based on a detected change in BMI-z score of -0.1 between 2013 and 2015 suggest a minimum of 25 students in each grade level (Grade 4, Grade 6, Grade 8 & Grade 10) are required to participate within each LGA.

Overview of measures and procedure

All students in two grade levels at each school, comprising both Grade 4 and 6 or Grade 8 and 10 will be invited to participate. We plan to collect a combination of self-report and objective measures among participants who consent to participate. All data collection will be conducted during normal class times and students will be asked to:

1. Complete a brief physical activity, sedentary behaviour, food intake and quality of life questionnaire which will take approximately 35 minutes to complete in class-time. This questionnaire will ask the amount of time students engage in physical activity and sedentary behaviour (television, computer use, video games etc.) in the previous 7-days (e.g. “How many minutes of hard physical activity did you do in the last 7-days?”). As well as intake of fruit and vegetables (e.g. “How many serves of vegetables do you usually eat each day?”) and perceived levels of physical, social, emotional and school functioning (e.g. “It is hard for me to walk more than one block”),
2. **Year 8 and 10 students (only)** will be invited to complete a short moods and feelings *questionnaire* which will take approximately 5 minutes to complete. This questionnaire asks students to indicate how they have felt or have acted in the previous two weeks (e.g. Please indicate if a statement was True, Sometime true or Not true about how you have felt or acted in the past two weeks, “I felt lonely”, “I didn’t enjoy anything at all” etc.)

3. Have their height, weight and waist circumference measured by trained researchers in a private and professional manner (5 minutes).

4. In addition some children in the study will be asked to wear a match box sized activity monitor (accelerometer) on their right hip during waking hours for 7-days.

**1-3 School staff** will also be invited to complete a school environment audit which examines the policy, physical, economic and socio-cultural environment within the school. This questionnaire can be completed during a lunch-time, free period or afterschool in a small group session with the researchers.

NB: Measurements will be taken in school hours in a sensitive, culturally appropriate and respectful manner. We will take special precautions when collecting physical information from children to ensure that these are collected in a private area that is screened away from other participants to eliminate potential distress or discomfort. An employed teacher at each school will oversee the measurements and supervise the students at all times. All measurements will be taken by trained data collectors who have undergone training at Deakin University regarding data collection techniques, student sensitivity and welfare concerns and techniques to minimise discomfort and distress. All data collectors will hold a current Working with Children Check. Each child’s verbal consent will also be sought to participate in this study on testing days and should a child wish to withdraw at any time during data collection, they may without any consequence.

It is envisaged that a maximum of two visits to each school will be required. The first visit will be to hand out the Plain Language Statements and consent forms and to inform and discuss the study with students (this could be done through a year-level assembly or morning roll call and will take <5 minutes). The second visit would be to conduct the survey and take anthropometric measurements among school children (this could be done during a Physical Education, Health or Science class or at a specified time during the school day). A third visit may be scheduled to pick up the activity monitor (1-2 minutes), although these can be returned using the provided reply paid envelope.
Possible benefits

There are no financial or other rewards/incentives offered to schools or students to participate in this study. We cannot guarantee or promise that schools or students will receive any benefits from this project. However, this study may have broad community benefits as it will examine changes in healthy weight among school children across many regions of Victoria. The above measurements will be taken from Victorian school children annually in 2013, 2014 and 2015 and will provide a detailed snapshot of changes in healthy weight and related behaviors.

All participating schools will be provided with a summary of the results in a timely manner, following the conclusion of each annual evaluation. Information on key indicators (e.g. weight status, physical activity, dietary patterns) will be presented at an individual and combined LGA level. In no report, publication or communication will individual students or schools be identified due to ethical reasons.

Who has approved this study? Ethical approval and funding

We have ethics approval from the Victorian Department of Education and Early Childhood Development, the Catholic Education Office Archdiocese (Melbourne, Sandhurst, Ballarat and Sale) and Deakin University’s Human Research Ethics Committee (DU-HREC). We have funding to conduct this study and support from the Victorian Department of Health and the Centre of Excellence in Intervention and Prevention Sciences.
What is involved for participants? The complete detail

Table 1 provides a detailed overview of the primary and secondary outcome(s) of interest and the selected instrument for each item. Each outcome variable is presented as the unit of measure to be examined for change from 2013 to 2015.

**Table 1 Primary and secondary outcomes of interests and proposed instrument/measure**

<table>
<thead>
<tr>
<th>Item</th>
<th>Outcome(s) of interest</th>
<th>Proposed Instrument/measure</th>
</tr>
</thead>
</table>
| **Anthropometry**         |  • Change in BMI-z score  
  • Change in overweight and obesity prevalence  
  • Change in abdominal obesity prevalence | Height, weight & waist circumference                                                        |
| **Physical activity**     |  • Change in minutes per day (mins.d-1) spent in daily moderate-to-vigorous physical activity (MVPA) and sedentary time  
  • Change in the proportion of participants meeting the national physical activity guidelines and screen-time recommendations  
  • Change in levels of perceived psychosocial influences on physical activity participation | Modified questionnaire containing items from the Core Indicators and Measures of Youth Health and SHAPES surveys. Grade 8-10: modified Child and Adolescent Physical Activity and Nutrition Survey, Physical Activity (CAPANS-PA) and the Child and Adolescent Physical Activity and Nutrition Survey, potential Correlates (CAPANS-C) questionnaire. *Accelerometry (some participants only) |
| and Sedentary behaviour   |                                                                                       |                                                                                             |
| Duration, intensity and perceived psychosocial influences |                                                                                       |                                                                                             |
| **Diet**                  |  • Change in typical/usual serves of fruit and vegetable daily  
  • Change in typical/usual serves of non-core foods  
  • Change in typical/usual serves of sugar-sweetened beverages  
  • Change in the proportion of participants meeting the Australian Dietary guidelines for fruit and vegetable intakes  
  • Change in usual caffeinated energy drink intake | Modified version of the Simple Dietary Questionnaire                                           |
| Type, frequency            |                                                                                       |                                                                                             |
| **Moods and Feelings**    |  • Change in depressive symptom score                                                   | Grade 8-10: Short Moods and Feelings Questionnaire                                           |
| Emotional wellbeing       |                                                                                       |                                                                                             |
| **Quality of Life**       |  • Change in psychosocial health summary score  
  • Change in physical health summary score | Paediatric Quality of Life Inventory (PedsQL)                                               |
| **Environments**          |  • Change in school policy environment  
  • Change in school physical environment  
  • Change in school economic environment  
  • Change in school socio-cultural environment | Primary Schools: Be Active Eat Well Environment questionnaire  
Secondary schools: It’s Your Move Environment Questionnaire |
|                           |                                                                                       |                                                                                             |
Data collector training

All data collectors will be required to attend a training session of approximately 3-hours to ensure they are properly prepared to undertake the outlined tasks. Data collectors will be paid for attendance at training (max 3-hours).

What will data collectors be required to do?

Data collectors will be required to run the administration, set-up and conduction of several processes during data collection, however, a classroom teacher will be present at each school in addition to the Team Leader to answer any questions/concerns that pop up.

1. Measure height, weight and waist circumference of children and adolescents
2. Fit an accelerometer to children and adolescents
3. Oversee the completion of the self-report questionnaires
4. Ensure appropriate set-up, pack-down and collation of data at all times.

When will data collectors be needed?

Data collectors will be needed throughout Term 4, (Oct 7-Dec 20). A particular focus will be on the first 3-weeks of October in order to measure Grade 8 + 10 students prior to the VCE exams. You will be informed at which times you are needed and which location by your Team Leader (Claudia, Kyle/Josh or Mary). It is estimated that you will only be required for 3 hours at the specified school (some days will be longer at larger schools).

How and when will you be paid?

Data collectors will be paid at the current Deakin University Casual RA Step 1 rate ($33.05/hour). Once you are given your staff ID number, you will need to lodge your hours worked through staff connect. Claudia Strugnell will approve your timesheet according to the below Deakin University Pay Calendar. You will only be able to claim the allocated hours worked.

Table 2 Deakin University Pay Calendar 2013

<table>
<thead>
<tr>
<th>Pay No.</th>
<th>Pay Period Start Date</th>
<th>Pay Period End Date</th>
<th>Payroll Processing</th>
<th>Pay Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>21/09/2013</td>
<td>4/10/2013</td>
<td>30/09/2013</td>
<td>3/10/2013</td>
</tr>
<tr>
<td>8</td>
<td>5/10/2013</td>
<td>18/10/2013</td>
<td>14/10/2013</td>
<td>17/10/2013</td>
</tr>
<tr>
<td>9</td>
<td>19/10/2013</td>
<td>1/11/2013</td>
<td>28/10/2013</td>
<td>31/10/2013</td>
</tr>
<tr>
<td>12</td>
<td>30/11/2013</td>
<td>13/12/2013</td>
<td>9/12/2013</td>
<td>12/12/2013</td>
</tr>
<tr>
<td>13</td>
<td>14/12/2013</td>
<td>27/12/2013</td>
<td>16/12/2013</td>
<td>24/12/2013</td>
</tr>
</tbody>
</table>
Your transport to and from schools will be paid for provided you meet your data collector team at either Geelong Waterfront campus or Burwood campus (some instances). E.g. Say you are going to Pie in the Sky High School in Wyndham and need to be there at 8:30am.

You can:

a) Meet your data collector team at Geelong Waterfront campus at 7am, travel with the team on the mini bus to the school. Data collection occurs until lunchtime (12pm), then you take the data collector team bus back to Geelong Waterfront campus (arrive 1pm). You will be paid for 6-hours.

b) Make your own way to Pie in the Sky High School and meet your data collection team at 8am, complete data collection until 12pm, leave via your own transport. You will be paid for 4-hours.

Regional/Overnight stays
In some instances 1-4 nights in a regional city will be required (e.g. Wodonga/Wangaratta). On these visits, you will be provided with triple-share accommodation at a 2-3 star hotel/motel. You will also be able to claim a $35/day (maximum) food allowance to cover costs of breakfast/lunch and dinner. Whilst this is a realistically token gesture, we do not have budget to cover any more. However, in order to save costs, the Team Leader may purchase bulk items (e.g. provide breakfast, purchase dinner for all). Unfortunately, alcohol cannot be refunded and comes at your own cost.

- You would be paid for your transport costs to and from the regional city. In some instances it may be cheaper to fly you instead of paying the 8-hour transport time. We will negotiate – unless you are uber keen for a road trip 😊

EG1. Wodonga/Wangaratta (Monday to Friday)
- Meet data collector team at Geelong Waterfront Campus at 8am on the Monday and drive to Wodonga. You will be paid the 4 hour drive time to get there
- Tuesday – Thursday, you will be paid travel time from hotel/motel to school and back e.g. 5 hours per day
- Friday, you will be paid the 4 hour drive time back to Geelong Waterfront campus.
Preparation Prior to School Visit

Class Lists
The school liaison officer is to provide class lists of students for each of the participating schools. This list, at a minimum, is to contain the class name (6A, 6B, 6C etc.) and the first/last name of each student. The provision of the date of birth and gender from schools, although beneficial for cross checking data, is not essential. We will collect date of birth and gender from the consent form to support self-reported information.

Once these lists are received by Deakin University each student is given a unique identification code based on their school name, class name and order on the class list. For example, a year 8 student in class A at Geelong High School listed 13th on the class list will be coded as GH8A13. A year 10 student in class D at Geelong High School listed 9th on the class list will be coded as GH10D09. Class lists with student first/last name and unique identification codes will be maintained in excel spread sheets in a password protected file with restricted access. Avery General Labels (70 x 35mm) containing each student name and unique identification code will be printed (x3) to enable the consent form, questionnaire and anthropometric data to be linked uniquely for each student.

Consent Forms
Deakin University will print the plain language statement to be sent home with students for parents with the consent form attached. The plain language statement with the attached consent form will be packaged a) into class lists and sent to the school liaison officer for distribution to class teachers or b) delivered to classroom teachers at the conclusion of assembly/presentations. For example, Geelong High School should receive a clearly marked envelope (one envelope per class for all year 8 and year 10 classes) containing the plain language statement with the attached consent form to parents.

Students are to receive the plain language statement and consent form 4-6 weeks prior to data collection to allow time for students to take it home, have parents read and consent for their child to participate.

School Visit

Pre-arrival
Deakin University team leaders in conjunction with school liaison officers will organise times and dates for data collection within schools. The school liaison officers are to arrange sites within the schools that will accommodate data collection; for example, a spare classroom with capabilities to suit the administration of the questionnaire as well as adequate space to set up private anthropometric stations. Approximately two weeks prior to data collection the Deakin University team leader will confirm the dates with the schools as cars, personnel and accommodation will need to be arranged by Deakin University team leaders.
**Arrival/Class Room Preparation**

The data collection team are to arrive at school approximately 30 mins prior to data collection. The team will register at the school reception office and wait to be directed to the data collection site (usually by the liaison teacher). In the class room, tables will be set up to seat 1 student per table to minimise any students discussing questions and answers.

Measurements are taken in a separate space, screened from other students by gender-matched research staff trained in anthropometrics and body image protection. As such, males will be measured in one corner and females in the other at the back of the class. Each corner will have their own stadiometer to measure height and scales to measure weight and surrounded with screens to provide privacy. For larger schools a third station can also be arranged if required. Students will be unable to see their height or weight measures. Verbal consent of the participating student will also be sought on the day of data collection.

**Consent Forms**

If possible, it would be of benefit for the consent forms arranged in class groups to be at the reception office upon arrival. After preparing the class room, withdrawal of consent forms will be checked against hard copy student class lists to ensure all students whose consent has been withdrawn by a parent or guardian are not present during data collection.

**Student Questionnaire and Measurements**

We would prefer 1-2 classes (20-30 students) per period to attend the designated data collection area. Upon arrival consenting students will be seated and checked against both the consent form and class list. Any absent but consented students are to be noted at this time. The questionnaire will then be administered by the team leader to the class as a whole. The questionnaire is anticipated to take 20-30 minutes. Upon completion of the questionnaire students will be measured for height, weight and waist. All students will be requested to remove shoes, heavy jumpers/blazers, keys, phones etc. Measurements are anticipated to take 10-15 minutes.

Following each session a Data Collection Checklist is to be completed by the team leader. Consent forms, questionnaires and anthropometry forms are to be counted and documented. Absent students and any other relevant information (i.e. cast on arm) are also to be documented. For all consenting students their unique identification code previously printed onto Avery General Labels will be placed on the consent form, questionnaire and anthropometry form and placed into their clearly labelled class envelope.

**Class Room Tidy Up/Departure**

The class room will be left in the same condition as on arrival. All equipment will be packed away and tables returned to their former position. If we are at the school for more than one day we may
request to leave some equipment set up (stadiometers, scales, screens) but permission will be left to the discretion of the school.
**Anthropometry (Height, weight and waist circumference)**

**Introduction:**
The current 2003 National Health and Medical Research Council’s (NHMRC) Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents recommend the use of the body mass index (BMI) to define overweight and obesity Australian children aged 2 to 18 years. The body mass index is calculated by dividing weight in (kg) by height in (m)$^2$ (kg/m$^2$). The criteria used to define overweight and obesity depends on the international growth reference used, for example the WHO BMI growth reference uses an age-sex-specific BMI z-score to define overweight (+1 to 2 standard deviations) and obesity (+2 standard deviations), whereas the International Obesity Task Force’s (IOTF) growth reference provides age-sex-specific cut-points to define overweight and obesity among youth. In addition to the BMI, the NHMRC’s Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents recommends the measurement of waist circumference to determine abdominal obesity among Australian youth aged 2 to 18 years. There are no standardised international waist circumference growth references or criteria to define abdominal obesity among children and adolescents, however, several national growth references exist (e.g. Australia, US, and the UK) and greater than the >90th percentile is used to define abdominal obesity among children aged 10 to 16 years by International Diabetes Federation. The below section describes in detail how height, weight and waist circumference will be collected in this study.

