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Complete List of Authors:	Hardy, Louise L.; Univ Sydney, Prevention Research Collaboration Baur, L; The University of Sydney, Prevention Research Collaboration, Sydney School of Public Health,; University of Sydney - Camperdown and Darlington Campus, NHMRC Centre for Research Excellence in The Early Prevention of Obesity in Childhood Wen, Li Ming; University of Sydney, Sydney School of Public Health Garnett, Sarah P.; Univ Sydney, Child and Adolescent Health ; The Children's Hospital at Westmead, Endocrinology and Diabetes Mihrshahi, Seema; University of Sydney, Prevention Research Collaboration

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Descriptive epidemiology of temporal changes in weight and weight-related behaviors of Australian children age 5 years: 2010-2015

Louise L Hardy PhD,[1, 2] Louise A Baur MD, PhD,[1,2 3] Li Ming Wen MD, PhD,[,2, 3, 4] Sarah P Garnett PhD,[2,5] Seema Mihrshahi PhD[1,2,3]

[1] Prevention Research Collaboration, Sydney School of Public Health, Charles Perkins Centre D17, Level 6, The Hub, The University of Sydney, Australia, NSW 2006.

[2] Sydney Medical School, The University of Sydney Australia, NSW 2006

[3] NHMRC Centre for Research Excellence in The Early Prevention of Obesity in Childhood, Charles Perkins Centre D17, Level 6, The Hub, The University of Sydney, Australia, NSW 2006

[4] Health Promotion Unit, Sydney Local Health District, NSW Australia 2050

[5] Institute of Endocrinology and Diabetes and Kids Research Institute at the Children's Hospital at Westmead, Australia

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ADDRESS CORRESPONDENCE TO:

Dr Louise L Hardy

Charles Perkins Centre D17 | Level 6, The Hub | THE UNIVERSITY OF SYDNEY | NSW | 2006 | **T:** +61 2 86271846 | **F:** +61 2 8627 1602 | **E:** louise.hardy@sydney.edu.au |

Abstract

Objective: To examine changes in weight and weight-related behaviors of 5-year old children between 2010 and 2015.

Design: Cross-sectional surveys conducted in 2010 and 2015.

Setting: Forty-one schools in New south Wales, Australia

Participants: Australian children in Kindergarten (2010 n=1,141 and 2015 n=1,150).

Outcome measures: Primary outcome was **a**nthropometry measured at school. Secondary outcomes were changes in indicators of diet, screen-time, school travel, and awareness of health recommendations. Additionally, we examined 2015 differences in weight-related behaviors by socio-demographic characteristics.

Results: Prevalence of overweight/obesity was 2.1% lower (AOR 0.83 95%CI 0.67, 1.04) and abdominal obesity 1.7% higher (AOR1.35 95%CI 0.93, 1.98) in 2015 than 2010. Significant positive changes in multiple weight-related behaviors were observed, especially in the highest tertile of junk food consumption (AOR 0.63, 95%CI 0.50, 0.80), rewarding good behavior with sweets (AOR 0.59, 95%CI 0.47, 0.74) and TVs in child's bedroom (AOR 0.65, 95%CI 0.43, 0.96). In 2015, children from low socioeconomic neighborhoods and non-English speaking backgrounds were generally less likely to engage in healthy weight related behaviors than children from high SES neighborhoods and from English-speaking backgrounds. Children in these demographic groups were less likely to eat breakfast daily, have high junk food intake, and eat fast food regularly. Children from rural areas tended to have healthier weight-related behaviours than children from urban areas.

Conclusions: There were significant positive changes in 5-year old children's weight-related behaviors but children from low socioeconomic neighborhoods and from non-English-speaking backgrounds were more likely to engage in unhealthy weight-related behaviors than children from high socioeconomic neighborhoods and English-speaking backgrounds. The findings indicate that there is a need to enhance efforts and ensure programs are targeted and tailored to meet different sub-population.

Strengths and limitations of this study

- Data come from two cross-sectional state population health surveys with high response rates, measured anthropometry, and validated measures of weight-related behaviours.
- Although there is no international consensus for dietary cut points which has led to considerable variation across studies, our cut points were based on dietary guidelines to represent a lower frequency or 'limiting' consumption of discretionary foods.
- Parents completed the questionnaire and may be influenced by social desirability bias given the increasing role of social media in shaping community perceptions and public discourse on obesity.

