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Type: Original article

Title: Clustering of obesity-related risk behaviours in children and their mothers.

Running title: Clustering of obesity-related behaviours.

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Word count: 3383

Word count (abstract): 220

Number of references: 38

Number of tables: 3

Number of figures: 2

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Abstract

Purpose
To examine the clustering and patterns of obesity-related behaviours in children and their mothers and the concordance between mother and child pairs.

Methods
Primary school-aged children and their mothers in Victoria, Australia participated (data from 549 mothers, 352 children, and 304 mother/child pairs). Examination of behaviour patterns included 1) assessment of the overlap in national physical activity, screen-time and fruit and vegetable consumption guidelines being met and 2) cluster analysis of positive (consumption of fruits and vegetables) and negative (consumption of energy dense food/drink) dietary behaviours, sedentary behaviour/screen-time and physical activity.

Results
Only partial overlap was observed between groups meeting national recommendations for sedentary behaviour and consumption of fruit and vegetables and energy-dense food. Less than 40% of mothers and children were meeting sedentary behaviour guidelines. In both mothers and children five clusters were identified. With the exception of a single cluster in children with high levels of physical activity, clusters of healthy and unhealthy behaviour were concordant in mothers and their children (p<0.0001), particularly those defined by sedentary behaviours and consumption of energy-dense food/drink.

Conclusion
Complex patterns of obesity-related behaviours exist in children and their mothers. The concordance of clusters between children and their mothers suggests that modelling of sedentary behaviour and creation of a child’s eating environment by parents may be particularly important influences on children’s behaviour.

Keywords
Obesity, Clustering, Physical Activity, Nutrition, Behaviour
Purpose

Sedentary behaviour (e.g., television viewing, time spent sitting), poor diet and a lack of physical activity have been shown to be independently associated with increased obesity in children, adolescents and adults. (1-7) Despite the fact that these behaviours operate through different mechanisms and have different determinants, their distributions are not random throughout the population, with clustering of health behaviours within individuals frequently observed. (8-11)

Simple correlations between health-related behaviours are often weak, as demonstrated (for example) by a Dutch study of almost 3,000 adults in which correlation coefficients between fruit consumption and physical activity, and smoking were 0.07 and 0.08 respectively. (12) The low correlations between health behaviours can be partly explained by complex clustering patterns which mean that behaviours are only correlated among certain sub-groups of the population. (12) Treating those exhibiting an individual health behaviour as a homogenous group can obscure the true relationships between health behaviours, and reduces the potential for a deeper understanding of behaviours and their outcomes.

Numerous studies have examined the patterns of health behaviours within populations of adults and adolescents, and have included those behaviours relevant to obesity. (8-15) Few, however, have focused solely on obesity-related behaviours, and fewer still have included the comprehensive range of obesity-related behaviours included in this study. (16) We are not aware of any evidence regarding the clustering of obesity-related behaviours among children.

The purpose of this study was to assess, with the inclusion of behaviours related to both diet (fruit/vegetable consumption and energy dense food/drink consumption) and activity (physical activity and sedentary behaviour), the clustering of obesity-related behaviours in children and their mothers. It might be expected that clustering patterns would be similar in children and their parents given the strong parental influence on childhood
environments, and the importance of parental modelling on the obesity-related behaviours of children,(13, 17, 18). Therefore an additional aim was to test the concordance of clustering patterns between mother-child pairs.

Methods

Sampling & Participants

The baseline data collection of the Resilience for Eating and Activity Despite Inequality (READI) study was conducted during 2007-8 among 4349 women from 40 urban and 40 rural randomly selected socioeconomically disadvantaged suburbs within 200km of Melbourne, Australia. Details of sample selection have previously been published.(19, 20) Briefly, disadvantaged areas, defined as those in the bottom tertile of the Socio-Economic Index for Areas Score (SEIFA) were randomly selected. Using the Australian Electoral Roll (which has near universal coverage in Australia), 150 women aged 18-45 were randomly selected from within each suburb and sent a questionnaire by post (total n=11,940). Responses were received from 4,349 eligible women still living in the suburb. Those with a 5-12 year old child living with them (n=1,457) were invited to participate in an additional survey about that child, with 684 (47%) providing information on the child in this age range in their family who had the next birthday. In this study, data were excluded if the woman was pregnant or was unsure if pregnant (n=26), or stated she had never given birth, suggesting that she was not the biological mother of the child (n=11). Prior to the exclusion of those with missing data, a total of 647 mother-child pairs were available for analysis in this study.