**Aim:**
- To examine change in BMI-z score
- To examine change in overweight and obesity prevalence
- To examine change in abdominal obesity prevalence

**Instrument(s):**
- Measured height (stadiometer)
- Measured weight (weight scale)
- Measured waist circumference (metal tape measure)

**Set-up:**
1. **Where to set up scales and stadiometer:** Think carefully where to put the equipment. Ensure that it is not in walkways or in the way of staff or other students. A quiet place away from where other students are is best, if possible. Set up equipment and check paperwork before students are brought in.
2. **Setting up the stadiometer:**
   - Bars of the stadiometer should be inserted with no gap
   - Match up symbols where applicable
3. **Setting up the scale:**
   - Turn the scales on (kick the little on button at the base of the scale)
- Make sure the display is reading 0kg before use
- Scales should sit flat on the provided tile or on the hard surface (i.e. don’t place scales on the carpet)

4. Fill in the date and time on the measuring session form
5. Ensure that only students whose parents have given consent are weighed and measured.
   UNDER NO CIRCUMSTANCES CAN ANY STUDENT BE WEIGHED AND/OR MEASURED IF THEY HAVE RETURNED A WITHDRAWAL OF CONSENT FORM. Be aware of more than one “Harry” or “Sarah” in a group and ensure you check surnames as well as first names.
6. Some students may be worried about being weighed, measured. Explain to them openly the procedure as this may help them feel more comfortable.

Procedure Height:
1. Where possible, remove and head garments (hats, headbands) and high pony tails. Any religious head wear can be worn (hajib/shroud or Kippah’s) where necessary. Try to make sure that ponytails/clip get in the way as little as possible. Note on your record sheet any student that wore something in their hair. Also note any physical problem that might impact on getting an accurate reading on height e.g. broken leg/arm.
2. Make sure students don’t have any shoes on.
3. Ask the student to step onto the stadiometer and place their heels together (touching the vertical measuring column) with their shoulders and bottom back (touching the vertical measuring column) .... ‘Tall like a soldier’
4. The student should look straight ahead with the lower border of the bony orbit (eye socket) and the upper margin of the external opening of the auditory canal (ear hole) in the same horizontal line (the Frankfurt plane (Figure 1).
5. Ask the student to take a deep breath in and stretch up tall while keeping their heels on the floor. The student should hold their breath.
6. Measure height across the highest part of the head by bringing the movable headboard down with sufficient pressure to compress the hair while the student is holding their breath.
7. Holding the measure in place, ask the student to breath out and duck down, stepping away from the stadiometer. Record the measure to the nearest 0.1cm on your data collection form.
8. Repeat this procedure for the second measure.
9. If the two measures differ by more than 0.5cm, record a third measure using the same method.

Points to watch:
- Make sure all pieces of the stadiometer are fitted firmly together and there are no gaps.
- Make sure that a student’s feet and heels are flat on the floor when you read the measurement.
- Make sure the square sits on the student’s head. Don’t press the set square down too hard on the student’s head as they may shrink down under the pressure. Do make sure the square is actually in contact with the student’s head and not just the hair as some children have big hair that can inflate their height by several millimetres.
Figure 1 The Frankfurt plane* 

The Frankfurt plane
Imaginary line between the lower border of the bony orbit (eye socket) and the upper margin of the external opening of the auditory canal (ear hole) in the same horizontal line.

* Figure from the UK Department of Health Obesity Team 18
Procedure Weight:

1. Place the scales on the tile provided or on a hard surface.
2. Switch on the scales (the ‘kick’ button at the bottom of the scales). Change the batteries if necessary.
3. Ask the student to remove anything they have in their pockets, particularly keys or other heavy items. Also have them remove watches and jewellery they may be wearing.
4. Have students wear one layer of clothing and take off any jumpers/coats they are wearing. If the student is wearing a cultural garment (e.g. kaftan) please note this on the record sheet.
5. If the student has one or more limbs missing, please note this on the data collection sheet.
6. If the student is wearing an artificial limb, record this information but do not have them remove the limb.
7. Ask the student to stand on the scales and look straight ahead (i.e. not down at the reading). The student should have their hands by their sides. Wait for the weight to stabilise on the monitor and record this to the nearest 0.1kg. If the number does not stabilise and continues to oscillate between two readings (e.g. 43.3 and 43.4 kg) then record the average of the two numbers (i.e. 43.35 kg) on the record sheet.
8. Ask the student to step off the scales. Allow the weight scale to return to zero and then repeat the procedure for a second reading.
9. If the two readings are more than 0.5kg different, repeat the process for a third reading. Record all three readings on your data collection form.

Points to watch:

- Students should stand on squarely, in the centre of the scales (e.g. not towards the front or the back of the platform) as to not underestimate actual weight.
- Make sure the weight panel has stabilised before you take the reading.
Procedure Waist circumference:

1. Discuss with the student what you are going to do, in simple language they can understand. Let them touch the tape if it makes them feel more comfortable.

2. The student should remove any belts and heavy outer clothing. Measurement should be taken at most over one layer of light clothing.

3. The student stands comfortably with feet shoulder width apart, the arms should be folded across the chest. Note that posture can affect waist-circumference.

4. The measurement is taken mid-way between the lower costal (10th rib) border and the top of the iliac crest, in the mid-axillary line, horizontally to the body.

5. Each landmark should be palpated and marked with a sticker, a coloured sticker is to be used to temporarily identify the level at which the measurement to be taken. The circumference is measured at the end of normal expiration.
   - Step 1: Speak to students about what you are going to do
   - Step 2: Palpate for iliac crest and mark with a sticker
   - Step 3: Palpate for 10th rib and mark with a sticker
   - Measure the distance between these two landmarks and mark with a sticker

6. Fit the tape around the waist, but make sure it does not compress underlying tissue. The measurer is positioned on the side of the student to read the tape.

7. If the two readings are more than 0.5cm different, repeat the process for a third reading. Record all three readings on your data collection form to the nearest 0.1cm.

Figure 2 Waist circumference measurement site
Please ensure that no other students’ can see or hear height, weight or waist-circumference results: Confidentiality must be assured. If a student wishes to know their measurements you can discretely tell them. It is important to record it without saying it and without any other students’ seeing the scales or the result. Also ensure that the student you are measuring does not see any other student’s results.
Physical activity and sedentary behaviour (Questionnaire)

Introduction:
Regular or habitual physical activity and sedentary behaviour participation are commonly examined through questionnaires at the population level as they are simple and inexpensive and have been associated with health outcomes among children and adolescents. Appendix 1 provides a quick overview of several self-report physical activity and sedentary behaviour participation questionnaires that were considered for application in this study. These questionnaires were ordered on their validity correlations with a criterion and were selected based on their prior application among Australian school children (if applicable), ease of administration, questionnaire length, reliability properties and administration type (e.g. proxy-report for young children and self-report for older children). The resulting list highlights the School Health Action, Planning and Evaluation System (SHAPES) questionnaire for children in Grade 4 to Grade 10 with construct validity correlations (accelerometry) being moderate for average MVPA min.d⁻¹ \((r = 0.44, P>0.01)\). This correlation is considerable given a recent systematic review found median criterion validity correlations of physical activity questionnaires to be \(r = 0.30\) to 0.39 for new questionnaires and \(r = 0.25\) to 0.41 for existing questionnaires. After consultation with the authors of the SHAPES, they highlighted the progress towards uniform measures of physical activity and sedentary behaviour across Canada (in consultation with several other universities). The additional benefit of standard measures would enable potential comparisons with other students. Therefore, three question items from the Core Indicators and Measures of Youth Health – Physical Activity & Sedentary Behaviour Module examining duration spent in MVPA, sedentary time and mode of active transport to and from school were also included alongside 15 question items from the SHAPES questionnaire. The SHAPES questionnaire and Core Indicators and Measures were developed in Canada and based on the Canadian physical activity and sedentary behaviour guidelines for youth which are identical to the Australian physical activity and sedentary behaviour guidelines. This supports the use of these question items in the Australian context, despite being validated among Canadian youth aged 11 to 18 years, as they are likely to have similar results in Australia. A modified version of the SHAPES questionnaire will be used for all participants. Students in Grade 8 & Grade 10 will also recall detailed sedentary behaviour duration and perceived psychosocial influences on physical activity participation using items from the CAPANS-PA (Child and Adolescent Physical Activity and Nutrition Survey, Physical Activity) and the CAPANS-C (Child and Adolescent Physical Activity and Nutrition Survey, potential Correlates) questionnaires. Duration of physical activity and sedentary behaviour participation will be recalled over the previous 7-days.

Aim:
To examine change in minutes per day (mins.d⁻¹) spent in daily MVPA and SB
To examine change in the proportion of participants meeting the national physical activity and screen-time guidelines
To examine change in perceived levels of influence on physical activity participation

**Instrument(s): A modified questionnaire involving several items from the following surveys**
- School Health Action, Planning and Evaluation System
- Core Indicators and Measures of Youth Health – Physical Activity & Sedentary Behaviour Module
- Child and Adolescent Physical Activity and Nutrition Survey, Physical Activity (Grade 8 & 10)
- Child and Adolescent Physical Activity and Nutrition Survey, potential Correlates (Grade 8 & 10)

**Set up:**
1. **Where to administer the questionnaire:**
   - As outlined in the recruitment and engagement strategy, the location of the questionnaire administration will vary according to the response rates of students. The questionnaire will either be administered to students a) in their current classroom at a specified time across the school e.g. P4 by trained data collectors or b) Students who have consented to participate will converge at a specified time e.g. P1 in the gym/assembly hall. They will be guided through the questionnaires by the trained data collectors

**Procedure Self-report PA and SB**
1. The data collector shall ‘walk’ through the group of participants through the questionnaire and use the standardised list of questionnaire prompts to answer student questions. This will ensure the responses to students are kept consistent across all measurement sites. The SHAPES questionnaire will take approximately 15 minutes to complete.
2. Once the questionnaire has been completed, please collect these and if time, see if there are any incomplete answers or missing responses.
Diet quality (Food Frequency Questionnaire)

Introduction:
Usual dietary intake is commonly examined through food frequency questionnaires at the population level as it is quick, inexpensive and has low participant burden in large scale studies. The examination of diet quality has been subject to increased attention over the last few decades with the global obesity pandemic, and marketing of energy-dense and nutrient poor foods (also known as non-core foods) to children. Appendix 1 provides a quick overview of several food frequency questionnaires considered for application in this study. The advantage of a food frequency questionnaire compared to a 24-hour diet recall questionnaire is that usual intake can be estimated, whereas a singular 24-hour diet recall is subject to intra-individual variation and requires several administrations to capture usual intake, which subsequently increases costs and subject burden. The analysed questionnaires were ordered according to their validity correlations and were selected based on their prior application among Australian school children, ease of administration, questionnaire length, and reliability and validity properties. The resulting list highlighted the use of the Simple Dietary Questionnaire (SDQ) which has previously been validated among Australian school children aged 13 to 16 years and demonstrated moderate validity correlations ($r = 0.42$ to $0.57$). A recent systematic review of food frequency questionnaires among youth found validity correlations ranged from $r = 0.1$ to $0.8$, further highlighting the use of the SDQ among Australian children. The SDQ is a quick 27-items questionnaire that examines intakes of fruit and vegetables, fat from dairy, sweetened beverages and non-core foods and was based on the former (2003) Australian dietary guidelines.

Aim:
- To examine change in typical/usual serves of fruit and vegetable daily
- To examine change in typical/usual serves of non-core foods
- To examine change in typical/usual serves of sugar-sweetened beverages
- To examine change in the proportion of participants meeting the Australian Dietary guidelines for fruit and vegetable intakes
- To examine change in caffeinated energy drink intake

Instrument:
Self-report and proxy-report dietary intake (SDQ questionnaire)

Set up:
1. Where to administer the questionnaire: Year 4 to Year 10
   As outlined above, the location of the questionnaire administration will vary according to the response rates of students. The questionnaire will either be administered to students a) in their current classroom at a specified time across the school e.g. P4 by trained data collectors or b)
Students who have consented to participate will converge at a specified time e.g. P1 in the gym/assembly hall. They will be guided through the questionnaires by the trained data collectors.

2. Ensure that only students who have given consent are weighed and measured. **UNDER NO CIRCUMSTANCES CAN ANY STUDENT BE WEIGHED AND/OR MEASURED IF THEY HAVE RETURNED A WITHDRAWAL OF CONSENT FORM.** Be aware of more than one “Harry” or “Sarah” in a group and ensure you check surnames as well as first names.

### Procedure Self-report dietary intake

1. The data collector shall ‘walk’ through the group of participants through the questionnaire and use the standardised list of questionnaire prompts to answer student questions. This will ensure the responses to students are kept consistent across all measurement sites. The CDQ will take approximately 10 minutes to complete.

2. Once the questionnaire has been completed, please collect these and if time, see if there are any incomplete answers or missing responses.
Emotional wellbeing (Questionnaire) Grade 8 & 10 only

Introduction:
Emotional wellbeing and depression in particular influence many young Australians with estimates indicating that approximately 25% of adolescent girls and approximately 10% of adolescent boys in Australia have high levels of depressive symptoms.32 Childhood obesity has many associated consequences, of which depression and social exclusion are associated.33 In addition, diet quality34 and physical activity35 participation have been associated with depressive symptoms among adolescents. In 2011, the NHMRC Clinical Practice Guidelines for depression in adolescents and young adolescents were released in partnership with Beyond Blue and highlight the use of questionnaires, scales and tools to help the initial identification of general distress and depressive symptoms.32 Although no specific instrument was encouraged over another, the Short Moods and Feelings Questionnaire (SMFQ) was mentioned as an instrument to examine depressive symptoms among Australian adolescents and young adults.32 Appendix 1 also examined several questionnaires that focus on depressive symptoms and general mental health. The Short Moods and Feelings Questionnaire (SMFQ) was demonstrated to have high internal consistency among Australian children aged 10-14 years,36 with the additional benefit of having international application and validation among children and adolescents.7 Therefore, the 13-item SMFQ was selected as the instrument to examine depressive symptoms.7

Aim:
To examine change in depressive symptom score

Instrument:
Grade 8 & 10: Short Mood and Feelings Questionnaire7

Set up:
1. Where to administer the questionnaire: Grade 8 and Year 10
   As outlined above, the location of the questionnaire administration will vary according to the response rates of students. The questionnaire will either be administered to students a) in their current classroom at a specified time across the school e.g. P4 by trained data collectors or b) Students who have consented to participate will converge at a specified time e.g. P1 in the gym/assembly hall. They will be guided through the questionnaires by the trained data collectors

2. Ensure that only students who have given consent are weighed and measured. UNDER NO CIRCUMSTANCES CAN ANY STUDENT BE WEIGHED AND/OR MEASURED IF THEY HAVE RETURED A WITHDRAWAL OF CONSENT FORM. Be aware of more than one “Harry” or “Sarah” in a group and ensure you check surnames as well as first names.