Introduction

Children who are obese during childhood are five times more likely to be obese in adulthood compared with non-obese children[1] and obesity-related behaviours including poor diet quality, decreased physical activity, increased sedentary behaviours and decreased sleep duration are established in, and track from, early childhood.[2] Together these findings suggest investment to promote healthy lifestyle behaviors during childhood may play a particularly strategic role in population obesity prevention.

Within a socio-ecological framework, the home environment exerts the most significant influence on children's acquisition of weight-related behaviours however, as children grow and their mothers return to the workforce, the early childcare setting also has an important role in the development of young children's weight-related behaviours. In 2014, in New South Wales (NSW, Australia) about 21% of <2-year-olds, 58% of 2-3 year-olds, and 44% of 4-5-year-olds attended some form of formal child-care services,[3] showing that these services are pivotal in reaching large numbers of children and their parents.

Over the past 10-15 years there has been substantial investment in NSW to reduce child obesity through a succession of state plans, policies, and programs to support the healthy development of children from birth to 5 years. The overarching strategy is a whole of government framework to encourage and support opportunities for the community to be healthy through the delivery of evidence-based, interactive, and relevant programs. These initiatives include up-skilling the early childcare sector,[4] supported playgroups,[5] web-sites (e.g., www.healthykids.nsw.gov.au), health screening programs for 4 year olds,[6] and telephone-based support services for parents of children age 0-2 years. To date a summary of the net effects of investment in early childhood obesity prevention in NSW is yet to be examined.

The purpose of this study was to use cross-sectional surveillance data and to examine changes between 2010 and 2015 in weight and weight-related behaviours of children in the first year of school.

The assumption is that changes in the weight and weight-related behaviors of children entering school reflect *overall* investment during their preschool years. We also examined weight-related behaviours by socio-demographic characteristics to identify sub-populations of children who may require greater support to change weight-related behaviours.

Methods

Data come from the 2010 and 2015 NSW Schools Physical Activity and Nutrition Survey, a representative cross-sectional population survey of weight and weight related behaviours of children age 5-16 years conducted every five years. This study examined only data from children in Kindergarten age approximately 5 years. Detailed descriptions of the survey methodology are published elsewhere.[7] Briefly, the surveys are designed to be representative of school age children in terms of type of school, residence and socioeconomic status. Sample size was based on detecting a difference of 10% in the prevalence of overweight/obesity between boys and girls within each year group, with 80% power and alpha=0.05. The surveys are school-based and use comparable sampling frames that are based on a two-stage probability sample (school and student). The probability of school selection was proportional to size of the school enrolment. Schools were sampled from each education sector (government, independent, Catholic) proportional to enrolment in that sector and all students from two randomly selected classes are invited to participate. The study protocols were comparable for each survey year and data were collected in schools by trained field teams during February–April of each survey year. Informed consent from each child's parent/carer was a requirement for participation. Ethics approvals were granted by the University of Sydney Human Research Ethics Committee, the NSW Department of Education and Training and the NSW Catholic Education Commission.

Measures

Parents completed the self-administered questionnaire for their child at home at time of consent. Socio-demographic information included the child's sex, date of birth, language spoken most often at home, and postcode of residence. Postcode of residence was used as proxy measure of socioeconomic status (SES) using the Australian Bureau of Statistics' Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage.[8] SEIFA scores from the 2011 Census were used to rank students into low, middle, and high SES neighborhoods. Postcode of residence was also used to determine residential locality using the Accessibility/Remoteness Index of Australia in 2010 and the Australian Statistical Geography Standard in 2015[9] and children were categorized as living in urban or rural areas. Language spoken most often at home was used to categorize children into English speaking or non-English speaking backgrounds.[10]

Height (m), weight (kg) and waist circumference (cm) were measured over one layer of light clothing during the school visit by field staff. Body mass index was calculated (kg/m^2) and children categorized as thin, healthy weight, overweight and obese using the International Obesity Task Force age-sex adjusted cut-points.[11] Waist-to-height ratio (WtHR), an indicator of abdominal obesity, was calculated as waist circumference (cm) divided by height (cm) and dichotomized as <0.5 or ≥ 0.5.[12]

