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Analysis of critical features for establishing a monitoring system for childhood obesity: Monitoring system design
Report 1:
Analysis of critical features for establishing a monitoring system for childhood obesity: Monitoring system design

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About the CO-OPS Collaboration
The Collaboration of Community-based Obesity Prevention Sites (CO-OPS Collaboration) is an initiative funded by the Department of Health and Ageing for 4 years until 2011. The initiative is managed by the WHO Collaborating Centre for Obesity Prevention and Related Research at Deakin University; and works in partnership with the University of Sydney and the University of Melbourne in delivering project outcomes.

Over recent years it has become clear that there are many community-based projects / programs promoting healthy eating, physical activity and healthy body weight in Australia and that evidence and knowledge is rapidly emerging from these projects. There is also a rapidly growing body of research evidence around the reasons this work is important, but additionally - advances in our understanding about ‘what works’ to improve healthy eating and increase levels of physical activity. CO-OPS is working to develop a collaborative approach to assist the translation and exchange of this knowledge amongst policy makers, practitioners and other key stakeholders who are involved in community-based obesity prevention initiatives or are working in policy and planning areas broadly relevant to obesity prevention.

As part of this process this evidence resource has been developed - it includes a series of evidence summaries designed to assist with policy and practice-level decisions and some useful resources to assist with using the evidence. This resource and additional resources are also available via the CO-OPS website at www.co-ops.net.au

Report 1:
Analysis of critical features for establishing a monitoring system for childhood obesity: Monitoring system design

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Analysis of critical features for establishing a monitoring system for childhood obesity

Executive Summary

Childhood obesity is a major health concern in Australia. It is associated with preventable, costly and chronic diseases and tracks strongly into adulthood. Monitoring the prevalence of childhood obesity is vital to targeting the groups at highest risk, formulating appropriate obesity-prevention interventions and policies and checking progress toward achieving obesity-related objectives. Determining the true prevalence of childhood obesity in Australia is difficult because there is currently no systematic method for collecting and reporting national and local childhood obesity prevalence data in a timely and consistent manner.

Several international organizations are regularly collecting epidemiological data on childhood obesity. Existing childhood obesity monitoring systems can be used to inform the design of an Australian childhood obesity monitoring system. In 2010, a three-part study was commissioned by the Collaboration of Community-based Obesity Prevention Sites (CO-OPS Collaboration) to provide advice on the way forward to address Australia’s lack of a systematic method for consistently and promptly collecting and reporting childhood overweight and obesity prevalence data. The research was led by three academics from Deakin University with extensive experience in the area of childhood obesity; Dr Peter Kremer, Dr Andrea de Silva-Sanigorski and Associate Professor Evie Leslie.

The final report, Analysis of critical features for establishing a monitoring system for childhood obesity, consists of three parts: the design of an obesity monitoring system, the ethical implications of implementing such a system and the best ways to communicate the information back. The purpose of the report was to make recommendations for the design of an Australian childhood obesity monitoring system based on established international systems while taking into consideration the Australian context.

Part 1:
Monitoring System Design aimed to identify, from the literature, ‘best practice’ in terms of design for a childhood obesity monitoring system and make recommendations for the establishment of a childhood obesity monitoring system in Australia. Recommendations to highlight include:

- An Australian childhood obesity monitoring system should be school-based
- If monitoring data are to be collected on children who are not of school age, then these data should be collected through the coordinated efforts of state-wide primary care organizations
- Data should be collected using pilot-tested standardized protocols and a web-based data management system
- Careful monitoring of potential negative consequences and adverse outcomes should be an integral component of the system
- Properly informed passive (otherwise known as ‘opt-out’) consent should be used

Part 2:
Ethics Assessment aimed to examine the ethical considerations relevant to Australia for using a passive parental consent method within a childhood obesity monitoring system. Conclusions to highlight include:
• Opt-out consent has several advantages to its use, including higher participation rates and more accurate obesity prevalence estimates
• Opt-out consent is used internationally for childhood obesity monitoring purposes
• Opt-out consent is used in Australia, but not for the collection of anthropometric data
• Properly informed opt-out consent should meet the ethical guidelines applicable to consent in Australia

Part 3:
Feedback Systems aimed to gather parents’ and adolescents’ opinions, thoughts and suggestions about ways of providing sensitive information to parents about their children and to adolescents about themselves, the appropriateness of the language used to talk about weight, body size and weight status with parents about their children and with adolescents about themselves and the types of resources about growth and body size that parents and adolescents want to receive. Two small focus groups with parents of 2- to 11-year-olds and two small focus groups of adolescents aged 12-17 years were conducted in Geelong, Victoria to collect information. Focus group highlights include:
• Parents and adolescents prefer accurate, sensitive, accessible and convenient information on healthy lifestyles and weight status
• Parents and adolescents prefer to have information delivered to them by specified health professionals with a good knowledge of nutrition and general health
• Parents and adolescents may be more responsive to lifestyle information and potential options for change, rather than simply receiving a weight status label
Introduction

Childhood obesity, a major health concern in Australia [1], is associated with many preventable, costly and chronic diseases [2], and a strengthening case exists for policy makers to implement nationwide interventions aimed at eradicating the obesity epidemic [3]. Childhood overweight and obesity also track strongly into adulthood [4-5]. Without appropriate interventions, obesity has the potential to affect the future wellbeing of not only individuals, but populations and economies as well [6-7].

In order to formulate appropriate intervention strategies, there is a need for parents, health professionals, public health personnel and policy makers to have access to readily available and up-to-date epidemiological data that accurately describe the prevalence of childhood obesity [7]. It is particularly important that policy makers have access to data not only at the national level, but also at the local level, including prevalence estimates calculated by gender, region and socioeconomic status in order to tailor effective strategies [8] and assist with priority setting [9,10]. Furthermore, regularly collecting data on children's height and weight would enable cost-effective evaluations of the impact of interventions [3], programs and policies [9,11] on childhood obesity prevalence at a population-level. Childhood obesity prevalence data could also be used to accurately describe trends in weight status over time in order to monitor progress toward achieving obesity-related targets [9].