Procedure for the SMFQ
1. The data collector shall ‘walk’ through the group of participants through the questionnaire and use the standardised list of questionnaire prompts to answer student questions. This will ensure the responses to students are kept consistent across all measurement sites. The SMFQ will take approximately 5 minute to complete

2. Once the questionnaire has been completed, please collect these and if time, see if there are any incomplete answers or missing responses.
Quality of Life (Questionnaire)

Introduction:
The WHO definition of health is multidimensional and is not merely a state where disease or ailment are absent; “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. The assessment of health-related quality of life in-part tries to capture this multidimensional state of health which can affect both physical and mental health. Although quality of life is a complex concept, questionnaires have previously been used among children and adolescents to assess these concepts. Appendix 2 contains a summary of several questionnaires that assess health-related quality of life. In particular, the Paediatric Quality of Life Inventory (PedsQL) has been used internationally to examine health-related quality of life and is a quick (1-page) 23-item questionnaire that examines physical, emotional, school and social health. The Australian validated Assessment of Quality of Life (AQoL) questionnaire was not considered appropriate for use as it contains 15-items over 4-pages and was considered to lengthy for the current study.

Aim:
To examine change in psychosocial health summary score
To examine change in physical health summary score

Instrument: Paediatric Quality of Life Inventory (PedsQL)

Set up:
1. Where to administer the questionnaire: Year 4 to Year 10
   As outlined above, the location of the questionnaire administration will vary according to the response rates of students. The questionnaire will either be administered to students a) in their current classroom at a specified time across the school e.g. P4 by trained data collectors or b) Students who have consented to participate will converge at a specified time e.g. P1 in the gym/assembly hall. They will be guided through the questionnaires by the trained data collectors.

2. Ensure that only students who have given consent are weighed and measured. UNDER NO CIRCUMSTANCES CAN ANY STUDENT BE WEIGHED AND/OR MEASURED IF THEY HAVE RETURNED A WITHDRAWAL OF CONSENT FORM. Be aware of more than one “Harry” or “Sarah” in a group and ensure you check surnames as well as first names.

Procedure for the (PedsQL)
1. The data collector shall ‘walk’ through the group of participants through the questionnaire and use the standardised list of questionnaire prompts to answer student questions. This will ensure the responses to students are kept consistent across all measurement sites. The (PedsQL) will take approximately 5 minutes to complete.
2. Once the questionnaire has been completed, please collect these and if time, see if there are any incomplete answers or missing responses.
Obesogenic school environments

Introduction
The landmark paper describing the obesogenic environment (physical, economic, political and sociocultural) as a driver for obesity has increased the international focus on environments within particular settings. Within a school, these four environments interact to promote or counter obesity at differing rates and are avenues in which interventions can target. The Be Active Eat Well environmental audit and the It’s You’re Move environment audit are two questionnaires that have been applied in large community-based intervention studies in Victorian schools. It is difficult to validate these questionnaires against a criterion, however, they both have high logic/face validity. Both questionnaires have a high number of items 53 to 67-items and are completed at the school-level, so there is no burden on children.

Aim
To examine change in school policy environment
To examine change in school physical environment
To examine change in school economic environment
To examine change in school socio-cultural environment

Instrument:
Primary Schools: Be Active Eat Well Environment questionnaire
Secondary schools: It’s Your Move Environment questionnaire

Set up:
1. The questionnaire should be administered to 1-3 teachers of the school in a quiet area e.g. staff room or spare classroom

Procedure for the Be Active Eat Well and It’s Your Move Environment questionnaires
1. The data collector shall supervise the teachers (of which have some knowledge in nutrition/physical activity (e.g. health, physical education or science teacher). Each questionnaire will take approximately 20-30 minutes to complete.
Issues with Data entry and cleaning

Issues

- missing information
- no documentation (paper or electronic)
- important and often highly relevant information in the head of key staff

What happens to the data collected?

3 types of data results from data collection;

- Consent Form
  - First entry
  - Second entry
- Anthropometry Form
  - First entry
  - Second entry
- Questionnaire(s)
  - First entry
  - Second entry

To create 1 usable ‘clean’ data file;

1. Compare consent form first entry to second entry. Any errors must be checked manually by locating the original consent form. Any missing information is irretrievable.
2. Compare anthropometry form first entry to second entry. Any errors must be checked manually by locating the original anthropometry form. Any missing information is irretrievable. Anthropometry is linked to the ‘clean’ consent form file where the name and identification number are checked against one another.
3. Compare the questionnaire first entry to second entry. Any errors must be checked manually by locating the original questionnaire. Any missing information is irretrievable. The questionnaire data is then linked to the consent form/anthropometry data by the identification number and DOB is checked. Again any errors must be checked manually by locating the original consent/anthropometry/questionnaire or by contacting the school.

Data collection requirements

- Identified the need to document the data collection process
- Very important not to just collect the data but to look at the data
  - Scan consent forms for missing data
  - Count students in each session, count consent forms, count anthropometry forms, count questionnaires, entries in first and second entry database for consent forms, anthropometry forms and questionnaires
  - Document ALL information for example students that do not wish to be weighed, students that are absent, students that are at sport, students with leg/arm casts etc.
- More laborious but much easier to track the data in the future
- Most importantly if by chance we are abducted by aliens then the data can be traced by others!!
References


8. Varni JW, Limbers CA, Burwinkle TM. How young can children reliably and validly self-report their health-related quality of life?: an analysis of 8,591 children across age subgroups with the PedsQL 4.0 Generic Core Scales. *Health And Quality Of Life Outcomes* 2007; 5: 1-


## Appendix

### Appendix 1. Testing day checklist

**School:** _______________________

**Date:** __/__/2013

### Testing Day Check List

<table>
<thead>
<tr>
<th>Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Scales (x3)</td>
<td></td>
</tr>
<tr>
<td>Spare Batteries</td>
<td></td>
</tr>
<tr>
<td>Charger for batteries</td>
<td></td>
</tr>
<tr>
<td>Boards for scales (x3)</td>
<td></td>
</tr>
<tr>
<td>Stadiometers (x3)</td>
<td></td>
</tr>
<tr>
<td>Step ladder (x2)</td>
<td></td>
</tr>
<tr>
<td>Screens (x3)</td>
<td></td>
</tr>
<tr>
<td>Clipboards (x3)</td>
<td></td>
</tr>
</tbody>
</table>

### Data Collection Checklist

<table>
<thead>
<tr>
<th>Checklist</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>School Class Lists</td>
<td></td>
</tr>
<tr>
<td>Protocol for Anthropometry</td>
<td></td>
</tr>
<tr>
<td>School Name Labels</td>
<td></td>
</tr>
<tr>
<td>Anthropometric Forms</td>
<td></td>
</tr>
<tr>
<td>Pens</td>
<td></td>
</tr>
<tr>
<td>Questionnaires</td>
<td></td>
</tr>
<tr>
<td>Accelerometers</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2. Anthropometry data entry sheet

<table>
<thead>
<tr>
<th>Healthy Together Children’s Evaluation</th>
<th>School Name ____________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Code</td>
<td>Student Name</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Healthy Adolescent Lifestyle (HAL) Mapping GMB Project

Understanding Physical Activity and Diet Behaviours in Victoria, Australia

Group Model Building Facilitation Manual V3

October-December 2015
Acknowledgements: This manual was developed by Josh Hayward from the WHO Collaborating Centre for Obesity Prevention at Deakin University with the guidance of Jill Kuhlberg and Peter Hovmand from the Social System Design Lab at Washington University in St. Louis.

Many of the scripts and activities presented in this document are directly taken from Scriptapedia (version 4.0.6), by Peter S Hovmand, Etiëne A.J.A. Rouwette, David F. Andersen, George. P. Richardson, and Alison Kraus (2013), or have been developed on the basis of existing scripts from that document. Scriptapedia is free to share and remix under the Creative Commons Attribution-ShareALike 3.0 Unported license.
Roles of Facilitation Team

Group model building involves successfully managing multiple roles from starting a session, to facilitating an exercise, and documenting the process. While a session could potentially be completed by as few as two experienced facilitators, the results may be compromised as the facilitators have to balance group process with the need to produce outputs using a series of structured exercises. Consequently, group model building is typically done in teams with one or more roles assigned to each team member. Below are some of the team roles needed for this project along with a description of their primary function and qualifications:

Meeting opener/closer: The meeting opener/closer convenes the meeting and brings the meeting to a close. This person is familiar with the project and its importance, and usually a recognized leader within the group. They provide a context for the overall issue and process. They do not have to be someone who was on the core modeling team or participated in the design of the sessions. The primary function of the meeting opener/closer is to start and end the meeting and set the overall stage for the group model building activities.

Modeler: The modeler is someone who is experienced in system dynamics modeling and modeling software (e.g., Vensim) and has some experience in group model building. The modeler develops the model and helps the group reflect on model structures that emerge during the session.

Facilitator: The facilitator is someone who has some experience in system dynamics and group model building facilitation. The facilitator works focuses on developing the diagrams, introducing concepts from system dynamics, and translating participants’ statements into phrases that are easier for the modeler to use.

Note Taker: The note taker will take notes during the large group discussions. The primary function of the recorder is to document the discussion and products, and then distribute the documentation to members of the facilitation team. Sessions may have an additional recorder if needed.

Wall builder: The wall builder is someone who is able to cluster concepts in meaningful categories based on the conversation in the room. It is helpful if the wall builder have some familiarity with the context of the issue being discussed. The wall builder arranges participants’ results on the wall into clusters as part of an exercise.
Table of Facilitation Team Members and Roles

<table>
<thead>
<tr>
<th>Roles</th>
<th>GMB Session I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opener/Closer</td>
<td>Josh</td>
</tr>
<tr>
<td>Facilitator</td>
<td>Josh</td>
</tr>
<tr>
<td>Wall Builder/Co-Facilitator</td>
<td>Bryn</td>
</tr>
<tr>
<td>Modeler</td>
<td>Andrew</td>
</tr>
<tr>
<td>Note Takers</td>
<td>Steffanie, Claudia</td>
</tr>
<tr>
<td>Observers</td>
<td>Steve, Kayla, Lynne</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Roles</th>
<th>GMB Session II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opener/Closer</td>
<td>Josh</td>
</tr>
<tr>
<td>Facilitator</td>
<td>Josh</td>
</tr>
<tr>
<td>Co-Facilitators</td>
<td>Bryn, Lynne</td>
</tr>
<tr>
<td>Modeler</td>
<td>Andrew/Jaimie</td>
</tr>
<tr>
<td>Note Takers</td>
<td>TBC</td>
</tr>
<tr>
<td>Observers</td>
<td>Steve</td>
</tr>
</tbody>
</table>
**Detailed Agenda: Session 1**

Stream 1: 20/10/15 (11:00am – 12:30pm)
Stream 2: 23/10/15 (12:30pm – 2:00pm)

**Healthy Adolescent Lifestyle Maps GMB Project**

**Group Model Building Project**

**Purpose of the Session:**

A group model building session will bring together stakeholders from different sectors and perspectives to integrate their knowledge and experience in order to identify the components and linkages that are relevant to these health behaviours in their community.

<table>
<thead>
<tr>
<th>Time (Str. 1)</th>
<th>Time (Str. 2)</th>
<th>Task Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30am</td>
<td>12:00pm</td>
<td>30mins</td>
<td>Room Setup</td>
<td>Members of the GMB team arrange the room.</td>
</tr>
<tr>
<td>11:00am</td>
<td>12:30pm</td>
<td>10mins</td>
<td>Welcome and Introduction to GMB Session</td>
<td>The <strong>convener (Josh)</strong> welcomes participants and opens the meeting. Introduction of participants and facilitation team. The <strong>facilitator (Josh)</strong> provides a brief introduction to the project and the purpose of the session.</td>
</tr>
<tr>
<td>11:10am</td>
<td>12:40pm</td>
<td>30mins</td>
<td>Graphs Over Time</td>
<td>The <strong>facilitator (TBC)</strong> introduces the “Graphs over Time” exercise and gives participants 10 minutes to work in groups of three to draw as many graphs over time as they can on “Things that affect or are affected by adolescent physical activity or diet in your community.” At the 9-minute time limit approaches the <strong>facilitator</strong> gives a 1 minute warning and tells participants to prioritize graphs over time from most favorite (on the top) to least favorite (on the bottom). Then in a round-robin fashion, the <strong>facilitator</strong> asks participants to share one graph over time. The <strong>facilitator</strong> takes each graph and brings it to the <strong>wall-builder (Bryn)</strong>. The <strong>wall-builder</strong> organizes the graphs over time into clusters of variables on wall. At the end of one rounds of sharing, the wall-builder summarizes emergent clusters or themes. The <strong>Modeler (Andrew)</strong> for the following connection circle activity pre-fills the</td>
</tr>
</tbody>
</table>
connection circle screen with participants’ graphs over time, as they are shared by participants.

11:40am 1:10pm 40mins  Connection Circle

The facilitator (Josh) introduces the connection circle script.

The goal of a connection circle exercise is to find the connections between different concepts or variables that contribute to or are affected by some issue—in this case adolescent health behaviours in your community.

We can start by taking two of the concepts you identified in the first exercises. We will use arrows drawn between the variables to show how one concept affects another.

Examples are given reflecting both the direction and polarity of relationships between variables. Participants are informed that we will also add variables to the circle.

The modeler (Andrew) draws the links as the facilitator is speaking, and Vensim is projected.

The facilitator (Josh) says that we are going to proceed in round-robin fashion around the group. Please pick two variables from this list or feel free to add another, then describe how the first influences the second.

The recorders (all) note the stories shared and conversations between participants.

With 10 minutes to go, the modeler (Andrew) will give the facilitator (Josh) an indication that the end of the session is approaching. The facilitator will ask participants if there are any last links they would like to add and closes the activity.
<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:20pm</td>
<td>1:50pm</td>
<td>10mins</td>
<td>Closing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The facilitator (Josh) explains the next steps including going over the notes and cleaning up the diagram to continue to build on the next meeting. Potential next dates are discussed with participants. Participants are thanked for their time, and invited to stay after if they have more questions.</td>
</tr>
<tr>
<td>12:30pm</td>
<td>2:00pm</td>
<td>n/a</td>
<td>Close session</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Session finished</td>
</tr>
</tbody>
</table>
Detailed Agenda: Session 2

Stream 1: 5/11/15 (11:00am – 12:30pm)
Stream 2: 6/11/15 (12:30pm – 2:00pm)

Healthy Adolescent Lifestyle Maps GMB Project
Group Model Building Project

Purpose of the Session:
Participants will revisit their work from the previous session and will revise the diagram.

<table>
<thead>
<tr>
<th>Time (Str. 1)</th>
<th>Time (Str. 2)</th>
<th>Task Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.30am</td>
<td>12:00pm</td>
<td>30mins</td>
<td>Room Setup</td>
<td>Members of the GMB team arrange the room.</td>
</tr>
<tr>
<td>11:00am</td>
<td>12:30pm</td>
<td>10mins</td>
<td>Welcome and Introduction to GMB Session</td>
<td>The convener (Josh) welcomes participants and opens the meeting. Introduction of participants and facilitation team. The facilitator (Josh) provides a brief introduction to the purpose of the session.</td>
</tr>
<tr>
<td>11:10am</td>
<td>12:40pm</td>
<td>10mins</td>
<td>Model Presentation</td>
<td>The Presenter (Josh) gives a brief outline of the development of the model from last workshop’s outputs to the current version of the map.</td>
</tr>
</tbody>
</table>
| 11:20am      | 12:50pm      | 30mins        | Community Feedback on GMB Model | The facilitator (Josh) at the front of the room explains the purpose of the exercise, inviting participants to work in groups of three, using use sticky notes to provide different types of feedback to the new version of the model.

Participants can convey positive comments (“things I liked”), concerns or proposed changes (“things I think are wrong/need to be changed”) and comments (“this is new knowledge/this requires further investigation”). Positive sticky notes should be given on a green post-it note, concerns or changes on red, and general comments on blue.

At this stage participants are also invited to add any links to the CLD that they think are missing, or add polarity to any connections...
which are missing polarities from the first version of the CLD.

Feedback loops are briefly presented (with an example from the diagram) and participants are encouraged to identify any other ones they can see.