Indicators of dietary intake were collected using a validated short food frequency questionnaire specifically developed for population surveillance surveys.[13] Parents reported the usual frequency their child consumed fruit, vegetables (Doesn't eat fruit/vegetables, <1serve/day, 1 serve/day, 2 serves/day, 3 serves/day, 4 serves/day, 5 serves/day, 6 or more serves/day); fried potato products, salty snack foods, snack foods, confectionery and ice cream (never/rarely, 1-2 times/week, 3-4 times/week, 5-6 times/week, 1 time/day, 2 times/day). For the analysis, fruit and vegetable intakes were dichotomized according to daily recommended serves for children age 5 years.[14] Discretionary foods (i.e., fried potato products, salty snack foods, snack foods, confectionery, ice cream) are not necessary for a healthy diet and the guidelines recommend limiting these foods.[14] For the analysis, 'limited' was defined *a priori* as less than three times a week and discretionary foods were dichotomized as <3 or ≥3 times/week. Additionally, because discretionary foods are rarely eaten in isolation were examined total consumption using a junk food intake measure (JFIM).[15]

Information on eating behaviours included the frequency of eating breakfast, eating dinner in front of the TV, and eating meals or snacks from fast-food outlets (never/rarely, <1/week, 1–2 times/week, 3–4 times/week, 5–6 times/week or every day). For the analysis, breakfast was dichotomized according to dietary guidelines as daily or not daily.[14] There is no consensus how often children should eat in dinner front of the TV or eat fast foods, however other research indicates that eating dinner in front of the TV five or more times/week is associated with poor diet quality and overweight in children[16], hence eating dinner in front of the TV was dichotomized as <5 or ≥5 times/week. Eating fast foods one or more times a week is associated with increased BMI in children[17], so we dichotomized fast-food as <1 (infrequent) or ≥1 time/week (frequent). Parents also reported how often they offered sweets to their child for good behavior (rarely/never, sometimes, or usually) and these were dichotomized for the analysis as rarely/never or sometimes/usually, based on dietary guidelines which recommend limiting discretionary foods.

Information about the home screen environment (TV, videos/DVDs, computer, smart phone, tablets, e-games) included whether their child had a TV in the bedroom (yes or no); limiting their child's screen-time (rarely/never, sometimes or usually) and these were dichotomized for the analysis as rarely/never or sometimes/usually. Time spent on screen devices was collected by questionnaire[18] and time dichotomized for the analysis according to screen-time recommendations: <2 hours/day or ≥2 hours/day. [19]

Parents reported how their child usually travelled to and from school separately for each school day, options included walk, cycle, skateboard or scooter, car, bus, train or ferry/boat. Parents could report more than one travel mode for each trip. For the analysis, children who were driven to and from school 5-days/week were classified as inactive travelers and children who walked, cycled, used a skateboard or scooter to travel to, and from, school 5-days/week were classified as active travelers.

Parents' awareness of national recommendations for children's physical activity and screen-time was assessed by two questions; *How many minutes of physical activity is it recommended that school age* *children do each day?* and *Up to how many hours of television, video, DVD or computer games is it recommended that school age children watch each day?* The response options were to report the time or check 'Don't know'. Parents who reported the correct times were deemed to know the recommendations and parents who reported the incorrect time or 'don't know' were classified as not knowing the recommendation.

Statistical analyses

Data were analyzed in June 2017 using SPSS Complex Sample Analysis (version 22 for Windows; IBM, Chicago, IL, USA) to account for the complex sampling design. Post stratification weights were calculated to account for variations in response rates, along with cluster and stratification variables to account for the complex sampling design. Missing values were not replaced (<5% of data). Categorical differences between 2010 and 2015 were first assessed using chi-square statistic, and ANOVA was used for continuous variables. Logistic models were used to assess change between survey periods in weight outcomes, dietary patterns and habits, screen-time, school travel and parent's awareness of national recommendations for physical activity and screen-time. Covariates included sex, age, residence, SES tertile and language background.

We were also interested to determine if there were sociodemographic differences in weight-related behaviours in children in 2015 to identify whether sub-groups of children may require greater or more targeted intervention. We examined differences between children from rural and urban residences, low and high SES neighborhoods and from non-English-speaking backgrounds and English-speaking backgrounds using logistic regression, controlling for sex. We present the odds ratios and their corresponding 95% confidence intervals for each independent variable. The significance level was set at $p \leq 0.05$.

Results

The sample characteristics are presented in Table 1 and show there were no significant socio-demographic differences between surveys. At both survey, the majority of children were from

English-speaking backgrounds and resided in urban areas. The prevalence and adjusted odds ratios of overweight, obesity overweight-obesity combined and WtHR≥0.5, stratified by sex are presented in Table 2 and show there were no statistically significant changes between survey years. In 2015, approximately one in six children were overweight/obese and had WtHR≥0.5.