Measures

Physical activity

Physical activity was assessed in mothers using the long version of the self-administered International Physical Activity Questionnaire (IPAQ-L), which when compared with accelerometer-measured physical activity, has been shown to have excellent 1-week test–retest reliability (pooled r=0.81) and acceptable validity (pooled r=0.33).(21)
To be comparable with the Active Australia physical activity questionnaire,(22) total physical activity time for the previous week was calculated as the sum of the time spent walking (if continuous and for 10 minutes or more, and including for transport) or performing moderate physical activity (including transport-related cycling), plus double the time spent in vigorous physical activity to reflect its greater intensity. Each of these activity types was truncated to 15 hours and the total time was truncated to 28 hours. Physical activity during gardening, household chores and work were excluded using this definition.

Physical activity was objectively assessed in children using uniaxial accelerometers (Manufacturing Technology Inc (MTI), Actigraph Model, AM7164-2.2C, Florida, USA) worn for eight days during waking hours. This method has been shown to be a valid objective measure of children’s physical activity.(7, 23) Moderate to vigorous physical activity was calculated as the time achieving ≥3 metabolic equivalent units (METS) between 6am and 9pm.

Mothers and children were categorised as meeting, or failing to meet, physical activity guidelines. For mothers, the recommendation to achieve at least 30 minutes of moderate-intensity physical activity on most (preferably all) days of the week (i.e. a minimum of 150 minutes/week) was based on the National Physical Activity Guidelines for Australians.(24) The recommendation for children to achieve ≥60 minutes of at least moderate- to vigorous-intensity physical activity on every day the accelerometer was worn was based on the Australian National Physical Activity recommendations for 5 to 12 year old children.(25)

**Sedentary behaviour**

In mothers, total sitting time at work, at home, doing study and during leisure time was assessed using the IPAQ-L. This item demonstrated good reliability (r mostly >0.7) and acceptable validity (r=~0.3) when compared to accelerometers in a 12-country, 14-site study. (21)

Screen-time in children was assessed by asking mothers how much time their child spent during a typical week (not during school holidays) in the following activities: TV/videos/DVDs, Playstation/Nintendo/computer games and Computer/Internet (excluding games). Objective accelerometer data were not used for measurement of sedentary
behaviour in children because there are currently only national recommendations for screen-time rather than total sedentary time.

As there are no sedentary behaviour recommendations for adults, we used a target of <4 hours total sitting time per day. In a recent Australian study, less than half of men and women were sitting for 4 hours or less. (26) For children, the Australian National Physical Activity recommendation that “children should not spend more than two hours a day using electronic media for entertainment (e.g. computer games, TV, Internet)” was used. (25)

Healthy eating behaviours

In both mothers and children, healthy eating behaviour was assessed by examining consumption of fruits and vegetables, using the question “About how many serves of fruit do you usually eat per day?” and a corresponding question for vegetables (serves defined as 0.5 cup cooked vegetables or 1 medium piece of fruit), which were adapted from the Australian National Nutrition Survey. (27) These items specifically excluded potatoes and fruit juice. For the purposes of determining whether recommended levels of fruit and vegetables were being consumed, potatoes (not including chips, French fries, wedges or fried potatoes which were the subject of a separate item) were included as this is consistent with the Australian Guide to Healthy Eating. (28) Potato consumption was not included as a positive eating behaviour in cluster analyses, however, as it considerably reduced the resolution of clusters, which may be due to the high proportion of total vegetables consumed as potatoes. (29) In addition, due to the common simultaneous consumption of fats (e.g. when consumed as chips/fries), and the higher energy density and lower nutrient density of potatoes in comparison with other vegetables, omitting them from our measure of healthy eating behaviours is likely to have resulted in a more distinct behaviour.