The facilitator (Josh) gives 30 minutes to write and display comments. With 5 minutes to spare, the facilitator instructs participants to place their remaining comments.

When the time has elapsed, the facilitator (Josh) thanks the group for their participation. Diagrams are retained for later use.

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:50am</td>
<td>1:20pm</td>
<td>30mins Live Model Update</td>
<td>The facilitator (Josh) reflects the work that the participants have just completed on the model. Participants are informed that they now have around 30 minutes to discuss their most important changes, as a way of beginning the second round of model development. The facilitator guides participants in a round-robin discussion, probing the group for clarifications, and detailed discussion of the changes being suggested. Throughout the discussion, the modeler (Andrew) is updating the current version of the map, which is being projected on a screen in real-time, to reflect the participants commentary.</td>
</tr>
<tr>
<td>1:20pm</td>
<td>1:50pm</td>
<td>10mins Closing</td>
<td>The closer (Josh) thanks participants for their time, invites them to stay after if they have more questions, and reminds participants that the map will now be revised into a final version, which will be sent back to them in their school or organization.</td>
</tr>
<tr>
<td>2:00pm</td>
<td>n/a</td>
<td>Close session</td>
<td></td>
</tr>
</tbody>
</table>
Scripts

Group model building sessions typically consist of a sequence of small group activities or “scripts”. These scripts describe the essential components of an exercise along with the inputs from other exercises needed to do the script and the outputs produced from the script. There are scripts for working directly with participants (“online” scripts) as well as scripts for the facilitation team before and after a group model building session (“offline” scripts). Additional information about scripts can be found in the latest version of Scriptapedia, available on request from the Social System Design Lab at Washington University in St. Louis.
Introduction to GMB session

<table>
<thead>
<tr>
<th>Description</th>
<th>This script is used to introduce people and set the stage for a GMB session.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>At the very beginning of a GMB session as participants are starting to get settled and the team wants to begin the session</td>
</tr>
<tr>
<td>Purpose</td>
<td>To introduce the GMB session, team members, participants, and stage the activities for the GMB session</td>
</tr>
<tr>
<td>Primary Nature of group task</td>
<td>Convergent</td>
</tr>
</tbody>
</table>
| Time         | Preparation: None  
Session: 10-20 minutes, depending on number of participants and complexity of session being reviewed  
Follow-up: None |
| Materials    | 1. Agenda of session for participants |
| Inputs       | None |
| Outputs      | None |
| Roles        | 1. Meeting opener with status among the participants who can start the session  
2. Modeling team  
3. Participants |
| Steps        | 1. The opener announces the start of the session.  
   • Welcome the participants and thank them for attending.  
   • If the session is taking place in unfamiliar room, inform participants of the location of restrooms, exits, etc.  
2. The opener begins the introductions:  
   • Introduce yourself, and then say that there are more members of the modeling team in the room, and before we get to the participants, we want to let you know who we are.  
   • Each team member introduces themself and describes their role.  
   • The facilitator then asks participants to introduce themselves, their organization, and how they are connected to this group today.  
   • The facilitator then describes the plan for the modeling session, when breaks will be, and asks if all participants are ready to begin. |
| Evaluation criteria | • Participants feel oriented to session activities |
| Author(s)    | Unknown |
| History      | Originally documented by Timothy Hower (thower@wustl.edu), Krista Rux (krux@wustl.edu) and Peter Hovmand (phovmand@wustl.edu) for the Federal Reserve Bank Project, September 21, 2011. |
| Revisions    | None |
| References   | None |
**Graphs over time (Prioritized version)**

<table>
<thead>
<tr>
<th><strong>Description</strong></th>
<th>Participants produce sketches of key variables over time, which are clustered by the modeling team</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Context</strong></td>
<td>At the beginning of a group model building workshop when the group has not develop a dynamic perspective of the problem or the variables involved</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>To frame the problem from a dynamic perspective and elicit variables that could be used to decide on the reference mode for the project</td>
</tr>
<tr>
<td><strong>Primary nature of group task</strong></td>
<td>Divergent</td>
</tr>
</tbody>
</table>
| **Time**        | **Preparation**: 10 minutes  
**Session**: 30 minutes  
**Follow-up**: none |
| **Materials**    | 1. Stacks of A5 coloured paper with axes drawn on them  
2. Large blank wall/white board  
3. Permanent markers  
4. Blu Tack  
5. Laptop with Vensim |
| **Inputs**      | None |
| **Outputs**     | Candidate variables for the dynamic model or causal map |
| **Roles**       |  
- Facilitator to work with the group with some experience with SD  
- Wall builder to cluster graphs and talk about themes with little or no experience in SD  
- Recorder to document the session and photograph the clustered graphs |
| **People in the room** |  
- Participants  
- All members of the core modeling team |
| **Steps**       | 1. The **facilitator** explains the purpose of the session, and begins by giving an example of how to draw a behavior over time graph, using a pre-filled PowerPoint slide.  
2. The **facilitator** then asks participants to work individually to draw one variable over time per piece of paper. The participants should be given the option of including hoped for behavior, expected behavior, and feared behavior on the same graph.  
3. The **facilitator** and **wall builder** walk around and help **participants** with the task if they need it. Allow 10 minutes or until the group runs out of steam to complete the task.  
4. Reconvene as large group.  
   The **facilitator** instructs subgroups to form groups of three, and share their graphs with each other and choose the ones they think are most important, prioritizing the graphs they have drawn, with the most important ones at the top of the pile – participants have 5 additional minutes for this task  
5. Reconvene again as large group.  
   The **facilitator** then goes to each subgroup and holds the first graph they have selected up in front of entire group. The subgroup
spokesperson talks about the graph. Ask subgroups to share the “best stuff” first. Clarify timescale, variable names, etc.
6. The facilitator then hands the graph to the wall builder.
7. The facilitator repeats steps 5 and 6 with each participant or subgroup, taking one graph at a time until a satisfactory number of graphs have been shown. Finish by asking if any participant has something else that really ought to be shown.
8. During steps 5-6, each graph is posted on the wall. The wall builder tries to cluster the graphs meaningfully on the fly, based on themes and variables.
9. As the variables are being clustered on the wall, the modeller is entering the variable names in Vensim (on the computer only, not yet projecting) and arranging the prioritized variables into a connection circle for the next script.
10. Once a list of 15-20 variables has been completed, the facilitator asks the wall builder to explain the clusters of graphs on the wall.

**Evaluation criteria**

- Interesting, self-sustaining group discussion after clusters described by the wall builder
- Meaningful clusters are possible to see
- Graphs tend to converge to a clear dynamic problem
- Some key dynamic variables emerge from reflecting on the graphs and clusters
- Modeling team can begin to see key stocks and perhaps important feedback loops
- Members of the group appear to have better understandings of the issues of interest to other members

**Authors**
George P. Richardson and David F. Andersen

**History**
Originally documented by George Richardson, David Andersen, Peter Hovmand, Timothy Hower and Annaliise Calhoun in February 2010

**Revisions**
Tailored to the March 5, 2014 GMB demonstration session for S65-5050 course

**References**
### Connection Circles

<table>
<thead>
<tr>
<th>Description</th>
<th>Connection circles help groups visualize important variables and connections between them.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Social systems have many variables and connections relating them. Seeing all the connections is challenging and we can quickly feel overwhelmed by the complexity of a system. To address this limitation, we need visual tools that can help us see and talk about the connections in a system.</td>
</tr>
</tbody>
</table>
| Purpose     | - To make explicit important variables and connections between variables  
              - Eliciting important variables  
              - Eliciting linkages |
| Primary nature of group task | - Divergent: Groups may come up with different connections between variables by generating a variety of variables and interpretations |
| Time        | **Preparation:** 5 minutes (pre-workshop, setting up Vensim projector)  
              **Session:** 40 minutes  
              **Follow up:** 60+ minutes, depending on exercise output |
| Materials   | - Overhead data projector & screen  
              - Computers running Vensim, connected to projector and a network for backup |
| Inputs      | - Variables from prior work (in this case, from the Graphs over time script) typed in Vensim on the side of a large circle. |
| Outputs     | - Connection Circle |
| Roles       | - Modeler with some experience on Vensim  
              - Facilitator with experience facilitating groups and some experience with building models in Vensim  
              - Recorder trained to take recorder notes during a meeting |
| People in room | - Participants  
                  - Modeling team |
| Steps       | 1. The facilitator is at the front of the room. The modeler is sitting with a laptop connected to the data projector at the side of the room. The recorder is seated on the periphery of the participant group where all members are audible.  
              2. The facilitator introduces the exercise:  
                 - The goal of our exercise is to identify the variables and connections between variables that are important in the system affecting adolescent diet and physical activity in your community.  
                 - A connection circle is a visual tool that can help us see the connections in a system.  
              3. The modeler projects the connection circle with variables arranged in circle on the screen. The facilitator introduces the variables as those from the Graphs Over Time activity, noting that participants are free to add variables that are not on the screen, but are important to understanding the system.  
              4. The facilitator opens the exercise by stating:  
                 - We are going to proceed in round-robin fashion around the group. Please pick two variables from this list or of your own choosing, then describe how the first influences the second. The modeler creates a Vensim drawing of what the facilitator is describing, simultaneously, for the participants |
to see. The facilitator uses language of both direction and polarity.

5. The **facilitator** then prompts the group by asking:
   - *What are some connections that you can see between any two variables on the screen?*
   - *Once a participant nominates connection between two or more variables the community facilitator needs to be sure the variable definitions and nature of the causal connection is clear. Consider prompting the participant to share how they are thinking about the variables.*

6. The **facilitator** alternate eliciting linkages and variables from participants.

7. As participants nominate linkages, the **modeler** selects the variables and draws the linkage on the screen. As the number of variables chosen grows, the **modeler** should expand and rearrange the circle as needed, being aware of positioning the variables such that they are not always physically adjacent. Once one complete round or approximately ten connections are made, the **facilitator** says:
   - *We have a good start and a number of connections, so we don’t need to continue to go around in order. Feel free to continue to suggest connections about these or additional variables that you think are important.*

8. The **facilitator** provides a 5 minute warning to the group as the session approaches a close. The **facilitator** indicates when there is approximately one minute left to elicit any final input.

---

**Evaluation criteria**

- Each participant engages in discussing linkages and variables
- A connection circle with multiple feedback loops is created
- Participants recognize there is a complex system surrounding adolescent physical activity and nutrition in their community.
- Participants enthusiastic about modeling process

---

**Author(s)** Unknown

**History of Script** Utilized in Rise Sisters Rise project July 2011

**Revisions** May 22, 2012 Revised by Alison Kraus and Peter Hovmand for Washington University TREC 4 GMB session Modified in June 2012 by the TREC-4 Core Modeling Team

**References** None

**Notes** None
Community Feedback on GMB Model (with feedback loops)

<table>
<thead>
<tr>
<th>Context</th>
<th>After a causal-loop diagram or stock-flow map has been developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>To give participants time to familiarize themselves with model or diagram that has been revised offline since the last workshop. (Rapid Session version not intended for work which will lead to further revision of the map)</td>
</tr>
<tr>
<td>Primary nature of group task</td>
<td>Divergent</td>
</tr>
</tbody>
</table>
| Time | **Preparation**: Very large representation(s) of a current version of the model/diagram (printed or drawn) taped/affixed to walls or windows  
**Session**: 30 minutes  
**Follow up**: 60 minutes (post session) to incorporate participant feedback into model. |
| Materials | • Very large poster-size representation of model/diagram (printed or drawn)  
• High quality sticky notes (high-stick)  
• Several dark felt tip pens (one for each participant) |
| Inputs | Causal loop diagram or stock and flow diagram currently being developed in GMB project |
| Outputs | Causal-loop diagram or stock-flow map with stakeholders’ anonymous comments on post-its (good = ticked; concern = crossed; neutral = dashed) attached at the relevant place on the diagram/model; digital photographs of map/model with post-it comments |
| Roles | • **Facilitator** to introduce the representation to the large group and introduce the guidelines for the activity |
| People needed in the room | • Participants |
| Steps | 1. Based on group size, decide on how many small groups and representations are required to have made before the script begins. An ideal group size is approximately 3 participants per large representation.  

2. The **facilitator** at the front of the room explains the overall purpose of the exercise (to gain feedback from the larger community on an interim model, having already provided a brief overview of question/focusing problem, process-to-date, and the model to the large group). Previously, the participants have been given the information required to have a useful interaction with the representation (i.e., descriptions/examples of polarity, directionality, feedback loops, etc.). Any of this information is also displayed for participants throughout the activity.  

3. The **facilitator** then sets up what the participants will be doing in the activity, inviting them to use sticky notes to provide different types of feedback on parts of the current version of the model. Comments may be positive (things they like/agree with/see as high value), negative (things that are erroneous/need adjustment/missing from the model) or general comments (new thoughts/things to investigate further/other). The same sticky notes are used for any kind of comment, but participants are to draw a tick in the top right corner for positive comments, a cross in the top right for concerns, and a dash for general comments. Participants write a brief comments explaining their like/concern/comment using felt tip pens on the sticky notes and place them on the part of the model
the note pertains to.

4. At the same time – the facilitator invites participants to add any new causal linkages to the model which they identify throughout the task of reviewing the model.

5. As a final task – the facilitator introduces the group to the concept of feedback loops. They are described as an interesting source of information from the maps (amount of detail depends on available time for activity), and an example from the map is given to illustrate the point. Participants are invited to locate any feedback loops which they spot during the 30 minutes.

6. The facilitator gives 30 minutes to the group to write and display their comments, and locate feedback loops. Any available facilitators can act as “floaters” to respond to participants’ questions.

7. Participants spend time with the representation, making and placing comments. With 5 minutes to spare, the facilitator asks the participants to write and place their remaining comments and questions.

8. The facilitator thanks participants for their participation, and runs through a quick debrief of the exercise based on some seed questions

   a. How did you find the exercise? What were your general reactions?

   b. What did you feel were some good aspects of the model – what did you place green sticky notes on?

   c. What did you feel were some areas that needed to be changed – what did you place red sticky notes on?

| Evaluation criteria | Feedback received from the community on the current version of the model
|                     | Participants feeling they have made a contribution to current and future steps towards a shared understanding of a problem |
| Author(s)           | Jill Kuhlberg & Don Greer & Laura Black |
| History             | Adapted for use with an interim CLD in GSC Portland Childhood Obesity GMB Community Session: July 17, 2014 |
| Revisions           | |
| References          | |
| Notes               | |
Live Model Update

<table>
<thead>
<tr>
<th>Description</th>
<th>Participants are involved in a round-table discussion of the current version of the model, and updates are made in real-time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>For the purpose of updating a model from a prior workshop, in the current workshop, to reflect new understandings generated during the session</td>
</tr>
<tr>
<td>Purpose</td>
<td>To create a revised CLD</td>
</tr>
<tr>
<td>Primary nature of group task</td>
<td>Convergent</td>
</tr>
</tbody>
</table>
| Time | Preparation: Nil  
Follow up: 30-40 minutes |
| Materials | • Vensim file of existing model version  
• Projector and screen |
| Inputs | • Previous CLD file to be updated  
• Participants comments attached to hard-copy version of the CLD from previous activity (Community feedback on model) |
| Outputs | • Revised CLD to be developed further offline |
| Roles | • **Facilitator** to lead the discussion around what needs to be added/changed/removed from the CLD  
• **Modeler** with experience in Vensim to update the model in real time  
• **Note takers** to capture the discussion |
| People needed in the room | • Participants  
• Facilitation team |
| Steps | 1. The Facilitator opens the session by reflecting that participants have just spent a block of time getting to know the most recent version of the CLD, and commenting on it, providing reactions to what is good in the model, what is interesting about the model, and what needs improvement.  
2. The Facilitator instructs participants that they will now have a chance to have some of those changes made in real-time, to begin the process of revising the map for the next session.  
3. The Facilitator outlines the task as being a round-robin type discussion, whereby the small groups who worked together on the model feedback task will have a chance to suggest their most important change to the model, whether it be an addition of new material, removal of old material, or alteration of existing material. Although groups will take it in turns to describe their desired changes to the model, discussion of the changes is encouraged between groups if other participants have something to add to the discussion. Note takers capture the discussion as best they can throughout the session.  
4. **As the facilitator** is eliciting new information from groups, and guiding the discussion in the room, **the modeler** captures the changes in Vensim, which is being projected on the screen in real time  
5. (OPTIONAL) – if the **modeling team** have any “dead buffalos” or variables which require specific attention, 5-10 minutes may be reserved to specifically query the participants on these points, if they do not naturally arise throughout the course of the activity. |
6. With 5 minutes to go, the facilitator alerts the room that we are almost out of time, and that we can take two or three quick last-minute changes before the model is taken away to be revised for the next workshop.

| Evaluation criteria | • Participants see their input incorporated into the model  
|                     | • Participants retain ownership of an evolving model  
|                     | • New data is obtained which can be used to further progress the model |
| Author(s)           | Written by Josh Hayward and Steven Allender (Deakin University, WHOCC for Obesity Prevention) |
| History             | Designed for the Barwon Medicare Local and Vic Pol workshops (May-June 2015) |
| Revisions           | Nil |
| References          | Nil |
Appendix D: Study Ethics Clearances

D.1 - HTCE Ethics Approval – Deakin University

Memorandum

To: Prof Steven Allender
   School of Health & Social Development

From: Deakin University Human Research Ethics Committee (DUHREC)

Date: 15 October, 2015

Subject: Healthy Together Kids Evaluation

Please quote this project number in all future communications

The modification to this project, submitted on 14/09/2015 has been approved by the committee executive on 15/10/2015.