Several international organisations are regularly collecting epidemiological data on childhood obesity. The Nutrition and Food Security Programme of WHO/EURO has established a childhood obesity surveillance system for 23 countries in the European Region [12]. Additionally, a number of governments around the world, including that of the United Kingdom and several state governments in the United States, have been conducting public health programs such as school-based screening or monitoring of children’s body mass index (BMI) [13,14].

Screening for obesity involves identifying individual children who are at risk for weight-related problems and subsequently referring them for additional testing or follow-up [15]. Results of BMI screening can be provided to parents in the form of personalised health information about the child [9]. Monitoring, on the other hand, refers to the ‘ongoing collection, analysis and interpretation of descriptive health information’ (page 812 in [16]). This information can be used for reporting data and estimating population prevalence [16]. ‘Monitoring’ is sometimes distinguished from ‘surveillance’ based on the level of precision of the data collection methods used, such that ‘monitoring’ refers to precise measurement of representative samples and ‘surveillance’ refers to less precise measurement (for example, self-reported weight and height) methods [17]. However, the term ‘surveillance’ has been defined similarly to ‘monitoring’ [7, 9], and obesity ‘surveillance’ data may be practically applied to ‘monitor’ population trends [9,18]. As ‘monitoring’ and ‘surveillance’ are frequently used interchangeably to refer to gathering information at the population level [7, 19], both terms will be used throughout the following report in reference to population-level information gathering.

In Australia, there is currently no systematic method for collecting and reporting national and local childhood overweight and obesity prevalence data in a timely and consistent manner [20-22]. A number of national [23-26], state [27-29] and regional [30-32] surveys have previously been used to assess childhood overweight and obesity prevalence. These are potentially useful for identifying ‘at risk’ groups, but data from these types of surveys are not consistently available. Additionally, these surveys have been cross-sectional in nature and, therefore, have not tracked changes in prevalence rates over time. While several investigators have compared data from these cross-sectional surveys in order to report changes in prevalence rates at the national [33], state [28] and regional [32,34] levels, this approach of utilising data from independent cross-sectional surveys has limitations because of methodological differences between surveys [28, 33]. Furthermore, this method is limiting because national data have been collected 10 years apart, preventing the calculation of shorter-term changes in national obesity prevalence.
Australia has been leading the way in obesity-related initiatives and was the first country to develop a national strategy for obesity prevention [35]. The importance of monitoring the Australian population to track trends in obesity prevalence in childhood and adolescence has previously been recognised [19, 21, 35]. Therefore, establishing an obesity monitoring system is an important next step. This report aims to 1) identify, from the literature, ‘best practice’ in terms of design for a childhood obesity monitoring system, and make recommendations for the establishment of a childhood obesity monitoring system in Australia, and 2) determine how information gathered from childhood obesity monitoring systems is currently used and how it could benefit Australian communities.

Methods

We undertook a systematic approach in order to identify potential sources of information (research and grey literature) related to this topic.

Information Sources

Thirteen databases (MEDLINE, ScienceDirect, PubMed, The Cochrane Library, Google Scholar, Academic Search Complete, BMJ, AAP, CINAHL, Embase, Global Health, PsycEXTRA, Wiley InterScience) and the internet search engines Google and Google Australia were used to collect sources using the search terms in Table No. 1.

Table 1. Search terms used to collect research and grey literature relevant to establishing obesity monitoring and screening systems.

<table>
<thead>
<tr>
<th>Search terms</th>
<th>Table 1. Search terms used to collect research and grey literature relevant to establishing obesity monitoring and screening systems.</th>
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<tbody>
<tr>
<td>child, obesity, monitoring, BMI, weight</td>
<td>child, obesity, monitoring, BMI, weight</td>
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<td>child, obesity, screening, BMI, weight</td>
<td>child, obesity, screening, BMI, weight</td>
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<tr>
<td>child, obesity, surveillance, BMI, weight</td>
<td>child, obesity, surveillance, BMI, weight</td>
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<tr>
<td>child, obesity, school program, BMI, weight</td>
<td>child, obesity, school program, BMI, weight</td>
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<td>BMI, child obesity, school, weight, surveillance</td>
<td>BMI, child obesity, school, weight, surveillance</td>
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<td>BMI, child obesity, school, weight, monitoring</td>
<td>BMI, child obesity, school, weight, monitoring</td>
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<tr>
<td>BMI, legislation, child, report</td>
<td>BMI, legislation, child, report</td>
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<tr>
<td>BMI, child obesity, report, parent</td>
<td>BMI, child obesity, report, parent</td>
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<tr>
<td>child obesity, epidemiology, screening, school, BMI</td>
<td>child obesity, epidemiology, screening, school, BMI</td>
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<tr>
<td>height measurements, weight measurements, Australia, obesity</td>
<td>height measurements, weight measurements, Australia, obesity</td>
</tr>
<tr>
<td>anthropometric data, Australia, obesity, children</td>
<td>anthropometric data, Australia, obesity, children</td>
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In addition to collecting sources via databases and Google Australia, relevant documents were identified through citations in primary sources and communication with experts in the field. Information specifically pertaining to Australian school and medical systems and personnel was obtained primarily through internet searches of Australian government websites and Google Australia. In cases where identified sources cited relevant references, the original references were collected and included in this report where appropriate.
**Information Selection**

One researcher reviewed titles and abstracts for the results of each of the terms per database and engine search. Where database and engine searches produced more than 100 results, only the first 100 results were reviewed. This occurred in several instances for searches in database PubMed (five searches ranging from 139 to 1797 results per search) and in search engine Google (four searches ranging from 137 to 597 results per search). Full papers of potentially relevant references were independently reviewed by two researchers. Information about both monitoring and screening systems was considered to be relevant because data gathered for screening purposes may also be used to monitor populations [36].