Mothers and children were categorised as meeting, or failing to meet, Australian national dietary recommendations for fruit and vegetables. (28) For non-pregnant women, the recommendation is 2 serves of fruit and 5 serves of vegetables per day, while for children, the age-based recommendations are: if aged 4-7 years, 1 serve of fruit and 2 serves of vegetables per day, if aged 8-11 years, 1 serve of fruit and 3 serves of vegetables per day and if aged 12-18 years, 3 serves of fruit and 4 serves of vegetables per day.
Unhealthy eating behaviours

In both mothers and children, unhealthy eating behaviour was based on consumption of energy dense foods and drinks including 1) potato crisps or other salty snack foods, 2) chocolate or lollies, 3) cakes, doughnuts, sweet biscuits, 4) pies, pasties or sausage rolls, 5) fast foods (e.g. McDonalds, KFC) 6) pizza and 7) soft drinks (non-diet, and including fruit flavoured and sports drinks). Consumption was measured based on the question “In the past month, about how often have you had the following...”, with the exception of soft drinks, for which the question related to usual serves per day (1 serve being equivalent to 1 can or 375ml). The number of energy dense foods eaten/drunk per day were summed to create a continuous variable for unhealthy eating/drinking. This definition differs from the relevant national guidelines for consumption of “extra foods” (which are broader, including items such as alcohol, ice-cream, spreads, margarine/butter). Therefore, the proportion meeting guidelines for unhealthy eating was not assessed.

Anthropometric and other measures

Women self-reported their age, number of children, self-rated health status, height and weight as well as the age of their child. Children’s height and weight were measured to the nearest 0.1cm and 0.1kg, respectively. BMI was calculated (kg/m²) and among children, was converted to BMI z-scores based on the US Centers for Disease Control 2000 reference population.(30) Education level of women was based on self-report of their highest qualification achieved.

Ethical approval

The Deakin University Human Research Ethics Committee, the Catholic Education Office and the Victorian Department of Education and Early Child Development gave ethical approval for the study, and mothers provided written, informed consent for the participation of themselves and their child.
Statistical analysis

The proportions of mothers and children meeting recommendations for physical activity, screen-time (children only) and fruit and vegetable consumption were calculated. The proportion of mothers who self-reported sitting for <4 hours/day was also calculated. The percentage of participants meeting one, two or all three behaviours were calculated and graphed in approximately proportional Euler diagrams to demonstrate the overlap between these behaviours.

For cluster analysis, physical activity, sitting/screen-time, healthy and unhealthy eating variables were considered as continuous variables. Cluster analysis using Ward’s method with squared Euclidean distances was conducted using standardised continuous variables for physical activity, sedentary behaviour, healthy and unhealthy eating. Standardisation was conducted because of the variation in means and variances of these variables.(31) Since Ward’s method is sensitive to the influence of outliers, all cases with values >3 standard deviations away from the mean for any of the four continuous variables tested were omitted (n=28 mother/child pairs). The choice of Ward’s method was designed to give clusters of meaningful size. This approach has been used previously in similar settings,(32) simulation studies that have shown it to be among the more useful techniques,(31) and in a discussion of the various techniques, it is noted that this method tends to result in clusters of more equal size.(33)

The validity of the clustering method was tested by using a five cluster solution in the total READI cohort of women (including mothers and all other women participating in the survey, n=3675). A similar clustering pattern was observed. The average difference of the mean of the four standardised variables used in clustering between the mothers only and the total cohort was 0.18. One-way ANOVA with Bonferroni adjustment for multiple comparisons was used to compare characteristics between clusters. Concordance of the clustering between mothers and children was tested using a chi-square test, with the observed and expected numbers in each cross-tabulation reported. Missing data meant that 549 mothers and 353 children were available for the cluster analysis, while 304 mother-child pairs were available for concordance analysis.
Results

The demographic and obesity-related behavioural characteristics of the mothers and children in the sample are reported in Tables 1 and 2.