Approval has been given for Prof Steven Allender, School of Health & Social Development, to continue this project as modified to 1/12/2021.

The approval given by the Deakin University Human Research Ethics Committee is given only for the project and for the period as stated in the approval. It is your responsibility to contact the Human Research Ethics Unit immediately should any of the following occur:

- Serious or unexpected adverse effects on the participants
- Any proposed changes in the protocol, including extensions of time.
- Any events which might affect the continuing ethical acceptability of the project.
- The project is discontinued before the expected date of completion.
- Modifications are requested by other HRECs.

In addition you will be required to report on the progress of your project at least once every year and at the conclusion of the project. Failure to report as required will result in suspension of your approval to proceed with the project.

DUHREC may need to audit this project as part of the requirements for monitoring set out in the National Statement on Ethical Conduct in Human Research (2007).

Human Research Ethics Unit
research-ethics@deakin.edu.au
Telephone: 03 9251 7123
D.2 - HTCE Ethics Approval – Department of Education and Early Childhood Development

Dear Professor Allender

Thank you for your application of 22 May 2013 in which you request permission to conduct research in Victorian government schools and/or early childhood settings titled Healthy Together Children’s evaluation.

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Early Childhood Development.

2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the DEECD approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.

3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Early Childhood Development for its consideration before you proceed.

4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.

5. You acknowledge the support of the Department of Education and Early Childhood Development in any publications arising from the research.

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study’s indicative completion date.
7. If DEECD has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research Register.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Youla Michaels, Project Support Officer, Research, Evaluation and Analytics Branch, by telephone on (03) 9637 2707 or by email at michael.youla.v@edumail.vic.gov.au.

Yours sincerely,

Joyce Cleary
Director
Research, Evaluation and Analytics Branch

19/07/2013

enc
Dear Professor Allender

I am writing with regard to your research application received on 22 May 2013 concerning your forthcoming project titled ‘Healthy Together Children’s Evaluation’. You have asked approval to involve Catholic schools in the Archdiocese of Melbourne, as you wish to involve students and teachers.

I am pleased to advise that your research proposal is approved in principle subject to the eight standard conditions outlined below.

1. The decision as to whether or not research can proceed in a school rests with the school's principal, so you will need to obtain approval directly from the principal of the school that you wish to involve.

2. You should provide the principal with an outline of your research proposal and indicate what will be asked of the school. A copy of this letter of approval, and a copy of notification of approval from the organisations/university's Ethics Committee, should also be provided. As advised, your project is currently under consideration by the university’s ethics committee.

3. A Working with Children (WWC) check – or registration with the Victorian Institute of Teaching (VIT) – is necessary for all researchers visiting schools. Appropriate documentation must be shown to the principal before starting the research in the school.

4. No student is to participate in the research study unless s/he is willing to do so and informed consent is given in writing by a parent/guardian.
5. Any substantial modifications to the research proposal, or additional research involving use of the data collected, will require a further research approval submission to this Office.

6. Data relating to individuals or the school are to remain confidential.

7. Since participating schools have an interest in research findings, you should consider ways in which the results of the study could be made available for the benefit of the school community.

8. At the conclusion of the study, a copy or summary of the research findings should be forwarded to the Catholic Education Office Melbourne. It would be appreciated if you could submit your report in an electronic format using the email address provided below.

I wish you well with your research study. If you have any queries concerning this matter, please contact Ms Lisa Guerin of this Office.

The email address is <km@ceomalb.catholic.edu.au>.

Yours sincerely

Cecille Jeffery
ACTING MANAGER, POLICY & RESEARCH
28 June 2013

Ms Claudia Strugnell
WHO Collaborating Centre for Obesity Prevention
Deakin University
Locked Bag 2001
GEELOONG 3220

Dear Claudia,

I am in receipt of your application requesting the participation of Catholic schools in the Diocese of Ballarat in your Research Project: Healthy Together Children’s Evaluation.

I am pleased to advise that on the basis of information you have provided I grant permission for you to approach the Principals of our schools seeking their involvement in the project. You will understand that many requests are made to our schools and I am conscious of the time commitment required by participants. With this in mind I stress that the decision as to whether or not to participate rests with the individual Principals.

The following general conditions apply to all persons/institutions conducting research in schools in the Diocese of Ballarat:

1) The decision as to whether or not your research can proceed in a school rests with the School Principal. For each school in which you wish to do the research, you must obtain approval directly from the School Principal.

2) You are requested to provide the Principal with an outline of your research proposal and the likely time that participation in the research project will demand. A copy of notification of approval from the appropriate Ethics Committee should also be provided to the participating school.

3) A Criminal Record check is necessary for all researchers visiting schools and should be shown to the Principal before starting research in each school.

4) No student is to participate in your research study unless s/he is willing to do so and permission is given by a parent/guardian. Sufficient information must be provided to enable a parent/guardian to make an informed decision. Permission to participate would generally be indicated by means of a consent form, signed by a parent/guardian and returned to the school. You are requested to liaise with the School Principal to assist in the writing of a letter to parents/guardians regarding information about the research project.

5) You are requested to forward a list of schools/participants to this office.

6) Any substantive modifications to the research proposal or additional research involving use of the data collected will require a further research approval submission to this office.

7) Data relating to individual students or schools is to remain confidential.

8) I will look forward to receiving a copy of the research findings and would expect that you offer such results to participating schools.

I take this opportunity to wish you success with your research project.

Yours sincerely,

Audrey Brown
Director

Director, Catholic Education Office Ballarat
PO Box 576 Ballarat Victoria 3353
Tel (03) 5337 7135 Fax (03) 5331 5166 Email: director@ceoballarat.catholic.edu.au

www.ceoballarat.catholic.edu.au
25 June 2013

Prof Steven Allendar, Ms Claudia Strugnell
WHO Collaborating Centre for Obesity Prevention
Geelong Waterfront Campus
Locked Bag 20001
GEELONG VIC 3220

Dear Prof Allendar and Ms Strugnell

Healthy Together Children’s Evaluation

I am pleased to advise that, in relation to schools in the Diocese of Sandhurst, your research proposal is approved subject to the following standard conditions:

1. The decision as to whether or not research can proceed in a school rests with the Principal of that school. You will therefore need to obtain approval directly from the Principal of each school that you wish to involve.
2. You should provide each Principal with an outline of your research proposal and indicate what will be asked of the school. A copy of this letter of approval and a copy of the notification of approval from the relevant Ethics Committee should also be included.
3. No student is to participate in research study unless s/he is willing to do so and informed consent is given by a parent/guardian.
4. You should provide a list of schools which have agreed to participate in the research project to the Professional Development section of this Office.
5. Any substantive modifications to the research proposal, or additional research using the data collected, will require a further research proposal approval submission to this Office.
6. Data relating to individuals or schools is to remain confidential.
7. Since participating schools have an interest in the research findings, you should discuss with each Principal ways in which the results of the study could be made available for the benefit of the school community.
8. At the conclusion of the study a copy of the research findings should be forwarded to

Catholic Education Office, Sandhurst
Attn: Assistant Director, Research, Policy & Governance

(Note: should the research be carried out over more than one year, a progress report is required each December)

I wish you well with your research study. If you have any queries concerning this matter, please contact Rosemary Rasmussen (Tel: 5443 2377) of this Office.

Yours sincerely,

Brenda Keenan
Assistant Director, Research, Policy & Governance
5 July, 2013

Professor Steven Allender
WHO Collaborating Centre for Obesity Prevention
Deakin University
Waterfront Campus
Locked Bag 20001,
GEELONG VIC 3220

Dear Professor Allender

Thank you for your correspondence dated 25 June, 2013 in which you have submitted documents to conduct research entitled “Healthy Together Children’s Evaluation” in primary and secondary schools in the Diocese of Sale.

I am happy for you to approach the schools in this diocese as indicated in your application. It is important that you understand that the final permission for you to undertake this work rests with the Principal.

This in principle approval is subject to the attached Research in Catholic Schools – Standard Conditions.

Should you require further information please contact Mrs Pauline Low at this Office, email plow@ceosale.catholic.edu.au or phone 5522 8634.

With best wishes

Yours sincerely

Maria Kirkwood
DIRECTOR OF CATHOLIC EDUCATION
DIOCESE OF SALE
RESEARCH IN CATHOLIC SCHOOLS – STANDARD CONDITIONS

This *in principle* approval is subject to certain standard conditions:

1. The decision as to whether or not a project can proceed in a school rests with the school principal. You will need to obtain approval directly from the principal of each school that you wish to involve.

2. You should provide the principal with:
   - a Plain Language Statement (PLS) for the principal describing the research;
   - documents to be used in the project e.g. PLS for participants/parents, consent forms etc;
   - a copy of the Catholic Education Office letter of approval which may include conditions placed on the approval;
   - a copy of notification of Ethics Committee approval, if applicable.

3. Consent from principals, parents and participants must be sought through an 'opt in' basis.

4. If your study involves one-to-one contact with a child, you are required to provide the principal with a certified copy of your registration with the Victorian Institute of Teaching or a current *Working with Children* Check.

5. You should provide to the Director of this Office, a list of schools which have agreed to participate in the research project.

6. Any substantive modifications to the research proposal or additional research involving use of the data collected will require a further research approval submission to this Office.

7. Data relating to individuals or schools is to remain confidential.

8. The collection and use of information from schools must conform with the *Privacy Amendment (Private Sector) Act 2000* as indicated in the School’s *Privacy Policy*.

9. Since participating schools have an interest in the findings, you should discuss with each principal ways in which the results of the study could be made available for the benefit of the school community.

10. At the conclusion of the study, a copy of the summary of the findings should be forwarded to the Director of this Office.
PLAIN LANGUAGE STATEMENT AND OPT-OUT CONSENT FORM

TO: Parent/Guardian

Plain Language Statement

Date: July, 2014
Full Project Title: Healthy Together Children’s Evaluation
Principal Researchers: Professor Steven Allender, Dr Claudia Strugnell & Dr Lynne Millar

Purpose and Background
The purpose of this study is to examine if healthy weight and related behaviours (physical activity, sedentary behaviour, diet quality, quality of life and aspects of mental health) among children and adolescents have changed in recent years. All students in Year 4 & 6 OR Year 8 & 10 at your child’s school are being invited to participate. All activities will be conducted throughout a normal school day, in school-time.

This letter outlines the intended study and includes an OPT-OUT consent form should you and or your child decide NOT TO participate. We ask that you please read this information carefully, so that you can make an informed decision about your child’s participation. We are using an OPT-OUT consent process whereby your child’s participation in this study is assumed unless you indicate via the return of the signed OPT-OUT consent form that you do not wish for your child to participate.

Methods
If you and your child agree to participate we would like your child to complete the following activities: a) Complete a series of questionnaires (detailed below); and b) Have their height, weight and waist circumference measured. Some students will be asked to wear a match-box sized activity monitor (accelerometer) during waking hours for 7-days. These activities are not harmful; however, they may produce some minor discomfort. Results of this study will provide information about effectiveness of current efforts to improve the health of Victorian children and adolescents. This information will be used by educators, policy makers and researchers in future efforts to improve the health of Victorian children and adolescents.

Plain Language Statement & Consent Form to Participants, DU-HREC 2013-095
Procedure

If you and your child agree to participate in this study, they will be asked to complete the following activities:

1. Complete a brief physical activity, sedentary behaviour, food intake and quality of life questionnaire which will take approximately 35 minutes to complete in class-time. This questionnaire will ask the amount of time your child engaged in physical activity and sedentary behaviour (television, computer use, video games etc.) in the previous 7-days (e.g. “How many minutes of hard physical activity did you do in the last 7-days?”). As well as their intake of fruit and vegetables (e.g. “How many serves of vegetables do you usually eat each day”) and perceived levels of physical, social, emotional and school functioning (e.g. “It is hard for me to walk more than one block”),

2. Year 8 and 10 students (only) will be invited to complete a short moods and feelings questionnaire which will take approximately 5 minutes to complete. This questionnaire asks students to indicate how they have felt or have acted in the previous two weeks (e.g. Please indicate if a statement was True, Sometimes true or Not true about how you have felt or acted in the past two weeks, “I felt lonely”, “I didn’t enjoy anything at all” etc.).

3. Have their height, weight and waist circumference measured by trained researchers in a private and professional manner (5 minutes).

4. In addition, some children in the study will be asked to wear a match box sized activity monitor (accelerometer) on their right hip during waking hours for 7-days.

NB: Measurements will be taken in school hours in a sensitive, culturally appropriate and respectful manner. We will take special precautions when collecting physical information from your child to ensure that these are collected in a private area that is screened away from other participants to eliminate potential distress or discomfort. An employed teacher at your child’s school will oversee the measurements and supervise the students at all times. All measurements will be taken by trained data collectors who have undergone training at Deakin University regarding data collection techniques, student sensitivity and welfare concerns and techniques to minimise discomfort and distress. All data collectors will hold a current Working with Children Check. Your child’s verbal consent will also be sought to participate in this study on testing days and should your child wish to withdraw at any time during data collection, they may without any consequence.

Possible Benefits

We cannot guarantee or promise that you or your child will receive any benefits from this project. However, this study may have broad community benefits as it will examine changes in healthy weight among school children across many regions of Victoria. The above measurements will be taken from Victorian school children annually in 2013, 2014 and 2015 and will provide a detailed snapshot of changes in healthy weight and related behaviors.
**Possible Risks**

There are no known risks associated with this project but should any discomfort be experienced at any time during the height, weight or waist circumference measurements or questionnaire completion, your child should stop the activity and alert the researcher immediately. At any time-point your child can stop involvement in the study and they are free to do so without any consequence. Should your child experience discomfort after these activities have been completed, please contact Kids Helpline on 1800 551 800. This is a free, confidential and anonymous counselling service for young people who will assist your child with any troubles. This study is for the purposes of the research and those administering the questionnaires will not be health professionals. As such, it is not appropriate to actively refer students for help on the basis of their scores. However, students are encouraged to seek support from their school counsellor and/or GP if they experience emotional discomfort.