**International childhood obesity monitoring and screening systems**

**School-based Monitoring and Screening Systems**

BMI monitoring and screening among school children has been trialled and implemented internationally over the past decade [14, 37, 38]. Several different methods of collecting data on the prevalence of childhood obesity and overweight have been used [39]. These include collecting anthropometric data through state-wide fitness evaluations, adopting a census-like procedure in which every child is measured and weighed, and measuring and weighing only children from specific grades or representative samples [39]. Some programs have included the notification of parents concerning their child's weight status (screening programs) [40, 41], while others have not (monitoring programs) [14, 39].

A number of monitoring or screening programs have been established by government bodies. For instance, the English National Child Measurement Programme (NCMP), a childhood obesity monitoring system, has been implemented across the Primary Care Trusts of the United Kingdom (UK) [14]. NCMP is the world’s largest database of its kind [14] and is part of the government’s target to “halt the year on year rise in obesity among children under 11 by 2010 (from 2002 baseline) in the context of a broader strategy to tackle obesity in the population as a whole” [42]. This aim is to be achieved through a national scheme to measure the heights and weights of all school children at initiation to infant school (child 5-6 years of age) and at transfer to senior school (child 11-12 years of age) [43] using national measurement guidelines [42]. This scheme was established strictly for population monitoring and not for feeding back information to parents or for identifying ‘at risk’ individuals [44].

In 1993, the Singapore government introduced a very different approach; a legal requirement for all children to be screened annually for obesity [38]. Those who were identified as having a high BMI, were required to eat their lunches separately from the other children and stay after school [38]. Parents of these children were required to modify their children’s eating habits [38]. This initiative included thorough training of every teacher in the country [38]. At first, the move had an impact on the prevalence rates of obesity, but it was ceased in 2007 in response to outcry from parents who felt that their children were being stigmatized [38].

Monitoring systems appear to be expanding in the US [13], with a number of states having enacted or proposed legislation related to childhood obesity monitoring or screening. In 2006, lawmakers in 15 states, including Alaska, California, Florida, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, Oklahoma, Tennessee, Virginia and West Virginia, introduced or passed 24 measures related to BMI assessment and parental feedback in schools [37].

Of particular relevance, is the screening program established in the state of Arkansas via Act 1220 of 2003 [45]. This Act was the first state-wide, comprehensive legislation passed to address childhood obesity in the US [41]. Act 1220 of 2003 included such components as the requirement of the annual assessment of all children’s BMIs in all public primary and secondary schools, the communication of...
confidential individual data to parents, the elimination of vending machines and the establishment of School Nutrition and Physical Activity advisory boards. BMI assessments were intended to evaluate the weight status of individual students in order to detect those at risk for weight-related health problems and, in conjunction, gather detailed epidemiological data.

In some parts of the US, the idea for a monitoring system was not initially proposed by politicians. For example, in 1998, school nurses in the East Penn School District (Pennsylvania) began to raise concerns about the increasingly noticeable levels of paediatric obesity and related health conditions in the district. School nurses suggested that schools should play a role in informing parents if their child is at risk and educating them on obesity-related health complications, and the nurses planned a systematic school-based screening program. State law in Pennsylvania now mandates that every child enrolled in public school is weighed and measured annually, and BMI is used to assess nutrition status. Results are communicated to parents via a confidential letter sent to their home address.

Alternatives to School-based Obesity Systems

Routine growth monitoring in primary health care settings also constitutes a population-based data source which can be used to estimate population levels of childhood obesity. In Canada, He and Sutton explored the feasibility of using routine growth monitoring data from physicians’ offices as an option for tracking the prevalence of obesity in children from two to six years of age in the County of Middlesex and the City of London, Ontario. Canadian children receive routine growth assessment from birth to age six years in primary health care settings, and data on height and body weight are collected by physicians on immunization visits and check-ups. Data were retrieved from five medical centres and the heights and weights of 1,370 children (aged two to six years) were analysed to obtain prevalence statistics. It was concluded that routine growth monitoring data from primary health care settings have great potential for tracking the prevalence of obesity in young children. There are, however, recognised limitations that need to be considered when using this type of data. For example, routine growth monitoring data are not always collected using a standardised protocol, children attend growth assessments less often as they get older, and there is likely to be lower representation of children from low-income families.

It has previously been shown that physicians in primary care settings often underestimate and under treat obesity in children, particularly in low-income circumstances. A study on physician recognition and treatment of paediatric obesity identified that a significant portion of overweight and obese children had not been diagnosed or given nutrition education by their physician or health care provider. Evidence suggests that there is a reduced occurrence of well-child visits as children age, and low-income families often do not have health insurance and may not regularly seek medical advice. Therefore, relying on physicians alone to provide feedback on weight status and weight-related advice may mean that some children will not receive this information.

Summary and Recommendations for Australia

On balance, school-based monitoring systems are considered more appropriate than using routine primary care assessments to obtain weight and height data on children. This is because school settings are more convenient and easily accessible for families of various income levels and, therefore, provide more population coverage for obesity tracking and prevention. The school setting also provides the advantage of being accessible to all students, regardless of their family’s insurance participation or level of income. School-based BMI screening may be more beneficial to parents with limited access to health care because it could give them an opportunity to receive personalised health information about their child and guidance from a health professional, such as a school nurse.