Proportion meeting national guidelines

The proportions of mothers and children meeting national guidelines for fruit and vegetable consumption, physical activity, screen-time (children only) and sitting time (< 4 hours/day, mothers only) are presented in Figures 1 and 2 respectively. Less than 40% of both mothers and children were meeting sedentary/screen time guidelines and only partial overlap was observed between groups. Fewer mothers than children ate the recommended serves of fruit and vegetables, and almost 20% of mothers, but only 10% of children, met none of the guidelines.

Cluster analysis of behaviours

From the cluster analysis a five-cluster solution emerged as that most able to define specific groups of both mothers and children. A five cluster solution also appeared as the most suitable when tested in the entire sample of women included in the READI study (n=3675).

The five clusters in mothers (Table 1) and children (Table 2) can be broadly divided into two healthy clusters and three unhealthy clusters. The titles for the clusters in mothers and children were based on the predominant characteristic of the cluster and are reported in Tables 1 and 2 respectively. Among mothers, one or two of the four behaviours included in the clustering algorithm predominated in each cluster. ‘Physical activity enthusiasts’ were shown to have greater self-rated health than ‘sedentary sitters’, ‘poor diet and little physical activity’ and ‘fruit and veg eaters who don’t sit’ (p<0.05). No significant differences in BMI were observed between clusters. Bivariate correlations between BMI and each of the four individual behaviours were also not significant among mothers, however among the total sample of almost four thousand women, significant correlations were seen between BMI and both sedentary time and physical activity (both p<0.05).
In contrast to the patterns in mothers, clusters identified in children included one in which all four behaviours were healthy, and one in which despite high screen time, high levels of physical activity and fruit and vegetable consumption, and a low level of energy dense food consumption were observed. The mean age of the cluster ‘young physical activity enthusiasts’ was two to three years younger than that of all other clusters (p<0.001 for each comparison, after Bonferroni adjustment), while the ‘all-round healthy behaviours’ cluster was younger than both the ‘low on fruit and veg and physical activity’ and ‘energy dense eaters who watch’ clusters (p<0.05). No differences in z-BMI were observed between any clusters (p>0.05).

Concordance of clustering between mothers and children

The cross-tabulation of cluster membership among mother and child pairs is presented in Table 3. The observed number in each cell is presented along with the number expected if no relationship between cluster membership in mothers and children were present (i.e. the null hypothesis). The overall chi-square statistic for the table was 42.8 (p<0.0001) with concordance observed in many, but not all cells. Particularly strong relationships were observed in those clusters of mothers and children in which the predominant traits were sedentary behaviour or consumption of energy dense food/drink. No concordance was observed for the ‘young physical activity enthusiasts’ cluster in children.

Discussion

This study has demonstrated the complex relations between obesity-related behaviours both within children and mothers and within mother-child pairs. We have shown that both the mothers and their children in this study could be effectively classified into sub-groups defined by particular behaviours. Concordance of clusters in children and their mothers, and particularly those based on sedentary behaviour and consumption of energy dense food/drink, demonstrate the important influence of the home environment on eating and activity behaviours.
The relationships between behaviours within a population can also be investigated by looking at overlap in the proportions meeting national recommendations. As only partial overlap was observed between those meeting the various recommendations, this is a further demonstration of the complexity in behaviour patterns related to obesity. The proportion of children consuming the recommended serves of fruit and vegetables was considerably higher than that reported from the National Children’s Nutrition and Physical Activity Survey (NCNPAS).(34) This discrepancy is likely based on the fact that he NCNPAS was based on a 2x24 hour food recalls as opposed to the food frequency questionnaire used here. The proportions meeting this recommendation must therefore be viewed with caution. Despite this, the food frequency questionnaire used can still effectively rank individuals, which is the characteristic most important for the cluster analysis.