**Privacy, Confidentiality and Disclosure of Information**

Any information obtained in connection with this research that can identify your child will remain confidential. All information provided will be used for the research purposes only, it will be collected and kept in confidence and will not be released to anyone outside the study team. It will be kept in locked facilities at Deakin University in accordance with the government guidelines. Consent forms will be stored separately to the data collected and data will be disposed of after a minimum period of 7 years from last publication. Only members of the study team will have access to the data/records and the computer records will be password protected. In any publication, presentation or discussion the information will be provided in such a way that your child cannot be identified.

**Funding and support**

This research is being supported by the Australian National Heart Foundation, the National Health and Medical Research Council, Deakin University, the Centre of Excellence in Intervention and Prevention Science and the Victorian Department of Health.

**Participation in voluntary**

Participation in this research is voluntary. If you and/or your child do not wish to take part you are not obliged. If you decide to take part and later change your mind, you are free to withdraw from this study at any stage until the data are processed. Any information obtained to date will not be used and will be destroyed. Your decision whether to take part or not, or to take part and then withdraw, will not affect your relationship with Deakin University or any other government departments.

Before you make your decision, a member of the research team will be available to answer any questions you have about the research. You can ask for any information you want. If you do
decide to withdraw from this research, please notify a member of the research team or complete and return the Revocation of Consent Form attached and send it to Claudia Strugnell at the address provided below.

**Ethical Guidelines**

This research will be carried out in accordance with the *National Statement on Ethical Conduct in Human Research 2007 – Updated 2009* which is produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies. The ethical aspects of this research have been approved by Deakin University's Human Research Ethics Committee (DU-HREC).

**Further Information**

If you require further information or have any problems or concerns regarding this research, you can contact Dr Claudia Strugnell

<table>
<thead>
<tr>
<th>Dr Claudia Strugnell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Fellow, World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre</td>
</tr>
<tr>
<td>Geelong Waterfront Campus, Deakin University</td>
</tr>
<tr>
<td>Locked Bag 20000, Geelong Vic, 3220</td>
</tr>
<tr>
<td>PH: (03) 5227 8483</td>
</tr>
</tbody>
</table>

**Complaints**

If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact:

The Manager, Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au

Please quote project number [DU-HREC 2013-095].
PLAIN LANGUAGE STATEMENT AND OPT-OUT

CONSENT FORM

TO: Parent/Guardian

PLEASE ONLY SIGN THIS FORM IF YOU DO NOT WISH FOR YOUR CHILD TO PARTICIPATE IN THIS STUDY, this study is using an OPT-OUT consent process. Your child’s participation will be assumed unless your return the signed OPT-OUT consent form to your school.

OPT-OUT Consent Form

Date: July, 2014
Full Project Title: Healthy Together Children’s Evaluation
Reference Number: [DU-HREC 2013-095].

I (parent/guardian) of _________________________________ (child’s name) have read and understood the attached Plain Language Statement.

I wish to OPT-OUT my child’s participation in this research according to the conditions in the Plain Language Statement.

I have been given a copy of the Plain Language Statement to keep.

The researcher has agreed not to reveal my identity and personal details that relate to my child, including where information about this research is published, or presented in any public form. I understand that by signing this form that my child will not be involved in this study.

Parent/Guardian Name (printed) …………………………………………………………………

Signature ……………………………………………………… Date ………………………

Child’s gender □ Male □ Female

Child’s date of birth: ____ / ____ / ____ (dd/mm/year)  Child’s school: ___________________________

Plain Language Statement & Consent Form to Participants, DU-HREC 2013-095
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Parent/Guardian

Withdrawal of Consent Form

(To be used for participants who wish to withdraw from the project)

Date: July, 2014
Full Project Title: Healthy Together Children’s Evaluation
Reference Number: [DU-HREC 2013-095].

I hereby wish to WITHDRAW my consent for my child to participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with Deakin University or any associated party.

Parent/Guardian Name (printed) …………………………………………………….
Child’s Name (printed) …………………………………………………………….
Child’s School (printed) …………………………………………………………….
Signature …………………………………………………………… Date ……………………

Please mail this form to:
Dr Claudia Strugnell
Research Fellow, World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre

Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8483

Plain Language Statement & Consent Form to Participants, DU-HREC 2013-095
Memo

To: Mr Joshua Hayward, Prof Steven Allender, Dr Claudia Strugnell, Dr Lynne Millar, 
Mr Brynle Owen 
Population Health SRC

From: Secretary – HEAG-H 
Faculty of Health

CC:

Date: 12 December 2014

Re: HEAG-H 189_2014: HAL Maps – Healthy Adolescent Lifestyle Maps GMB 
Project

Approval has been given for Mr. Joshua Hayward, Prof Steven Allender, Dr Claudia Strugnell, Dr 
Lynne Millar and Mr. Brynle Owen, Population Health to undertake this project for a period of 3 
years from 12th December, 2014. The current end date for this project is 12th December, 2017.

The approval given by the Deakin University HEAG - H is given only for the project and for the period 
as stated in the approval. It is your responsibility to contact the Secretary immediately should any of 
the following occur:

- Serious or unexpected adverse effects on the participants
- Any proposed changes in the protocol, including extensions of time
- Any events which might affect the continuing ethical acceptability of the project
- The project is discontinued before the expected date of completion
- Modifications that have been requested by other Human Research Ethics Committees

In addition you will be required to report on the progress of your project at least once every year 
and at the conclusion of the project. Failure to report as required will result in suspension of your 
approval to proceed with the project.

An Annual Project Report Form can be found at: 

This should be completed and returned to the Administrative Officer to the HEAG-H, Pro-Vice 
Chancellor’s office, Faculty of Health, Burwood campus by Tuesday 17th November, 2015 and when 
the project is completed. HEAG-H may need to audit this project as part of the requirements for 

Good luck with the project!
D.9 - HAL Ethics Approval – Department of Education and Early Childhood Development

2014_002552

Mr Joshua Hayward
World Health Organisation Collaborating Centre for Obesity Prevention
Deakin University
1 Gheringhap Street
GEELONG 3220

Dear Mr Hayward

Thank you for your application of 11 November 2014 in which you request permission to conduct research in Victorian government schools and/or early childhood settings HAL Maps – The Healthy Adolescent Lifestyles GMB Mapping Project.

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Training.

2. Separate approval for the research needs to be sought from school principals and/or centre directors. This is to be supported by the Department of Education and Training approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.

3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Training for its consideration before you proceed.

4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.

5. You acknowledge the support of the Department of Education Training in any publications arising from the research.
6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.

7. If the Department of Education Training has commissioned you to undertake this research, the responsible Branch/Division will need to approve any material you provide for publication on the Department's Research and Evaluation Register.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Youla Michaels, Project Support Officer, Insights and Evidence Branch, by telephone on (03) 9637 2707 or by email at michaels.youla.y@edumail.vic.gov.au.

Yours sincerely

[Signature Redacted by Library]

Susan Thomas
Director
Insights and Evidence Branch

4/04/2015
Dear Mr Hayward,

I am writing with regard to your research application received on 17 July 2015 concerning your forthcoming project titled HAL Maps: Health Adolescent Lifestyle Maps GMB Project. You have asked approval to approach Catholic schools in the Archdiocese of Melbourne, as you wish to involve teachers & students.

I am pleased to advise that your research proposal is approved in principle subject to the eight standard conditions outlined below.

1. The decision as to whether or not research can proceed in a school rests with the school's principal, so you will need to obtain approval directly from the principal of the school that you wish to involve. You should provide the principal with an outline of your research proposal and indicate what will be asked of the school. A copy of this letter of approval, and a copy of notification of approval from the organisation's/university's Ethics Committee, should also be provided.

2. A copy of the approval notification from your institution’s Ethics Committee must be forwarded to this Office, together with any modifications to your research protocol requested by the Committee. You may not start any research in Catholic Schools until this step has been completed.

3. A Working with Children (WWC) check – or registration with the Victorian Institute of Teaching (VIT) – is necessary for all researchers visiting schools. Appropriate documentation must be shown to the principal before starting the research in the school.

4. No student is to participate in the research study unless s/he is willing to do so and informed consent is given in writing by a parent/guardian.
5. Any substantial modifications to the research proposal, or additional research involving use of the data collected, will require a further research approval submission to this Office.

6. Data relating to individuals or the school are to remain confidential.

7. Since participating schools have an interest in research findings, you should consider ways in which the results of the study could be made available for the benefit of the school community.

8. At the conclusion of the study, a copy or summary of the research findings should be forwarded to the Catholic Education Office Melbourne. It would be appreciated if you could submit your report in an electronic format using the email address provided below.

I wish you well with your research study. If you have any queries concerning this matter, please contact Ms Shani Prendergast of this Office at apr@ceomelb.catholic.edu.au.

Yours sincerely

[Signature Redacted by Library]

Dr Paul Sharkey
DIRECTOR CATHOLIC EDUCATION SERVICES
**Plain Language Statement**

Date: 05/10/2015  
Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project  
Principal Researchers: Mr Joshua Hayward, Professor Steven Allender, Dr Claudia Strugnell, Dr Lynne Millar & Mr Brynle Owen.

Purpose

We would like to find out more about the factors that could contribute to healthy physical activity and nutrition among adolescents in your community. We are inviting approximately 20 stakeholders, people who have a good understanding of the community, from all sectors to help explain what drives the physical activity and nutrition patterns of adolescents in your area.

This letter outlines the intended research study and includes a consent form should you agree to participate. We ask that you please read this information carefully, so that you can make an informed decision about participation.

Methods

If you agree to participate in this study we would like you to attend 90-minute workshop on Tuesday 20th of October, from 11:00am until 12:30pm at the Western Beach Room at Deakin University Waterfront Campus (Building AD, Level 6, Deakin University Waterfront Campus, 1 Gheringhap Street, Geelong). In this workshop, you will develop a picture of the things that drive healthy physical activity and nutrition patterns for adolescents in your region. After the completion of the initial workshop, you will be invited to a second 90-minute workshop to provide a second round of input to finalise the picture.

At no time point will you be asked to discuss personal information. You will be bringing your knowledge and experience to the workshops as a valued member of the community.

Possible Benefits

The purpose of the initial workshop is to develop a picture of the things that drive healthy physical activity and nutrition patterns for adolescents in your region. This information is critical in being able to examine what affect initiatives in your
community are having on physical activity and nutrition among adolescents. In addition, the data and knowledge derived from this research will be able to highlight future areas for action in your community as well as things that are being done well.

**Possible Risks**

This research is very low risk. However, should you feel uncomfortable at any point; you may withdraw participation without any consequences.

**Participation is Voluntary**

Participation in this research is voluntary and no reimbursements or incentives (financial or other) will be offered to participants.

**Privacy, Confidentiality and Disclosure of Information**

At no time-point will you be asked to discuss personal information. All information collected in the workshops will be anonymous and you will not be identified or identifiable in any report or publication arising from this session. The nature of the focus group requires participants to think at a community level (e.g. where people live, work and play) thus avoiding the need to discuss any personal information or stories.

**Funding**

This research is being by the school of Health and Social Development, and the Population Health Strategic Research Centre at Deakin University.

**Results of the research**

Information/data arising from this research will be stored in confidence and will not be released to anyone outside the study team. The information will be kept in locked facilities in accordance with government guidelines. The consent forms will be stored separately to the data collected and data will be disposed of after a minimum period of 7 years. The information and data arising from the stakeholder workshops will be used to develop and monitor changes to the healthy weight system in your community. We plan to share and discuss the results with government departments, policy makers and publish the results in peer-reviewed journals and present the findings at relevant conferences and meetings. In any publication, presentation or discussion the information will be provided in such a way that no individual can be identified.

**Ethical Guidelines**

This research will be carried out in accordance with the *National Statement on Ethical Conduct in Human Research 2007 – Updated 2009* which is produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies. The ethical aspects of this research have been approved by the Faculty of Health’s Human Research Ethics Advisory Group (HEAG), Deakin University.

Plain Language Statement & Consent Form to Participants, HEAG-H 189_2014
Further Information
If you require further information or have any problems or concerns regarding this research, you can contact Joshua Hayward.

Mr Joshua Hayward
PhD Candidate, World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre

Geelong Waterfront Campus, Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305

Complaints
If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact:

The Manager, Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au

Please quote project number [HEAG-H 189_2014].
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: LGA Participant

Date: 05/10/2015
Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project Reference Number: [HEAG-H 189_2014].

I have read and I understand the attached Plain Language Statement.
I freely agree to participate in this project according to the conditions in the Plain Language Statement.
I have been given a copy of the Plain Language Statement and Consent Form to keep.
The researcher has agreed not to reveal my identity and personal details, including where information about this project is published, or presented in any public form.

Participant’s Name (printed) .................................................................

Signature ................................................................. Date .........................
Withdrawal of Consent Form

(To be used for participants who wish to withdraw from the project)

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project Reference Number: [HEAG-H 189_2014].

I hereby wish to WITHDRAW my consent to participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with Deakin University or any associated party.

Participant’s Name (printed) …………………………………………………………..

Signature …………………………………………………………………….. Date ……………………

Please mail this form to:

Mr Joshua Hayward
World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre

Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305
Plain Language Statement and Consent Form

TO: Student

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project
Principal Researchers: Mr Joshua Hayward, Professor Steven Allender, Dr Claudia Strugnell, Dr Lynne Millar & Mr Brynle Owen.

Purpose
We would like to find out more about the factors that could contribute to healthy physical activity and dietary intake among adolescents in your community. We are inviting approximately 20 stakeholders, people who have a good understanding of the community, from all sectors to help explain what drives the physical activity and nutrition patterns of adolescents in your area.

This letter outlines the intended research study and includes a consent form should you agree to participate. We ask that you please read this information carefully, so that you can make an informed decision about participation.

Methods
If you agree to participate in this study we would like you to attend a 90-minute workshop, accompanied by a member of the teaching staff from your school who will also be participating, on Tuesday 20th of October, from 11:00am until 12:30pm at the Western Beach Room at Deakin University Waterfront Campus (Building AD, Level 6, Deakin University Waterfront Campus, 1 Gheringhap Street, Geelong). In this workshop, you will develop a picture of the things that drive healthy physical activity and nutrition patterns for adolescents in your region. After the completion of the initial workshop, you will be invited to a second 90-minute workshop (again, along with a teacher from your school) to provide a second round of input to finalise the picture.

At no time point will you be asked to discuss personal information. You will be bringing your knowledge and experience to the workshops as a valued member of the community.
Possible Benefits
The purpose of the initial workshop is to develop a picture of the things that drive healthy eating and physical activity for adolescents in your region. This information is critical in being able to examine what effect initiatives in your community are having on physical activity and nutrition among adolescents. In addition, the data and knowledge derived from this research will be able to highlight future areas for action in your community as well as things that are being done well.

Possible Risks
This research is very low risk. However, should you feel uncomfortable at any point; you may withdraw participation without any consequences.

Participation is Voluntary
Participation in this research is voluntary and no reimbursements or incentives (financial or other) will be offered to participants.

Privacy, Confidentiality and Disclosure of Information
At no time-point will you be asked to discuss personal information. All information collected in the workshops will be anonymous and you will not be identified or identifiable in any report or publication arising from this session. The nature of the focus group requires participants to think at a community level (e.g. where people live, work and play) thus avoiding the need to discuss any personal information or stories.

Funding
This research is being by the school of Health and Social Development, and the Population Health Strategic Research Centre at Deakin University.