The evidence provided in this report suggests that in order to collect nationally representative obesity prevalence data on school-aged children, the most appropriate and widely used method is to conduct school-based assessments following the enactment of a government initiative. These types of assessments have been, and continue to be, conducted in many countries. The implementation of a school-based
A school-based monitoring system would not provide data on children aged 4 years and younger. If these data are desired, then an additional means of collecting such data would be needed to compliment the collection of school-based data. Though it has been suggested that data collection via primary care settings may not be ideal, data on very young children (from birth to preschool age) could be collected via the coordinated efforts of state-wide primary health care organisations. One example is Child and Youth Health (CYH) in South Australia. CYH is operated under the direction of the South Australian Government Department of Human Services [27]. Height and weight data are routinely collected in CYH centres and kindergartens using standardised protocols and data are stored centrally [27]. Data have been collected from an estimated 70-80% of all 4-year-old children in South Australia, and these have been effectively used to estimate obesity prevalence [27].

Another example of a potential resource that could be used to collect height and weight data on young children is The Maternal and Child Health Service (MCHS) in Victoria. The MCHS is a universal service available to all Victorian residents, and nurses from MCHS encounter young children during ten key ages and stages (home visit, 2 weeks, 4 weeks, 8 weeks, 4 months, 8 months, 12 months, 18 months, 2 years and 3.5 years) [56]. Height and weight data from MCHS have previously been used to calculate overweight and obesity prevalence in 2- and 3.5-year-old children in order to evaluate the effectiveness of a childhood obesity intervention [57]. As data collection procedures are already in place in some Australian states and the usefulness of these data for determining obesity prevalence rates has previously been demonstrated, it would be feasible to collect and coordinate nationally representative data on young Australians in a standardised manner.

Organisation and operation of childhood obesity monitoring systems

Nature of the Data to Be Collected

When developing a monitoring program, the nature of the data to be collected must be carefully considered. For instance, the quality of data to be collected must be taken into account as any self-report data need to be interpreted with caution [7] and, therefore, may not be as meaningful or as useful as data collected via direct measurement by trained personnel. Collecting height and weight data from children via self-report methods would not be feasible unless they were older, but even 16- to 18-year-old children may be inaccurate in their height and weight estimates. Flood et al. [58] compared BMI classifications from both self-reported and measured heights and weights of 16- to 85-year-olds and found that self-reported heights and weights led to misclassification of weight status. Direct measurement of height and weight is preferable to self-report collection of this information [27].

Perhaps the most important thing to keep in mind when selecting the amount and types of data to collect is that the potential benefits of obtaining the data must be balanced with the financial cost and the amount of participant burden incurred [7]. One example of a situation in which more data were collected than may have been necessary comes from The Coronary Artery Risk Detection in Appalachian Communities (CARDIAC) program in the US. CARDIAC is a school-based cardiovascular health intervention with the goal of measuring
obesity prevalence and risk factors for cardiovascular disease in the population [48]. The measured risk factors include weight, height, blood pressure and lipids, and children found to be ‘at risk’ are then referred on for further clinical tests. Although lipid profiles and blood pressure can be valuable indicators of cardiovascular risk, alongside anthropometric measures, they are much more intrusive and could possibly lead to lower participation rates and, therefore, biased results [48]. Findings from the CARDIAC program suggest that obesity screening may be enough to detect children at risk of cardiovascular problems without requiring the more invasive measurements of blood pressure or lipid levels [48]. The CARDIAC program is not a childhood obesity monitoring system, but this program highlights the importance of determining exactly which data need to be collected in order to obtain valuable information while avoiding unnecessary costs and participant burden.

Wilkinson et al. [7] propose that the core information needed for obesity surveillance can be divided into three levels: prevalence indicators (height, weight, age, gender, BMI and waist circumference); predictor indicators (ethnic group, disability, fitness and deprivation indicator); and intervention indicators (habitual dietary intake, physical activity/fitness level, associate co morbidities and smoking status). Some of the cited prevalence indicators warrant further examination. In particular, BMI and waist circumference deserve attention because there has been considerable debate over the appropriateness and usefulness of these measures.

Calculation of BMI is the most commonly used method for estimating obesity prevalence [7] and is considered to be the easiest, cheapest and least intrusive way to measure adiposity [43]. Although BMI is significantly correlated with level of body fat [59], it is a proxy measure and a true measure of body fat can only be obtained via laboratory-based body composition assessment [60]. Nonetheless, among children and adolescents, BMI is the recommended indicator of both body fat and weight status [59].

BMI-for-age is the childhood obesity screening method recommended by the US Centers for Disease Control and Prevention [61]. Using this measure, children with a BMI greater than or equal to the 95th percentile would be classified as overweight and those with a BMI between the 85th and 95th percentile would be classified as ‘at risk of overweight’ [61]. However, these cut-off points are considered to be arbitrary and unrelated to evidence of health risk [62, 63]. Furthermore, these cut-off points set prevalence rates at 15% for ‘at risk of overweight’ and 5% for overweight assuming that the population is similar to the population on which the BMI-for-age chart was based [63]. Another problem with using BMI-for-age is that centiles are based on a reference population and not an ‘ideal’ population, creating the potential for misinterpretation of percentiles [62]. While several different countries have developed their own BMI-for-age charts, Australia does not have their own locally derived BMI-for-age charts [62] and, thus, relies on international cut-offs.

In 2001, the Australian Commonwealth Department of Health and Aged Care funded the development of standard definitions of child and adolescent overweight and obesity for use in the National Health Data Dictionary, an online reference intended for use by people interested in health-related research [62, 63]. In the process of developing these standard definitions, recommendations were made for the type of BMI reference that would be most appropriate for use in each of four settings, population and clinical research, clinical practice and non-health care settings. It was recommended that in both population and clinical research overweight and obesity should be defined using the international growth reference established by Cole et al. [64]. For clinical practice and non-health care settings, the BMI-for-age reference was recommended to be utilised in Australia [62, 63]. Although the group was not charged with recommending a specific BMI-for-age chart for use in clinical practice, they felt that the 2000 US Centres for Disease Control and Prevention charts would be appropriate [62, 63]. Stakeholders presented with these recommendations accepted the use of one set of definitions for epidemiological use and another for clinical practice [62]. The most recent version of the National Health Data Dictionary was released in 2008 and maintains these recommendations [63].
The previously mentioned international growth reference was developed by Cole et al. [64] after an expert committee convened by the International Obesity Task Force recommended that BMI cut-offs for children and adolescents should be based on the accepted adult cut-off points of 25 kg/m² for overweight and 30 kg/m² for obesity. Using nationally-representative survey data from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the United States, Cole et al. [64] created an international growth reference with age- and sex-specific BMI cut-offs for children aged 2 to 18 years. This growth reference provides standard definitions for child overweight and obesity that are more internationally based than available alternatives [64]. Since their creation, these cut-off points have been utilised both in Australia [65] and abroad [66].