The clustering pattern among mothers revealed two clusters with both low intake of fruit and vegetables and the equal lowest level of physical activity. These two behaviours are key targets of obesity prevention efforts. The one of these clusters that also had the highest level of energy dense food/drink consumption may be a particularly good target for specific intervention. Importantly, these two clusters represented over half of the total sample.

The clustering patterns in children were different to those observed in mothers. In contrast to the mothers, the largest cluster identified was one that had a healthy profile on each of the four tested parameters. This cluster had the best dietary profile, as well as low levels of screen-time and a moderate amount of physical activity. The cluster identified in children with extremely high levels of physical activity, also had a very young mean age of 6.9 years, which was between 2.5 and 3.7 years younger than each of the other clusters. The known decline in levels of physical activity that occurs during childhood and adolescence(35, 36) is likely to be an explanation for this cluster, and as such may represent an age effect rather than a true cluster of behaviours. The fact that concordance between this cluster and the “healthy” and “unhealthy” clusters in mothers was poor further supports this proposition. It is also possible that age is a partial explanation for the two “unhealthy” clusters, which were 0.8 and 1.2 years older than the ‘all-round healthy’ cluster.
An interesting observation arising from this work is that only in children was a cluster identified with optimal indicators for each of the behaviours tested. The majority of clusters were defined by only one or two positive or negative behaviours, and in the case of the ‘screen time focused’ cluster, a mixture of both. The identification of entirely “healthy” or “unhealthy” groups based on health behaviours is therefore difficult, particularly in adults. Sub-groups of the population are defined by their characteristics according to only one or two obesity-related behaviours, but not all. The balance of “healthy” and “unhealthy” behaviours within clusters may explain the absence of any statistically significant differences in BMI between clusters. In this regard, it is worth noting that the lowest z-BMI in children was seen in the cluster ‘all-round healthy behaviours’, which had low screen time, high levels of physical activity, low consumption of energy dense foods and drinks and high levels of fruit and vegetable consumption. Although not statistically significantly different from the other clusters, this result may indicate a trend in the expected direction. The absence of significant differences in BMI between clusters for both mothers and children may also be partly due to sample size considerations. Bivariate correlations between BMI (or z-BMI) and each of the four behaviours tested in both mothers and children were non-significant (p>0.05). In the larger cohort of almost four thousand women from the READI study, significant correlations between BMI and each of screen time and physical activity were seen (p<0.05). In relation to the differences in self-rated health seen between clusters of mothers, the direction of the association cannot be assumed, it being likely that self-rated health may both impact, and be impacted upon, by the obesity-related behaviours tested.

Our observation of concordance between behaviours of mothers and children is consistent with previous data that has shown clear relationships between the behaviour of parents and children, particularly in relation to eating habits,(13, 17) but also physical activity.(18) Parental physical activity levels and dietary patterns have been shown to be useful predictors of obesity in children.(37) Familial clustering of obesity and obesity behaviours is mediated by both genetic and environmental influences,(38) with parents creating environments and modelling behaviours for children that influence their eating, physical activity and sedentary behaviours.
Concordance was stronger for clusters based on sedentary behaviour and consumption of energy dense food than physical activity or fruit and vegetable consumption. Parental modelling and creation of environments relating to both of these behaviours may therefore be particularly important influences on children's behaviours.

A simplistic approach can obscure the true interrelationships between health behaviours.(8) Taking into consideration the complexity of behaviours is important when developing obesity prevention interventions, however, it must also be remembered that cluster analysis is an exploratory technique. The cluster pattern observed here may have differed with the inclusion of more or different variables, a different clustering algorithm or a different sample. It is for these reasons that we advocate a view of health behaviours that considers the complexities apparent; however we do not necessarily suggest that the particular clustering patterns observed here are definitive.