The prevalences and change in weight-related behaviours are given in Table 3 and showed there were some significant positive changes in indicators of diet including consumption of junk food, less children had TV's in their bedrooms and higher parental awareness of screen-time and physical activity recommendations. Although changes were not statistically significant, the daily consumption of vegetables remained low, with less than 3% of children meeting the recommendation; 15% of children did not eat breakfast daily, one-in-five children regularly ate dinner in front of the TV and ate fast food one or more times a week. Parental awareness of the screen-time recommendation increased between surveys, yet one third of children did not meet the recommendation on school days and four in five did not meet the recommendation on weekend days. There were no changes to children's school travel.

Table 4 shows the odds ratio, adjusted for sex, for unhealthy weight-related behaviours by socio-demographic characteristics in 2015. Children residing in urban areas were less likely to meet recommended daily serves of vegetables, eat breakfast daily and to regularly eat dinner in front of the TV, than children living in rural areas. Compared with children from high SES neighborhoods, children in low SES neighborhoods were generally more than twice as likely to have a high junk food intake; not eat breakfast daily, eat fast food one or more times a week, have a TV in the bedroom, not meet screen-time recommendations on week days and be driven to and from school daily.

Children from non-English speaking backgrounds were more likely to have higher junk food consumption, not eat breakfast daily, regularly eat dinner in front of the TV and eat fast food one or more times a week, than children from English-speaking backgrounds. Parents from non-English speaking backgrounds were more than twice as likely to not know the daily recommendations for screen-time and physical activity than parents from English speaking backgrounds. Compared with children from English-speaking backgrounds, those from non-English speaking backgrounds were less likely to not meet screen-time recommendations on weekend days.

Discussion

This study shows there have been significant, positive changes in weight-related behaviours of 5-year old children between 2010 and 2015 and, importantly, no statistically significant changes in the prevalence of overweight, obesity and abdominal obesity. While the changes in adiposity were not statistically significant, the higher prevalences of obesity and WtHR≥0.5 in 2015 may indicate that the degree of obesity is increasing. That is, the distribution of BMI is shifting to the right and the prevalence of morbid obesity among children may be increasing; a finding previously reported among Australian children.[20] Although based on cross-sectional data, the sample is representative of the children of NSW and these findings are promising. Understanding the drivers for the changes we observed is difficult because of the complex interacting contexts of obesity prevention. In NSW there has been substantial investment in population obesity prevention since 2002[21-24] and potentially, the changes we observed in some behaviors reflect a compounding effect of continual and multiple investments over the past 10-15 years, so that the children who participated in the 2015 survey will have had greater opportunity to be exposed to obesity prevention programs, compared with the children we measured in 2010.

While there were positive changes in many weight-related behaviours, the prevalence of some behaviours in 2015 remain a concern. The most notable is the very low proportion of children (2.3%) meeting the recommended intake of vegetables, indicating these children are missing the benefits of dietary vitamins, minerals and fibre.[14] This findings is consistent with national estimates.[25] Conversely, 79% of children met recommended intake of fruit, but adherence was lower among children living in urban areas, than children living in rural areas. Potentially, national school-based fruit and vegetable programs[26] need to focus on promoting vegetables.

Children's consumption of discretionary or 'junk' foods was lower in 2015 than 2010 but the consumption of these foods remains higher than dietary guidelines recommend. Our findings are consistent with national data which estimates that more than one third of energy intake among children age 4-8 years comes from discretionary foods.[27] In 2015, the consumption of discretionary foods was higher among children living in low SES neighborhoods and children from non-English speaking backgrounds, than their peers. A recent systematic review[28] concluded that fast food outlets were more prevalent in low, than middle and high SES neighborhoods, and in areas with high concentrations of ethnic minority groups however further qualitative work is required to determine if factors other than availability influence consumption. Potential promising strategies to reduce children's junk food consumption include limiting the accessibility, availability and advertising of these foods to young children, increasing food literacy among parents, and working with the food industry to improve nutrient profiles of junk foods.[29]

Home-based eating practices associated with overweight/obesity in children include eating breakfast daily, eating dinner in front of the TV, eating snacks/meals from fast food and take-away outlets and parent's rewarding children's good behavior with sweets.[30] Eating a healthy breakfast daily (e.g., whole grains, fresh fruit/vegetables) has been linked to a decrease risk in obesity[31] better nutrient intakes,[32] and improve school attendance, which in turn may improve academic outcomes in school children,[33] yet one-in-seven children in this study did not eat breakfast daily and those children were more likely to live in urban areas, low SES neighborhoods and be from non-English speaking backgrounds.