The World Health Organisation (WHO) has recently released the WHO Child Growth Standards for infants and children up to age five years [67] and the WHO Reference 2007 growth reference for children aged 5 to 19 years [68]. The WHO Child Growth Standards are based on growth data collected from healthy breastfed infants living in conditions of good hygiene. These infants were from diverse geographical regions from six countries: Brazil, Ghana, India, Norway, Oman and the US. The WHO Child Growth Standards are thought to represent ‘normal human growth under optimal conditions and can be used to assess children everywhere, regardless of ethnicity, socioeconomic status and type of feeding’ (page 48 in [69]). The growth curves for school-aged children and adolescents were developed in accordance with the WHO Child Growth Reference and designed to be aligned with the recommended adult cut-offs for overweight and obesity at 19 years of age [66]. These WHO references are a good alternative to the growth reference developed by Cole et al. [64].

As previously described, Wilkinson et al. [7] identify waist circumference as one of the prevalence indicators for obesity surveillance. Waist circumference is strongly correlated with dual energy X-ray absorptiometry for both children and adolescents [70], and it is recognised as the best indicator of central adiposity and metabolic risk in children and adolescents [71]. However, there are no universally accepted age-related cut-offs for children and adolescents, so use of waist circumference in children and adolescents remains limited [71]. Eisenmann et al. [72] have proposed a set of waist circumference percentiles for Australian children, but these have not yet been officially accepted [72].

Two of the predictor indicators identified by Wilkinson et al. [7], ethnic group and deprivation indicator, would need to be included in data collection for basic BMI assessments as there is strong contemporary evidence showing associations between these factors and obesity [71]. Certain minority groups experience higher levels of obesity [60, 73, 74], including children from disadvantaged families [68] and those of parents with low levels of education [48, 74]. Additionally, children of Pacific Islander backgrounds and those of Middle Eastern/Arabic backgrounds have been identified as ‘at risk’ groups in Australia [74]. Information on race/ethnicity may also be important because standard BMI classifications may be inaccurate for determining health risk and fatness in some ethnic groups [7, 74].

Summary and Recommendations for Australia
A number of factors need to be taken into account when determining the amount and types of data to collect. At a minimum, child date of birth, sex, height, weight, ethnicity and socioeconomic status should be collected. In Australia, postcode is often used as a proxy for socioeconomic status [79]. Postcodes can be used to determine the Socio-Economic Indexes for Areas (SEIFA) number, which shows how disadvantaged an area is compared to other areas in Australia [78]. Collected data should be used to calculate BMI, and child weight status derived using the BMI classifications recently determined by the WHO [67, 68].

Weighing and Measuring
Focusing obesity prevention and awareness strategies at younger children may be more effective at reducing obesity than targeting
children at later ages \cite{11}, which suggests that data collection should commence when children are young. Indeed, many of the established monitoring and screening programs collect data on young children, usually during their first or second years of school \cite{11, 39-41, 43}.

Originally, Act 1220 of 2003 in the US state of Arkansas prescribed that all children in all school years from kindergarten to year 12 (children aged 17-18 years), in public schools should be measured annually \cite{41}. However, due to community opposition to the lack of funding allocated within the Act and the level of disruption of academic time caused by the measurement process, this was changed so that children would be measured every two years in selected school years kindergarten, 2, 4, 6, 8 and 10 \cite{41}. Although screening of this type would necessitate frequent measurements to track individual children’s weight status over time, it may not be necessary to measure all children from every school in order to obtain reliable obesity prevalence estimates. For example, a pilot study conducted for the US state of Utah’s Height and Weight Measurement Project determined the sample size and number of primary schools needed to obtain reliable state-wide estimates. All children from 27 urban and rural primary schools were weighed and measured \cite{39}. The measured variability within schools was less than that between schools, suggesting that fewer children from each school could be measured but the number of schools in which measurements take place should be increased \cite{39}. This pilot study also determined the school year levels when children should be measured to track prevalence. Using these identified ‘sentinel grades’ (grades 1, 3 and 5) reduced school disruption while maintaining the reliability of sample estimates for children in kindergarten through grade 6 \cite{39}. Follow-up work determined that data from randomly selected classes from each of the three sentinel grades from 69 schools provided accurate state-level estimates of childhood obesity prevalence \cite{39}.

Another way to reduce the number of children to measure is to calculate the sample size needed to specifically identify a zero increase in obesity prevalence. This approach was tested in the UK during The TRENDS Project \cite{77}. It was found that a representative sample of less than 10% of schools (1900-2400 children per age group per year) could be used in their monitoring system, and such a method was suggested to be easily implementable and less costly than measuring every child.

Levine et al. \cite{78} have gone so far as to recommend that obesity monitoring should be confined to primary schools. When developing a low-cost school-based model for a monitoring scheme, they found that when compared to high schools, it was more cost effective and less disruptive to implement monitoring in primary schools. However, it should be noted that the study sample was skewed (25 primary schools versus 3 high schools) and that the study itself was conducted in the UK school system \cite{78} and not the Australian school system. Furthermore, adolescence has been identified as a critical risk period for the onset of obesity, which may persist into adulthood and lead to adverse health complications in later life \cite{8, 10, 48, 79}.