When interpreting these findings, some aspects of the study design warrant further consideration. While the measures were well-validated, assessment of physical activity in mothers and sedentary behaviour in mothers and children was based on self-report. Furthermore, since response to the study was moderate and the cohort was sampled entirely from areas of lower socioeconomic status, the results may not necessarily be generalisable to all Australian women and children.

**Conclusion**

In conclusion, we have demonstrated that complex patterns of obesity-related behaviours exist in both children and their mothers, and such patterns of behaviours should be considered in the creation of obesity prevention interventions. Studies that can test the effect of either isolated or multi-faceted interventions on distinct clusters of individuals may be warranted, with such studies being able to inform the targeting of obesity prevention activities. Our findings in relation to the familial clustering of behaviours, or the concordance of clusters between children and their mothers, suggests that modelling of sedentary behaviour and creation of a child’s eating environment by parents may be particularly important.
Acknowledgements

The READI study was funded by an Australian National Health and Medical Research Council (NHMRC) Strategic Award, ID 374241. AC is supported by a capacity building grant from the NHMRC (grant 425845). JS and SAM are supported by the National Heart Foundation of Australia (JS, Career Development Fellowship; SAM, Research Fellowship). KB is supported by a NHMRC Senior Research Fellowship (grant 479513). DC and KC are supported by fellowships from the Victorian Health Promotion Foundation (DC, Senior Research Fellowship; KC, Public Health Research Fellowship).

Disclosure

The authors have no conflicts of interest to declare

References

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Tables and Figures

Table 1. Clustering of obesity-related behaviours in mothers and relationships with demographic and health parameters*.

<table>
<thead>
<tr>
<th>Description of key cluster features</th>
<th>'Fruit and veg eaters who don’t sit'</th>
<th>'Physical activity enthusiasts'</th>
<th>'Sedentary sitters'</th>
<th>'Low on fruit and veg and physical activity'</th>
<th>'Poor diet and little physical activity'</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>133</td>
<td>101</td>
<td>39</td>
<td>183</td>
<td>93</td>
<td>549</td>
</tr>
<tr>
<td>Fruit &amp; Veg (serves/day)</td>
<td>6.0</td>
<td>4.3</td>
<td>4.1</td>
<td>3.4</td>
<td>2.5</td>
<td>4.1</td>
</tr>
<tr>
<td>Energy dense food/drink (serves/day)</td>
<td>.7</td>
<td>.7</td>
<td>.6</td>
<td>.5</td>
<td>2.0</td>
<td>.8</td>
</tr>
<tr>
<td>Sitting (min/day)</td>
<td>249.8</td>
<td>329.9</td>
<td>1042.5</td>
<td>363.1</td>
<td>298.7</td>
<td>366.9</td>
</tr>
<tr>
<td>Leisure time PA (min/week)</td>
<td>291.9</td>
<td>779.0</td>
<td>267.2</td>
<td>184.8</td>
<td>185.9</td>
<td>326.1</td>
</tr>
<tr>
<td>Self-rated health (Likert scale)</td>
<td>3.5</td>
<td>3.8</td>
<td>3.3</td>
<td>3.5</td>
<td>3.2</td>
<td>3.5</td>
</tr>
<tr>
<td>Age (years)</td>
<td>39.4</td>
<td>38.2</td>
<td>38.3</td>
<td>39.2</td>
<td>37.9</td>
<td>38.8</td>
</tr>
<tr>
<td>Highest education (scale 1-7)</td>
<td>2.2</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>No. of children &lt;18 yrs</td>
<td>2.4</td>
<td>2.3</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>2.3</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.8</td>
<td>26.3</td>
<td>26.1</td>
<td>26.9</td>
<td>26.1</td>
<td>26.6</td>
</tr>
</tbody>
</table>

*Significant differences (p<0.05): ‘Fruit and veg eaters who won’t sit down’ higher education than all other clusters; ‘Physical activity enthusiasts’ higher self-rated health than all except ‘Low on fruit and veg and physical activity’; ‘Low on fruit and veg and physical activity’ higher self-rated health than ‘Poor diet and little physical activity’.
Table 2. Clustering of obesity-related behaviours in children and relationships with z-BMI and age.