Results of the research
Information/data arising from this research will be stored in confidence and will not be released to anyone outside the study team. The information will be kept in locked facilities in accordance with government guidelines. The consent forms will be stored separately to the data collected and data will be disposed of after a minimum period of 7 years. The information and data arising from the stakeholder workshops will be used to develop and monitor changes to the healthy weight system in your community. We plan to share and discuss the results with government departments, policy makers and publish the results in peer-reviewed journals and present the findings at relevant conferences and meetings. In any publication, presentation or discussion the information will be provided in such a way that no individual can be identified.

Ethical Guidelines
This research will be carried out in accordance with the National Statement on
Ethical Conduct in Human Research 2007 – Updated 2009 which is produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies. The ethical aspects of this research have been approved by the Faculty of Health’s Human Research Ethics Advisory Group (HEAG), Deakin University.

Further Information
If you require further information or have any problems or concerns regarding this research, you can contact Joshua Hayward.

Mr Joshua Hayward
PhD Candidate, World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre

Geelong Waterfront Campus, Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305

Complaints
If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact:

The Manager, Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au

Please quote project number [HEAG-H 189_2014].
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Student

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project Reference Number: [HEAG-H 189_2014].

I have read and I understand the attached Plain Language Statement.

I freely agree to participate in this project according to the conditions in the Plain Language Statement.

I have been given a copy of the Plain Language Statement and Consent Form to keep.

The researcher has agreed not to reveal my identity and personal details, including where information about this project is published, or presented in any public form.

Participant’s Name (printed) ………………………………………………………………………

Signature ……………………………………………………… Date  …………………………

Plain Language Statement & Consent Form to Participants, HEAG-H 189_2014
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Parent/Guardian

PARENT/GUARDIAN Consent Form

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project
Reference Number: [HEAG-H 189_2014].

I have read and I understand the attached Plain Language Statement.

I freely agree to my child’s participation in this project according to the conditions in the Plain Language Statement.

I have been given a copy of the Plain Language Statement and Consent Form to keep.

The researcher has agreed not to reveal my child’s identity and personal details, including where information about this project is published, or presented in any public form.

Parent/guardian’s name (printed) …………………………………………………………………

Signature ……………………………………………………… Date ………………………

Plain Language Statement & Consent Form to Participants, HEAG-H 189_2014
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Student

Withdrawal of Consent Form

(To be used for participants who wish to withdraw from the project)

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project Reference Number: [HEAG-H 189_2014].

I hereby wish to WITHDRAW my consent to participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with Deakin University or any associated party.

Participant’s Name (printed) .................................................................

Signature ................................................................. Date ....................... 

Please mail this form to:

Mr Joshua Hayward
World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre

Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305

Plain Language Statement & Consent Form to Participants, HEAG-H 189_2014
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Teacher

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project

Principal Researchers: Mr Joshua Hayward, Professor Steven Allender, Dr Claudia Strugnell, Dr Lynne Millar & Mr Brynle Owen.

Purpose

We would like to find out more about the factors that could contribute to healthy physical activity and nutrition among adolescents in your community. We are inviting approximately 20 stakeholders, people who have a good understanding of the community, from all sectors to help explain what drives the physical activity and nutrition patterns of adolescents in your area.

This letter outlines the intended research study and includes a consent form should you agree to participate. We ask that you please read this information carefully, so that you can make an informed decision about participation.

Methods

If you agree to participate in this study we would like you to attend 90-minute workshop on Tuesday 20th of October, from 11:00am until 12:30pm at the Western Beach Room at Deakin University Waterfront Campus (Building AD, Level 6, Deakin University Waterfront Campus, 1 Gheringhap Street, Geelong). In this workshop, you will develop a picture of the things that drive healthy physical activity and nutrition patterns for adolescents in your region. Secondary school students will also form part of the participant group in this study, and you will attend the workshop along with a year 10 student from your school. After the completion of the initial workshop, you (along with the accompanying student from your school) will be invited to a second 90-minute workshop to provide a second round of input to finalise the picture.

At no time point will you be asked to discuss personal information. You will be bringing your knowledge and experience to the workshops as a valued member of the community.
Possible Benefits

The purpose of the initial workshop is to develop a picture of the things that drive healthy physical activity and nutrition patterns for adolescents in your region. This information is critical in being able to examine what affect initiatives in your community are having on physical activity and nutrition among adolescents. In addition, the data and knowledge derived from this research will be able to highlight future areas for action in your community as well as things that are being done well.

Possible Risks

This research is very low risk. However, should you feel uncomfortable at any point; you may withdraw participation without any consequences.

Participation is Voluntary

Participation in this research is voluntary and no reimbursements or incentives (financial or other) will be offered to participants.

Privacy, Confidentiality and Disclosure of Information

At no time-point will you be asked to discuss personal information. All information collected in the workshops will be anonymous and you will not be identified or identifiable in any report or publication arising from this session. The nature of the focus group requires participants to think at a community level (e.g. where people live, work and play) thus avoiding the need to discuss any personal information or stories.

Funding

This research is being by the school of Health and Social Development, and the Population Health Strategic Research Centre at Deakin University.

Results of the research

Information/data arising from this research will be stored in confidence and will not be released to anyone outside the study team. The information will be kept in locked facilities in accordance with government guidelines. The consent forms will be stored separately to the data collected and data will be disposed of after a minimum period of 7 years. The information and data arising from the stakeholder workshops will be used to develop and monitor changes to the healthy weight system in your community. We plan to share and discuss the results with government departments, policy makers and publish the results in peer-reviewed journals and present the findings at relevant conferences and meetings. In any publication, presentation or discussion the information will be provided in such a way that no individual can be identified.

Ethical Guidelines

This research will be carried out in accordance with the National Statement on
Ethical Conduct in Human Research 2007 – Updated 2009 which is produced by the National Health and Medical Research Council of Australia. This statement has been developed to protect the interests of people who agree to participate in human research studies. The ethical aspects of this research have been approved by the Faculty of Health’s Human Research Ethics Advisory Group (HEAG), Deakin University.

Further Information
If you require further information or have any problems or concerns regarding this research, you can contact Joshua Hayward.

Mr Joshua Hayward
PhD Candidate, World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre

Geelong Waterfront Campus, Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305

Complaints
If you have any complaints about any aspect of the project, the way it is being conducted or any questions about your rights as a research participant, then you may contact:

The Manager, Research Integrity, Deakin University, 221 Burwood Highway, Burwood Victoria 3125, Telephone: 9251 7129, research-ethics@deakin.edu.au

Please quote project number [HEAG-H 189_2014].
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Teacher

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project Reference Number: [HEAG-H 189_2014].

I have read and I understand the attached Plain Language Statement.

I freely agree to participate in this project according to the conditions in the Plain Language Statement.

I have been given a copy of the Plain Language Statement and Consent Form to keep.

The researcher has agreed not to reveal my identity and personal details, including where information about this project is published, or presented in any public form.

Participant’s Name (printed) ..................................................................................................................

Signature ....................................................... Date ........................................
PLAIN LANGUAGE STATEMENT AND CONSENT FORM

TO: Teacher

Withdrawal of Consent Form

(To be used for participants who wish to withdraw from the project)

Date: 05/10/2015

Full Project Title: HAL Maps – Healthy Adolescent Lifestyle Maps GMB Project Reference Number: [HEAG-H 189_2014].

I hereby wish to WITHDRAW my consent to participate in the above research project and understand that such withdrawal WILL NOT jeopardise my relationship with Deakin University or any associated party.

Participant’s Name (printed) …………………………………………………….

Signature ………………………………………………………………. Date ……………………

Please mail this form to:

Mr Joshua Hayward
World Health Organization Collaborating Centre for Obesity Prevention, Deakin Population Strategic Research Centre
Geelong Waterfront Campus
Deakin University
Locked Bag 20000,
Geelong Vic, 3220
PH: (03) 5227 8305

Plain Language Statement & Consent Form to Participants, HEAG-H 189_2014
Appendix E – Outputs

E.1 - HAL School Report – Stream 1

Healthy Adolescent Lifestyle (HAL) Mapping Project

Understanding Physical Activity and Diet Behaviours in Victoria, Australia

Workshop Report

October-December 2015
Executive Summary:

Two workshop sessions were held on the 20/10 and 5/11 2015, with participants from Healthy Together Geelong, and representatives from health service providers and secondary schools across the Greater Geelong region. The workshops were facilitated by Mr Josh Hayward, Mr Brynle Owen, and Mr Andrew Brown from Deakin University, along with Ms Jaimie McGlashan, Professor Steven Allender, Dr Lynne Millar (also from Deakin University) and Professor Kayla de la Haye from University of Southern California who joined as note-takers and observers. The objectives of the workshops were to:

- Create a shared understanding of the interrelated causes and effects of healthy diet and physical activity behaviours among adolescents within the Geelong region, and;
- Generate a “Healthy Adolescent Lifestyle Map” depicting this shared understanding.

Session 1 involved a series of exercises including the “Graphs over Time” and “Connection Circles” activities, in which participants identified the initial set of causes and effects of adolescent healthy diet and physical activity within the region, and began to identify the complex causal linkages between these variables. The activities of session 1 formed the basis for the first iteration of the HAL Map, which was presented to participants in Session 2.

Session 2 introduced the Map to participants, and included the “Community Feedback” and “Live Model Update” exercises, to explore participants’ initial reactions to the model and obtain feedback for further development of the map. The session concluded with an activity which saw some of this feedback immediately incorporated into the model during the live model update.
# Table of Contents

Executive Summary .................................................................................................................................. 2  
HAL Maps Session 1: Introduction, Graphs over Time and Connection Circles ......................................... 4  
  Figure 1: Slide presentation from workshop 1 ...................................................................................... 4  
  Figure 2: Spaghetti map from workshop 1 ........................................................................................... 7  
HAL Maps Session 2: Model Presentation and Feedback from Participants ............................................. 8  
  Figure 3: Slide presentation from workshop 2 ...................................................................................... 8  
  Figure 4: Updated map from workshop 2 ............................................................................................ 10  
  Figure 5: Example of community feedback on map during workshop 2 ............................................. 11  
  Figure 6: Map from workshop 2 after live map update activity ............................................................ 12  
HAL Maps Post-Workshop: ................................................................................................................... 13  
  Figure 7: Finalised map after post-workshop revision .......................................................................... 13  
Summary: .............................................................................................................................................. 14  
APPENDIX A: HAL Workshop Session Agendas, .................................................................................. 15  
APPENDIX B: Figure 7 (Enlarged) ......................................................................................................... 17

HAL Maps Session 1: Introduction, Graphs over Time and Connection Circles
20th October, 2015 - 11:00am – 12:30pm

Session welcome and introduction:

The first morning of the workshop began with an overview of adolescent mental health and the lifestyle behaviours related to it, specifically adolescent physical activity and diet behaviours. The session brought together stakeholders from Healthy Together Geelong, health service providers, and secondary school teachers and students from around Greater Geelong. The session began with an overview of the structure of the first workshop session. The slideshow presentation which was used throughout the session is presented below in Figure 1, and the agenda for the session is presented in Appendix A.

![Figure 1: Slide presentation from workshop 1 (Cont’d over page)](image-url)
Figure 1 (Cont’d): Slide presentation from workshop 1
Graphs over time activity:

The graphs over time activity was introduced, followed by a 10 minute session allowing participants to work in small groups to draw as many “Graphs over Time” as they could think of, in response to the prompt: “What things can you think of which affect or are affected by adolescents’ ability to eat healthily or be physically active in the Geelong region?” Each group prioritized their graphs and then presented their most important ideas to the group. The graphs were used as a method for identifying the most important factors related to adolescent lifestyle health from the group’s perspective, and provide a starting point for the next activity.

Connection circles activity:

The connection circles activity was introduced to the group as an exercise to find the causal connections (i.e. which factors cause a change in which other factors) between the important factors that had been identified in the graphs over time activity. Each of the factors which had been identified by the group during the graphs over time activity was displayed in a circle on a projector screen. During the activity, participants were able to specify connections between the factors, and those connections were added to the connection circle. Participants were also able to introduce new factors into the connection circle as they became relevant. Over the course of the session, participants worked on the connection circle until they had created a “spaghetti map” (shown below in Figure 2). The spaghetti map provided the initial information which was developed into a revised and clarified map, to be presented in the second workshop. The first session was closed by the facilitator after reflecting briefly on the session outcomes and explaining the next steps involved in upcoming sessions.
Figure 2: Spaghetti map from workshop 1.
HAL Maps Session 2: Model Presentation and Feedback from Participants

5th November, 2015 - 11:00am – 12:30pm

Session welcome and introduction:

The second session of the workshop began by restating the purpose of the workshop – to build shared understanding of the drivers of adolescent lifestyle health in the Geelong region. This was followed by a presentation from Josh Hayward, outlining the development of the map based on the outputs from the previous session.

Between workshops 1 and 2, the facilitation team had taken the spaghetti map (Figure 2) and clarified it by re-arranging where the variable names were located on the page. Through the process (referred to as “detangling”) the facilitation team arranged the variables and connections which had been identified by participants in the first workshop in such a way to minimise crossovers between the connection arrows. The slides used in the session are presented in figure 3, below, along with the updated version of the map presented in Figure 4. The agenda for the session is presented below in Appendix A.
Figure 3 (Cont’d): Slide presentation from workshop 2
Community feedback on map activity:

The first activity of the session involved a 30 minute session allowing participants to convey positive comments (“things I liked”), concerns or proposed changes (“things I think are wrong/need to be changed”) and general comments (“this is new knowledge/this requires further investigation”) on the basis of the map which had been presented. The comments were attached to the map using post-it notes (see example in Figure 5 below). At this stage participants were also invited to add any causal connections (new arrows) to the map that they thought were missing. The feedback from the group was retained for further development of the map after workshop 2:
Live map update activity:

Participants worked on a final activity, clarifying and adding detail to the map, based on the discussions and outputs from the initial feedback session. During the live map update, participants discussed content in the map which was incorrect or required clarification, as well as missing factors or connections which needed to be included. As participants proposed changes to the map, the changes were incorporated, in real time on a projected screen in a similar fashion to the connection circles activity in workshop 1. The outputs of this session are shown below, in figure 6. This process helped the facilitation team to gauge the most important revisions to the map, and to commence the process of revising and finalising the map after the workshop.
Figure 6: Map from workshop 2 after live map update activity.

HAL Maps Post-Workshop:

Post workshop map revision:

Following workshop 2, the facilitation team again completed a round of clarification on the updated map from the live map update activity, and incorporated the feedback that participants had provided during the community feedback activity. As with the second workshop, clarification involved working to minimise the crossover of connection arrows in the map that participants had created.

The final version of the map which was created after workshop two is presented below, in figure 7, and in an enlarged version in Appendix B.

Figure 7: Finalised map after post-workshop revision.
Summary:

In summary, the workshops achieved the initial goals of a) creating shared understanding of the causes and effects of healthy diet and physical activity behaviours among adolescents within Greater Geelong, and b) creating a “HAL Map” to visually represent the understanding reached by the group.

The results of this workshop will be used to inform research undertaken as part of Josh Hayward’s PhD thesis at Deakin University. This research endeavours to understand whether this approach is a feasible method for sharing and building understanding around the issue of adolescent lifestyle. Secondly, it aims to see how different groups agree or differ on what they see as the primary causes of adolescent’s diet and physical activity behaviours. The workshop series seems to suggest that the approach is feasible for sharing understanding (based on the maps attached to this document) however more research will be undertaken in the coming months to answer the second question, and find out where the two workshop groups agreed, and where their perceptions were different. If you would like to be kept abreast of the research as it goes on, please feel free to contact me at jnh@deakin.edu.au and I will let you know what the results were when the study is complete.