Summary and Recommendations for Australia

If the goal of the system established in Australia is to monitor obesity prevalence, then the available evidence suggests that it would not be necessary to weigh and measure all Australian children; a representative sample could be used to establish reliable obesity prevalence estimates. The use of a representative sample could potentially reduce school disruption and the cost of the program.

Protocol and Standardised Staff Training

Providing measuring personnel with regular training and opportunities to update their measurement skills is crucial to the successful implementation of school-based monitoring programs \cite{47, 51}. Training of measuring staff should include the following elements: a) how to plan a measurement process that is private and confidential, b) how to discuss height, weight and BMI measurements with parents and children, and c) procedures for collecting accurate height and weight measurements \cite{47}. 


Each of these elements can be addressed through a well-designed, standardised protocol. First, persistent issues of privacy and body image sensitivities during measurement [78] can be addressed by limiting the number of children waiting for measurements and collecting measurements individually in a private space [47], such as behind a privacy screen [78]. Gibbs et al. [80] have developed and tested a body image protection protocol for conducting height and weight measurements. This protocol incorporates strategies to prevent peer comparison of individual measurements and to make certain that height and weight measuring does not exacerbate body image concerns. Gibbs et al. [80] recommend that children’s height and weight measurements be conducted separately from their peers and that the measurements are not shown to children in order to minimise comparison of individual measurements.

Second, guidance can and should be provided for effectively communicating with diverse populations and for dealing with issues that arise from the emotionally laden topic of childhood obesity [81]. Additionally, services should be in place for effectively dealing with responses to height and weight information [82]. This may be more important in screening than monitoring programs and a detailed discussion concerning relaying information to parents and children can be found in Report 3: Analysis of critical features for establishing a monitoring system for childhood obesity: Feedback systems. In addition, there may also be a need for addressing negative attitudes about obese children that may be held by school staff [81].

Finally, a protocol is required to standardise the measurements collected [36, 47]. Stoddard et al. [47] examined the reliability of school nurses’ measuring techniques and found that when measurement followed a standardized protocol, reliability was very good for weight but some inconsistencies presented in height measurements. These inconsistencies were explained by the fact that measuring height can be more difficult than weight, as stadiometers are not as easy to read as digitalized scales and correct measurement involves the child being positioned in a particular way (e.g. arms by side, facing forward, straight back) [47]. Getting staff to measure height twice and then using the average of these two height measurements to calculate BMI may increase the accuracy of height measurement [36, 47].

Height is usually measured to the nearest 0.1 cm and weight to the nearest 100 grams in order to provide the greatest precision for BMI calculations [87, 48]. Weight measuring has been found to be most accurate when children’s shoes are removed and light clothing is worn, and this method has been adopted in a number of monitoring and screening programs [11, 48, 63, 64].

Measuring height in duplicate is in accordance with the height measurement protocol described in the Australian National Health Data Dictionary [63]. According to this resource, height should be measured in duplicate to the nearest 0.1 cm. If the two measurements disagree by more than 0.5 cm, then a third measurement should be taken. Height is then calculated by taking an average of the two measurements, or taking the average of the two closest measurements if three measurements are taken [63].

The Australian National Health Data Dictionary contains a protocol for measuring weight that is also aligned with the methods described above for measuring weight [63]. According to this resource, the measurement is to be recorded to the nearest 0.1 kg. If a digital scale is not used, then a second measurement should be taken, and if these two measurements disagree by more than 0.5 kg, then a third measurement should be taken. As with height measurements, weight is then calculated by taking an average of the two measurements, or taking the average of the two closest measurements if three measurements are taken [63].

Training of personnel to perform the measurements is critical. A ‘train the trainer’ teaching model was utilised in the US state of Arkansas [36] in which researchers trained a core group of community health nurses, who subsequently trained school nurses and other school personnel.
Additionally, each school was given an 8-minute training video for future reference[85], and a BMI ‘hotline’ was set up to take calls from people with questions about the protocol[36]. This hotline received about 400 calls per year[36], suggesting that it has been useful. After training, about 600 students could be measured and weighed in six hours when two people were positioned at each of six work stations[85].

Summary and Recommendations for Australia

When creating an obesity monitoring system, it is important to establish a protocol and training program that will enable the standardised, efficient and confidential collection of data in a sensitive way. Pilot work will be needed in order to inform and test the development of the protocol and training procedures. This preliminary work will assist with determining the training requirements, staff and time requirements and most appropriate equipment.

Personnel

Internationally, school nurses are recognised as vital partners to school-based obesity monitoring programs when they are available[39, 42]. The use of school health services in school-based obesity prevention has previously been supported by health professionals and school staff[51]. Trained school nurses are widely used to deliver health services and measure heights and weights of school children[51, 52, 86-88]. In the UK, school nurses were utilised to measure over 90% of children on entry to infant school[43]. In the US state of Arkansas, 415 school nurses were charged with measuring and weighing all Arkansas public school students[85]. School nurses have also been shown to deliver reliable height and weight measurements in a private and confidential manner, minimising potential teasing or weight stigmatization of pupils[47].

Several school-based monitoring programs have made use of trained physical education (PE) teachers[11] or health visitor assistants[43] as opposed to, or alongside, school nursing staff. It has been suggested that trained volunteers, rather than school nursing staff, should take measurements because nurses have specific skills that could be better utilised in performing other tasks, such as implementing school health interventions[78]. Further, because school nurses may not be available in all schools, it may be more universally appropriate to use other specifically trained measuring personnel[78]. However, utilising people other than school nurses may raise some other issues. For instance, having teachers take measurements could be uncomfortable for some students and could be problematic for maintaining confidentiality and privacy (See Report 2: Analysis of critical features for establishing a monitoring system for childhood obesity: Ethics assessment), and requiring the use of external assistants could potentially increase the cost of the measurement program and also involve similar issues relating to confidentiality.