<table>
<thead>
<tr>
<th>Description</th>
<th>'Young physical activity enthusiasts'</th>
<th>'All-round healthy behaviours'</th>
<th>'Screen time focused'</th>
<th>'Low on fruit and veg and physical activity'</th>
<th>'Energy dense eaters who watch'</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit &amp; Veg (serves/day)</td>
<td>3.7</td>
<td>5.7</td>
<td>4.9</td>
<td>2.6</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Energy dense food (serves/day)</td>
<td>1.1</td>
<td>.5</td>
<td>.6</td>
<td>.8</td>
<td>1.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Screen-time (min/day)</td>
<td>97.0</td>
<td>82.8</td>
<td>219.4</td>
<td>131.0</td>
<td>175.8</td>
<td>145.9</td>
</tr>
<tr>
<td>Mod-Vig PA (min/day)</td>
<td>303.2</td>
<td>174.9</td>
<td>176.3</td>
<td>127.1</td>
<td>157.4</td>
<td>188.6</td>
</tr>
<tr>
<td>z-BMI</td>
<td>.60</td>
<td>.37</td>
<td>.74</td>
<td>.43</td>
<td>.52</td>
<td>.54</td>
</tr>
<tr>
<td>Age (years)*</td>
<td>6.9</td>
<td>9.4</td>
<td>9.9</td>
<td>10.6</td>
<td>10.2</td>
<td>9.4</td>
</tr>
</tbody>
</table>

*Significant differences (p<0.05): 'Young physical activity enthusiasts' younger than all other groups; 'All-round healthy behaviours' younger than both 'Low on fruit and veg and physical activity' and 'Energy dense eaters who watch'.

Table 3. Cross tabulation of cluster membership in children and their mothers.

<table>
<thead>
<tr>
<th>Mothers</th>
<th>Children</th>
<th>'Young exercise enthusiasts'</th>
<th>'All-round healthy behaviours'</th>
<th>'Screen time focused'</th>
<th>'Low on fruit and veg and physical activity'</th>
<th>'Energy dense eaters who watch'</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Fruit and veg eaters who don't sit down'</td>
<td>Observed n</td>
<td>12</td>
<td>26</td>
<td>11</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Expected n</td>
<td>15</td>
<td>15</td>
<td>16</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Exercise enthusiasts'</td>
<td>Observed n</td>
<td>11</td>
<td>10</td>
<td>12</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Expected n</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>'Sedentary sitters'</td>
<td>Observed n</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Expected n</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>'Low on fruit and veg and physical activity'</td>
<td>Observed n</td>
<td>21</td>
<td>18</td>
<td>23</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Expected n</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td>'Poor diet and little exercise'</td>
<td>Observed n</td>
<td>14</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Expected n</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>14</td>
</tr>
</tbody>
</table>

*Note, expected n is based on a Chi-square analysis with 19 degrees of freedom. Overall chi square = 42.8 (p<0.0001). Cells in which concordance was strongest indicated in bold.
Figure 1. Proportions of mothers meeting Australian recommendations for physical activity, fruit and vegetable consumption and sitting time.

*Low sitting time = sitting for four hours or less per day

*Physically active = 150+ minutes per week of leisure time physical activity

*Consumes recommended fruit and vegetables = 2+ serves of fruit and 5+ serves of vegetables or legumes per day
Figure 2. Proportions of children meeting Australian recommendations for physical activity, fruit and vegetable consumption and screen-time.

*Low screen time = two hours or less screen time per day

†Physically active = 60+ minutes of moderate to vigorous physical activity on each day (accelerometer data)

‡Consumes recommended fruit and vegetables = (age<8, 1+fruit, 2+veg per day) (age 8-12, 1+fruit, 3+veg per day) (age>12, 3+fruit, 4+veg per day)