Acknowledgements:

The HAL Maps facilitation team would like to thank the City of Greater Geelong & Healthy Together Geelong team for its assistance with coordination and recruitment throughout the HAL Maps workshop series.

The team also wishes to thank each of the participants who volunteered their time, and brought their knowledge and expertise to the workshops. A final, special thanks goes to the students who attended and were such great representatives of their peers in the Geelong community.
## APPENDIX A: HAL Workshop Session Agendas.

### Agenda: Session 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00am</td>
<td>10mins</td>
<td>Welcome and Introduction to Session</td>
<td>The <em>convener (Josh)</em> welcomes participants and opens the meeting. Introduction of participants and facilitation team. The <em>facilitator (Josh)</em> provides a brief introduction to the project and the purpose of the session.</td>
</tr>
<tr>
<td>11:10am</td>
<td>30mins</td>
<td>Graphs Over Time</td>
<td>The <em>facilitator (Josh)</em> introduces the “Graphs over Time” exercise and gives participants 10 minutes to work in groups of three to draw as many graphs over time as they can on “Things that affect or are affected by adolescent physical activity or diet in the Greater Geelong region.”</td>
</tr>
<tr>
<td>11:40am</td>
<td>40mins</td>
<td>Connection Circle</td>
<td>The <em>facilitator (Josh)</em> introduces the connection circle script as an exercise for participants to discuss, and find the connections between different factors that contribute to or are affected by adolescent health behaviours in Geelong. The <em>modeler (Andrew)</em> draws the links as the participants are speaking, and the connection circle is projected for participants to see.</td>
</tr>
<tr>
<td>12:20pm</td>
<td>10mins</td>
<td>Closing</td>
<td>The <em>facilitator (Josh)</em> explains the next steps including going over the notes and cleaning up the map to continue to build on the next meeting. Potential next dates are discussed with participants. Participants are thanked for their time, and invited to stay after if they have more questions.</td>
</tr>
<tr>
<td>12:30pm</td>
<td>n/a</td>
<td>Close session</td>
<td>Session finished</td>
</tr>
</tbody>
</table>
Agenda: Session 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00am</td>
<td>10mins</td>
<td>Welcome and Introduction to Session</td>
<td>The convener (Josh) welcomes participants and opens the meeting. Introduction of participants and facilitation team. The facilitator (Josh) provides a brief introduction to the purpose of the session.</td>
</tr>
<tr>
<td>11:10am</td>
<td>10mins</td>
<td>Model Presentation</td>
<td>The Presenter (Josh) gives a brief outline of the development of the map from last workshop’s outputs to the current version.</td>
</tr>
<tr>
<td>11:20am</td>
<td>30mins</td>
<td>Community Feedback on Map</td>
<td>The facilitator (Josh) at the front of the room explains the purpose of the exercise, inviting participants to work in groups of three, using use sticky notes to provide different types of feedback to the new version of the map. Feedback loops are briefly presented (with an example from the diagram) and participants are encouraged to identify any other ones they can see.</td>
</tr>
<tr>
<td>11:50am</td>
<td>30mins</td>
<td>Live Model Update</td>
<td>The facilitator (Josh) reflects the work that the participants have just completed on the map. Participants are informed that they now have around 30 minutes to discuss their most important changes, as a way of beginning the second round of map development. Throughout the discussion, the modeler (Andrew) is updating the current version of the map, which is being projected on a screen in real-time, to reflect the participants commentary.</td>
</tr>
<tr>
<td>12:20pm</td>
<td>10mins</td>
<td>Closing</td>
<td>The closer (Josh) thanks participants for their time, invites them to stay after if they have more questions, and reminds participants that the map will now be revised into a final version, which will be sent back to them in their school or organization.</td>
</tr>
<tr>
<td>12:30pm</td>
<td>n/a</td>
<td>Close session</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B: Figure 7 (Enlarged)
Healthy Adolescent Lifestyle (HAL) Mapping Project

Understanding Physical Activity and Diet Behaviours in Victoria, Australia

Workshop Report

October-December 2015
**Executive Summary:**

Two workshop sessions were held on the 23/10 and 6/11 2015, with participants from Healthy Together Geelong, and representatives from health service providers and secondary schools across the Greater Geelong region. The workshops were facilitated by Mr Josh Hayward, Mr Brynle Owen, and Mr Andrew Brown from Deakin University, along with Ms Jaimie McGlashan, Professor Steven Allender, Dr Lynne Millar (also from Deakin University) and Professor Kayla de la Haye from University of Southern California who joined as note-takers and observers. The objectives of the workshops were to:

- Create a shared understanding of the interrelated causes and effects of healthy diet and physical activity behaviours among adolescents within the Geelong region, and;
- Generate a “Healthy Adolescent Lifestyle Map” depicting this shared understanding.

Session 1 involved a series of exercises including the “Graphs over Time” and “Connection Circles” activities, in which participants identified the initial set of causes and effects of adolescent healthy diet and physical activity within the region, and began to identify the complex causal linkages between these variables. The activities of session 1 formed the basis for the first iteration of the HAL Map, which was presented to participants in Session 2.

Session 2 introduced the Map to participants, and included the “Community Feedback” and “Live Model Update” exercises, to explore participants’ initial reactions to the model and obtain feedback for further development of the map. The session concluded with an activity which saw some of this feedback immediately incorporated into the model during the live model update.
Table of Contents

Executive Summary:............................................................................................................ .......... 2
HAL Maps Session 1: Introduction, Graphs over Time and Connection Circles......................... 4
  Figure 1: Slide presentation from workshop 1 ................................................................. 4
  Figure 2: Spaghetti map from workshop 1 ........................................................................ 7
HAL Maps Session 2: Model Presentation and Feedback from Participants............................... 8
  Figure 3: Slide presentation from workshop 2 ................................................................. 8
  Figure 4: Updated map from workshop 2 ........................................................................ 10
  Figure 5: Example of community feedback on map during workshop 2 ......................... 11
  Figure 6: Map from workshop 2 after live map update activity ....................................... 12
HAL Maps Post-Workshop:..................................................................................................... 13
  Figure 7: Finalised map after post-workshop revision ..................................................... 13
Summary:.............................................................................................................................. 14
APPENDIX A: HAL Workshop Session Agendas. ................................................................. 15
APPENDIX B: Figure 7 (Enlarged) .......................................................................................... 17
HAL Maps Session 1: Introduction, Graphs over Time and Connection Circles
23rd October, 2015 - 12:30pm – 2:00pm

Session welcome and introduction:

The first morning of the workshop began with an overview of adolescent mental health and the lifestyle behaviours related to it, specifically adolescent physical activity and diet behaviours. The session brought together stakeholders from Healthy Together Geelong, health service providers, and secondary school teachers and students from around Greater Geelong. The session began with an overview of the structure of the first workshop session. The slideshow presentation which was used throughout the session is presented below in Figure 1, and the agenda for the session is presented in Appendix A.
Figure 1 (Cont’d): Slide presentation from workshop 1
Graphs over time activity:

The graphs over time activity was introduced, followed by a 10 minute session allowing participants to work in small groups to draw as many “Graphs over Time” as they could think of, in response to the prompt: “What things can you think of which affect or are affected by adolescents’ ability to eat healthily or be physically active in the Geelong region?” Each group prioritized their graphs and then presented their most important ideas to the group. The graphs were used as a method for identifying the most important factors related to adolescent lifestyle health from the group’s perspective, and provide a starting point for the next activity.

Connection circles activity:

The connection circles activity was introduced to the group as an exercise to find the causal connections (i.e. which factors cause a change in which other factors) between the important factors that had been identified in the graphs over time activity. Each of the factors which had been identified by the group during the graphs over time activity was displayed in a circle on a projector screen. During the activity, participants were able to specify connections between the factors, and those connections were added to the connection circle. Participants were also able to introduce new factors into the connection circle as they became relevant. Over the course of the session, participants worked on the connection circle until they had created a “spaghetti map” (shown below in Figure 2). The spaghetti map provided the initial information which was developed into a revised and clarified map, to be presented in the second workshop. The first session was closed by the facilitator after reflecting briefly on the session outcomes and explaining the next steps involved in upcoming sessions.
Figure 2: Spaghetti map from workshop 1.
HAL Maps Session 2: Model Presentation and Feedback from Participants
6th November, 2015 - 12:30pm – 2:00pm

Session welcome and introduction:

The second session of the workshop began by restating the purpose of the workshop – to build shared understanding of the drivers of adolescent lifestyle health in the Geelong region. This was followed by a presentation from Josh Hayward, outlining the development of the map based on the outputs from the previous session.

Between workshops 1 and 2, the facilitation team had taken the spaghetti map (Figure 2) and clarified it by re-arranging where the variable names were located on the page. Through the process (referred to as “detangling”) the facilitation team arranged the variables and connections which had been identified by participants in the first workshop in such a way to minimise crossovers between the connection arrows. The slides used in the session are presented in figure 3, below, along with the updated version of the map presented in Figure 4. The agenda for the session is presented below in Appendix A.

Figure 3: Slide presentation from workshop 2 (Cont’d over page)
Figure 3 (Cont’d): Slide presentation from workshop 2
Community feedback on map activity:

The first activity of the session involved a 30 minute session allowing participants to convey positive comments (“things I liked”), concerns or proposed changes (“things I think are wrong/need to be changed”) and general comments (“this is new knowledge/this requires further investigation”) on the basis of the map which had been presented. The comments were attached to the map using post-it notes (see example in Figure 5 below). At this stage participants were also invited to add any causal connections (new arrows) to the map that they thought were missing. The feedback from the group was retained for further development of the map after workshop 2:
Live map update activity:

Participants worked on a final activity, clarifying and adding detail to the map, based on the discussions and outputs from the initial feedback session. During the live map update, participants discussed content in the map which was incorrect or required clarification, as well as missing factors or connections which needed to be included. As participants proposed changes to the map, the changes were incorporated, in real time on a projected screen in a similar fashion to the connection circles activity in workshop 1. The outputs of this session are shown below, in figure 6. This process helped the facilitation team to gauge the most important revisions to the map, and to commence the process of revising and finalising the map after the workshop.
Figure 6: Map from workshop 2 after live map update activity.
HAL Maps Post-Workshop:

Post workshop map revision:

Following workshop 2, the facilitation team again completed a round of clarification on the updated map from the live map update activity, and incorporated the feedback that participants had provided during the community feedback activity. As with the second workshop, clarification involved working to minimise the crossover of connection arrows in the map that participants had created.

The final version of the map which was created after workshop two is presented below, in figure 7, and in an enlarged version in Appendix B.

Figure 7: Finalised map after post-workshop revision.
**Summary:**

In summary, the workshops achieved the initial goals of a) creating shared understanding of the causes and effects of healthy diet and physical activity behaviours among adolescents within Greater Geelong, and b) creating a “HAL Map” to visually represent the understanding reached by the group. The results of this workshop will be used to inform research undertaken as part of Josh Hayward’s PhD thesis at Deakin University. This research endeavours to understand whether this approach is a feasible method for sharing and building understanding around the issue of adolescent lifestyle. Secondly, it aims to see how different groups agree or differ on what they see as the primary causes of adolescent’s diet and physical activity behaviours. The workshop series seems to suggest that the approach is feasible for sharing understanding (based on the maps attached to this document) however more research will be undertaken in the coming months to answer the second question, and find out where the two workshop groups agreed, and where their perceptions were different. If you would like to be kept abreast of the research as it goes on, please feel free to contact me at jnh@deakin.edu.au and I will let you know what the results were when the study is complete.

**Acknowledgements:**

The HAL Maps facilitation team would like to thank the City of Greater Geelong & Healthy Together Geelong team for its assistance with coordination and recruitment throughout the HAL Maps workshop series.

The team also wishes to thank each of the participants who volunteered their time, and brought their knowledge and expertise to the workshops. A final, special thanks goes to the students who attended and were such great representatives of their peers in the Geelong community.
APPENDIX A: HAL Workshop Session Agendas.

Agenda: Session 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30pm</td>
<td>10mins</td>
<td>Welcome and Introduction to Session</td>
<td>The <em>convener (Josh)</em> welcomes participants and opens the meeting. Introduction of participants and facilitation team. The <em>facilitator (Josh)</em> provides a brief introduction to the project and the purpose of the session.</td>
</tr>
<tr>
<td>12:40pm</td>
<td>30mins</td>
<td>Graphs Over Time</td>
<td>The <em>facilitator (Josh)</em> introduces the “Graphs over Time” exercise and gives participants 10 minutes to work in groups of three to draw as many graphs over time as they can on “Things that affect or are affected by adolescent physical activity or diet in the Greater Geelong region.”</td>
</tr>
<tr>
<td>1:10pm</td>
<td>40mins</td>
<td>Connection Circle</td>
<td>The <em>facilitator (Josh)</em> introduces the connection circle script as an exercise for participants to discuss, and find the connections between different factors that contribute to or are affected by adolescent health behaviours in Geelong. The <em>modeler (Andrew)</em> draws the links as the participants are speaking, and the connection circle is projected for participants to see.</td>
</tr>
<tr>
<td>1:50pm</td>
<td>10mins</td>
<td>Closing</td>
<td>The <em>facilitator (Josh)</em> explains the next steps including going over the notes and cleaning up the map to continue to build on the next meeting. Potential next dates are discussed with participants. Participants are thanked for their time, and invited to stay after if they have more questions.</td>
</tr>
<tr>
<td>2:00pm</td>
<td>n/a</td>
<td>Close session</td>
<td>Session finished</td>
</tr>
</tbody>
</table>
### Agenda: Session 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30pm</td>
<td>10mins</td>
<td>Welcome and Introduction to Session</td>
<td>The convener (Josh) welcomes participants and opens the meeting. Introduction of participants and facilitation team. The facilitator (Josh) provides a brief introduction to the purpose of the session.</td>
</tr>
<tr>
<td>12:40pm</td>
<td>10mins</td>
<td>Model Presentation</td>
<td>The Presenter (Josh) gives a brief outline of the development of the map from last workshop’s outputs to the current version.</td>
</tr>
<tr>
<td>12:50pm</td>
<td>30mins</td>
<td>Community Feedback on Map</td>
<td>The facilitator (Josh) at the front of the room explains the purpose of the exercise, inviting participants to work in groups of three, using use sticky notes to provide different types of feedback to the new version of the map. Feedback loops are briefly presented (with an example from the diagram) and participants are encouraged to identify any other ones they can see.</td>
</tr>
<tr>
<td>1:20pm</td>
<td>30mins</td>
<td>Live Model Update</td>
<td>The facilitator (Josh) reflects the work that the participants have just completed on the map. Participants are informed that they now have around 30 minutes to discuss their most important changes, as a way of beginning the second round of map development. Throughout the discussion, the modeler (Andrew) is updating the current version of the map, which is being projected on a screen in real-time, to reflect the participants commentary.</td>
</tr>
<tr>
<td>1:50pm</td>
<td>10mins</td>
<td>Closing</td>
<td>The closer (Josh) thanks participants for their time, invites them to stay after if they have more questions, and reminds participants that the map will now be revised into a final version, which will be sent back to them in their school or organization.</td>
</tr>
<tr>
<td>2:00pm</td>
<td>n/a</td>
<td>Close session</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B: Figure 7 (Enlarged)
E.5 - HAL Student Participation Certificate

This certificate recognises the participation and outstanding contributions of:

[Student name]

in the Healthy Adolescent Lifestyles Mapping Project, which took place at Deakin University, December 2015.

Your voluntary participation in this research has contributed to a shared understanding of the factors that support positive health among your peers in the Greater Geelong region.

The research team and I sincerely thank you for your involvement in this project.

Regards,

Josh Hayward

WHO Collaborating Centre for Obesity Prevention
Deakin University, Geelong.