Summary and Recommendations for Australia

School nurses are the most widely used personnel for conducting measuring programs and it would be recommended that school nurses be utilised in an Australian obesity monitoring system. A number of Australian states and territories employ school nurses[89-91], and in some cases, these nurses are already involved in some form of screening. For example, the Primary School Nursing Program in Victoria employs 75 full-time nurses to perform universal vision screening and targeted hearing screening on all prep grade students in primary schools across the state[91]. The Secondary School Nursing Program in Victoria provides funding for 100 full-time nurses in 199 Victorian Government Schools[91]. One of the roles of these nurses is to provide individual health counselling for students[91]. Additionally, school nurses in Queensland provide individual health consultations for students[89].

Equipment

It is essential that equipment used is affordable, reliable, accurate and easily accessible for schools[36]. Utah’s Height and Measurement
Project (US) concluded that the best types of equipment in terms of accuracy and convenience were calibrated digital scales and portable stadiometers with metal tape measures [39].

An efficient data entry system is also fundamental. The paper-based measurement process initially used in Arkansas was labour and time intensive and not entirely efficient or accurate [36]. In an attempt to remedy this, a web-based data entry system was adopted [36]. This has improved the efficiency of the measurement and reporting process and also provided an interface-level method to screen data for entry errors and completeness [36]. Computer-based data management systems have also been used in several other monitoring systems [11, 38, 81].

Summary and Recommendations for Australia

Equipment should be affordable, reliable, accurate and easily accessible for schools, and pilot work may need to be done to assess the accuracy and reliability of equipment. Additionally, a web-based data management system would be the recommended method of storing and accessing data in Australia.

Consent

A number of obesity monitoring and screening systems have utilised passive (‘opt-out’) parental consent [14, 39-41, 77, 81], which means that a child is assumed to be a participant in data collection unless their parent/guardian notifies the school that they do not wish for their child to take part in data collection activities. In some cases, parents may be required to notify their child’s school of their refusal to consent by writing a letter each school year stating that they do not consent to their child’s participation [41].

In Utah’s Height and Weight Measurement Project [39], investigators examined the effects on participation rates and observed obesity rates of using passive versus active consent (parents are required to give their consent for their child to participate in data collection). When compared with schools where passive consent was used, the response rate was lower in schools where active consent was used [39]. Additionally, there was a significant difference in estimates of obesity by consent type. Specifically, obesity rates for students from schools where active consent was used were 1% lower than those for students in schools where passive consent was used, indicating that active consent processes may have led to underestimation of obesity prevalence [39]. However, in the UK National Childhood Obesity Database, where opt-out consent is also used, anecdotal evidence suggests that parental consent is often not provided for children who are likely to be classified as overweight or obese [14].

The use of opt-out consent may also be advantageous compared to the use of opt-in consent because opt-out would be less burdensome for schools, parents and data collectors and could be less expensive than using opt-in consent. If opt-in consent were utilised, personnel would potentially need to perform rounds of follow-up consent form collection in order to achieve high participation rates, and this extra time spent collecting forms could increase the cost of data collection [85].

Summary and Recommendations for Australia

Opt-out consent is widely used in obesity monitoring and screening programs and may increase student participation in monitoring programs. Opt-out consent would be the recommended option for use in an Australian obesity monitoring system. A more detailed discussion of the use of opt-out consent in the context of an Australian monitoring program can be found in Report 2: Analysis of critical features for establishing a monitoring system for childhood obesity: Ethics assessment.

Assessing the impact of childhood obesity monitoring systems

An important consideration in establishing a childhood obesity monitoring system is evaluating the impact of the system. The impact should be assessed by monitoring the effects of the programs on children, parents, schools, communities and obesity prevalence rates. Two of the biggest existing monitoring programs, the National Child Measurement Programme in the UK and the system established in the
US state of Arkansas, have been collecting data for several years. These have measured large samples of children, with over half a million English children weighed and measured in the first round of data collection of the National Child Measurement Programme [14] and about half a million Arkansas students have been measured each year since establishment [36].

**Child Impacts**

Extensive evaluations have been undertaken annually on the impact of Arkansas’s Act 1220 of 2003 [93-95]. Originally, concerns were raised about whether BMI screening in schools would lead to increases in weight-based teasing, weight concerns, embarrassment, diet pill use or unhealthy diet practices among the children involved [81]. However, none of these adverse consequences have been reported among children in any of the evaluations [83-86]. In particular, weight-based teasing, which was initially of great concern, has reportedly decreased over the years since the Act’s implementation [93, 94, 97]. Similarly, no notable change in weight-based teasing has also been reported in a London-based study in which children’s reactions to a weighing and measurement program with parental feedback were assessed [82]. Additionally, in London, body esteem remained unchanged in overweight children and actually improved in healthy-weight children [82].

Kalich et al. [98] assessed the comfort levels of a group of 5th – 8th grade students participating in school-based weight screening in Cambridge, Massachusetts (US). These students were informed of their height and weight, but were not given information about their BMI or weight status classification. The students’ level of comfort was assessed using survey items that asked about adequate privacy, comfort level with weighing in general, comfort level with weighing specifically in physical education class, and the locations where students thought height and weight measurements should take place. The majority of students supported some form of weight screening as only two percent reported that weight screening should not occur at all. The majority of students (85%) did not report discomfort with screening, but students’ level of comfort varied with their weight status. Compared with healthy weight students, a greater proportion of overweight students reported being uncomfortable with weight screening in general and school-based weight screening specifically. This disparity in comfort levels was more pronounced in female students; more than half of overweight female students reported discomfort with school-based weight screening while only an eighth of healthy weight female students reported discomfort. Students’ reasons for feeling discomfort were not assessed, but it is possible that discomfort may have been related to privacy as fewer overweight females (61%) than healthy weight females (84%) reported having enough privacy during school-based screening. The results of this study suggest that male and female children and children of varying weight status may be affected differently by the measurement process and this highlights the importance of stratifying evaluation results by sex and weight status when examining the impact of an obesity monitoring system. Evaluations should also be built into the system in order to determine whether repeated exposure to school-based height and weight measurements decreases students’ discomfort by making these practices routine.