Parental use of sweets as rewards may adversely impact on children's diet through reinforcing a child's preference and liking for sweet food rewards.[34] We found the proportion of parents using sweets as a reward for good behavior was significantly lower in 2015 which may influence caloric intake and the development of dental caries. Parents can inadvertently promote excess weight gain in childhood through role modeling food routines such as eating in front of the TV and regular consumption of fast foods that establish these behaviours as normal eating routines. One-in-five children in this study frequently ate in front of the TV and this practice was more prevalent among children living in urban areas and from non-English speaking backgrounds. We have no information on the quality of the dinners that were eaten in front of the TV, however other studies suggest children's food choices deteriorated with increased frequency of eating in front of the TV.[35] Qualitative research is required to understand cultural differences in this practice which can then inform health promotion efforts to encourage meals to be eaten without the TV on or other screen devices at a table. Consumption of fast food was two-fold higher among children from low SES neighborhoods and non-English speaking cultural backgrounds, compared with their high SES and English-speaking peers. We did not collect information on the type of fast food eaten but a recent review showed that fast food outlets are more concentrated in lower income neighbourhoods.[36] Hence efforts to reduce fast food consumption need to consider town planning and regulations on the placement of fast food outlets in communities.

Australia recommends limiting screen-time among 5-year old children to <2-hours a day,[19] yet less than one-in-seven parents in this study knew this recommendation in 2015. Therefore, it is not surprising that one third of children did not meet the recommendation on week days, increasing to four-in-five children on weekend days. Internationally, children's adherence to the screen-time recommendation are low[37] leading to debate on whether the 2-hour limit is relevant, or whether parents need assistance to adhere to the recommendation. Fewer children had a TV in the bedroom in 2015 which may reduce excessive exposure to unhealthy food advertising that targets children[35] however we were unable to ascertain if TVs were replaced with other screen devices. Ascertaining the use of LED screen devices at bedtime is important given the potential deleterious effects on children's melatonin which is associated with harmful effects on children's sleep and well-being.[38]

Ideally, children should accrue at least 60-minutes of moderate-to-vigorous physical activity daily[19] but in 2015 less than one third of parents knew the recommendation, and awareness was low among parents from non-English speaking backgrounds. Active school transport is an opportunity to increase children's daily physical activity, however three-in-five children were driven to/from school and the prevalence of passive school transport was twofold higher among children from low SES neighborhoods than children from high SES neighborhoods. We were unable to determine why children from low SES neighborhoods were more likely to be driven to school however there are a range of factors which may influence young children's active school travel, including distance, parent (and child's) perception of heavy traffic, pedestrian infrastructure, connectivity, and family time constraints.[39] These factors may have greater influence on children's active school transport in low SES neighborhoods, however Australia is increasingly becoming a car-dependent country which may influenced school commuting.[40]

Key strengths of our study include the large representative sample, high response rates, and validated measures of weight-related behaviors but there are limitations to consider. At age 5-years, children cannot reliably respond to a questionnaire so parents are viewed as an appropriate alternative. The accuracy of proxy reporting is not known, but parents are potentially more strongly affected by social desirability bias which may have influenced our findings particularly given the rise in information about child obesity and the increasing role of social media in shaping community perceptions and public discourse on obesity.[41] Similarly, the potential for non-responder bias which raises the issue of whether population surveillance surveys which benefit public health should have passive rather than active consent. The lack of international consensus regarding dietary cut points has led to considerable variation across studies and our cut points were based on dietary guidelines to represent a lower frequency or 'limiting' consumption of discretionary foods. Finally, our sampling frames are designed to be representative of NSW children, and while NSW is Australia's most populous state, the findings may not necessarily be generalizable to all Australian children.

Conclusions

Our findings suggest here have been positive changes in the weight related behaviours of children entering their first year of school following years of child obesity prevention investment. Establishing healthy behaviours in preschool age children may off-set the challenges of changing established unhealthy behaviours in older children and adolescents. It is not possible to attribute the findings to one intervention; rather the changes reflect the sum of the many obesity prevention activities. These 5-year old children have had exposure to a range of obesity prevention programs, including state-wide interventions to up-skill the early childhood sector workforce in the delivery of healthy eating and physical activity activities. We showed that greater investment is required among families living in low SES neighborhoods and areas with high concentrations of families from non-English speaking backgrounds to reduce health inequalities in these children. Qualitative research will assist with determining the needs of families with less social and economic advantage which can then be adapted to the current intervention frameworks so that interventions are targeted and tailored to meet different sub-population needs.