**Parent and Community Impacts**

Several studies have surveyed parents involved in child BMI monitoring and screening programs to find out whether they support such programs. Kubik et al.[52] surveyed parents involved in a pilot BMI screening program for kindergarten to 6th grade children in Minneapolis and St Paul, Minnesota in the US. Results indicated that the majority (78%) of the parents believed that annual BMI measuring was important and wanted height, weight and BMI feedback about their children [52]. Likewise, most Arkansas parents have supported the monitoring and feedback program, as evidenced through a low rate of complaints received by school principals [53].

The BMI screening program in Arkansas has also led to increased awareness of obesity and related disease in parents [53]. Parents of overweight children were also found to be more likely to express concern about their child’s weight and reduce the amount of ‘junk’ food
kept in the household as a result of the BMI feedback process [96]. In addition, according to surveyed physicians in the community, BMI letters have led to parents asking more questions about their child’s weight and health status [93]. Furthermore, over the years, parents, along with principals, have reported fewer negative issues and increased community acceptance with the BMI monitoring process [93, 95]. However, not all parents have had positive reactions to monitoring or screening programs. Initial attempts to provide feedback to the parents of overweight or obese children in the East Penn school district in the US state of Pennsylvania led to some parents becoming upset. They believed that BMI was a family matter and should not be addressed by the school district [40]. In addition, some parents had received contradictory information from their family health care provider, further complicating the situation [40]. This reaction initiated media coverage, which inadvertently positively increased awareness within the community as well as the number of people wanting to be involved [40]. After the initial community reaction, parental notification techniques were reviewed and it was decided that all parents would be sent letters, not just those whose children had been identified as overweight or obese [40]. Parents were also then offered the opportunity to opt-out of receiving a letter [40]. Similar to the case in Arkansas, parental acceptance of the program increased as each year passed [40]. The East Penn district experience demonstrates the need to directly involve parents and health professionals in the planning stages of the program [40] and to carefully consider what feedback mechanisms, if any, are to be used.

The state of Arkansas has also increased the involvement of teachers, schools, public health personnel, and the community in efforts to reduce obesity [8, 46, 99]. Stakeholders and child health advocates agree that this is the first, and vital step toward halting the year on year rise of obesity [79].

**Impact on Childhood Obesity Prevalence**

Childhood obesity prevalence in the US state of Arkansas did not increase significantly within the first four years of the enactment of Act 1220 of 2003, suggesting that the implementation of the Act has contributed to halting the persistent rise in rise childhood obesity [6, 41].

**Summary and Recommendations for Australia**

The available evidence confirms the importance of regular and systematic evaluations in an obesity monitoring system. Throughout this report, examples have been provided in which monitoring or screening systems have been adapted in response to complaints and issues. Elements of systems established in one locality may not work well in others and for this reason it is important that evaluation and review processes be built into any obesity monitoring system.

**Accessibility and utility of data gathered from childhood obesity monitoring systems**

**Community Use of Monitoring Data**

Data from BMI monitoring programs can be used for several purposes. Nihiser et al. [9] suggest that these data can be used to:

- Describe trends in weight status over time
- Identify demographic or geographic subgroups at greatest risk of obesity in order to target prevention and treatment programs
- Create awareness among school and health personnel, community members, and policy makers of the extent of childhood obesity
- Provide an impetus to improve policies, practices, and services to prevent and treat childhood obesity
- Monitor the effects of obesity prevention programs and policies
• Monitor progress toward achieving obesity-related targets

Monitoring data have been used for a number of purposes, and the utilisation of this data has been increasing in some areas [43]. For example, obesity prevalence rates have been used in state-wide reports, information for legislature, grant applications and to inform the general public [39]. Data have also been used to notify and educate communities through the compilation of individual school, district and state-wide reports of obesity prevalence [36].

**Individual Use of Monitoring Data (Screening)**

Controversy exists over whether to pass on information to parents and children about children’s weight [44, 77, 81]. There is some uncertainty about what information should be provided and how this information should be presented. Screening children could also potentially increase program costs. Additional and more detailed information about feeding back information to parents and children can be found in Report 3: Analysis of critical features for establishing a monitoring system for childhood obesity: Feedback systems.

**Summary and Recommendations for Australia**

Monitoring data can be used for a number of purposes, and Australian communities could greatly benefit from the collection and availability of this type of data. The information gathered through an obesity monitoring system has great public health utility, ranging from creating awareness of obesity risk to improving policy and monitoring progress towards achieving health objectives. Whether to pass on information about children’s weight to parents and children is a contentious issue that requires careful consideration.

**Summary of recommendations for Australia**

Monitoring of the prevalence of childhood obesity is an important indicator of population health. As the obesity epidemic is more prominent now than in past decades [33, 65, 100, 101], it has been recommended that children are weighed and measured and calculated body mass index used to estimate population adiposity [43, 52, 79, 84]. After a review of existing childhood obesity monitoring and screening systems we recommend that:

1) An obesity monitoring system should be school-based and, if possible, school nurses should collect data
2) If data are to be collected on children who are not of school-age, then these data should be collected through the coordinated efforts of state-wide primary healthcare organisations
3) At a minimum, date of birth, sex, height, weight, ethnicity and socioeconomic status should be collected
4) Weight status should be derived using BMI classifications determined by the WHO [67, 68]
5) A nationally representative sample of children should be used to establish obesity prevalence rates
6) A protocol and training program should be established for standardised data collection
7) Pilot data should be collected to inform the sampling strategy, protocol and training procedures, and equipment
8) Equipment should be affordable, reliable, accurate and accessible for schools
9) A web-based data management system
10) Opt-out consent should be used
11) Inbuilt evaluations should monitor negative consequences of the program

**References**

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