Footnotes

Contributors LLH, LAB, SPG, LMW and SM had equal contributions to this paper. LLH led the writing and conducted the data analysis. LLH had full access to all of the data (including statistical reports and tables) in the study and can take full responsibility for the overall content.

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Table 1 Socio-demographic characteristics of children by survey year* (%; 95%CI)

	2010	**2015**	**p-value**
N	1,141	1,150	
Response rates (%)	62.0	69.7	
Age (years; SE)	5.35 (0.006)	5.39 (0.025)	0.079
Girls (%)	48.3 (47.6, 49.0)	50.2 (46.9, 53.5)	0.274
Residential locality			
Urban	88.5 (82.1, 92.8)	80.0 (64.6, 89.8)	0.168
Socioeconomic status (%)			
Low	30.8 (22.9, 39.9)	21.5 (11.9, 35.7)	
Middle	41.5 (28.9, 55.4)	32.0 (20.1, 46.9)	0.097
High	27.7 (22.9, 33.1)	46.5 (31.8, 61.7)	
Language background (%)			
English-speaking	85.1 (81.6, 88.0)	85.8 (79.2, 90.5)	0.838
Non-English-speaking backgrounds	14.9 (12.0, 18.4)	14.2 (9.5, 20.8)	

* Weighted percentages;

Table 2 Prevalence and change between 2010 and 2015 of overweight, obesity and waist-to-height ratio and adjusted odds ratio (AOR; 95% CI.)

	Survey year		Change (%)	AOR
	2010	2015	(2010-2015)	(2010 = reference group)
All children*				
Overweight (%)	13.9	11.1	-2.8	0.83 (0.67, 1.04)
Obese (%)	5.7	6.3	0.6	1.49 (0.83, 2.68)
Overweight/obese (%)	19.6	17.5	-2.1	0.83 (0.67, 1.04)
WtHR≥0.5†	14.8	16.5	1.7	1.35 (0.93, 1.98)
Girls**				
Overweight (%)	15.6	12.6	-3.0	0.83 (0.60, 1.14)
Obese (%)	6.4	6.6	0.2	1.41 (0.83, 2.40)
Overweight/obese (%)	22.0	19.2	-2.8	0.98 (0.73, 1.33)
WtHR≥0.5†	16.7	18.1	1.4	1.30 (0.83, 2.03)
Boys**				
Overweight (%)	12.4	9.6	-2.8	0.85 (0.51, 1.40)
Obese (%)	5.0	6.1	1.1	1.77 (0.77, 4.07)
Overweight/obese (%)	17.3	15.7	-1.6	1.11 (0.64, 1.93)
WtHR≥0.5†	13.1	14.8	1.7	1.51 (0.98, 2.32)

*AOR adjusted odds ratio, adjusted for age, sex, residence, SES, and language background,

**AOR adjusted odds ratio, adjusted for age, residence, SES, and language background

† WtHR = waist-to-height ratio

Table 3 Prevalence of children's weight-related behaviors, by survey year (%, 95%CI)

	Survey year			2010 vs 2015
Weight related behaviors	**2010**	**2015**	**p-value**	**AOR (95%CI)***
Dietary patterns and behaviors				
Meets recommend daily fruit serves	73.2 (69.6, 76.5)	79.0 (75.9, 81.8)	**0.013**	**1.32 (1.05, 1.65)**
Meets recommend daily vegetable serves	2.6 (2.1, 3.3)	2.3 (1.6, 3.4)	0.626	0.81 (0.49, 1.34)
Junk food intake measure (JFIM: range 0-25)				
Low tertile (range 0-5)	42.1 (38.9, 45.4)	51.6 (47.5, 55.7)		**1.58 (1.25, 2.00)**
Middle tertile (range 6-8)	33.4 (29.5, 37.4)	31.1 (28.3, 34.1)	**0.002**	0.81 (0.63, 1.03)
High tertile (range 9-25)	24.5 (23.8, 25.3)	17.3 (14.5, 20.4)		**0.63 (0.50, 0.80)**
Eats salty snacks foods ≥3/week	31.6 (30.9, 32.3)	22.7 (18.1, 28.1)	**0.003**	**0.73 (0.61, 0.87)**
Eats sweet/savory snacks foods ≥3/week	56.4 (54.9, 58.0)	49.3 (45.5, 53.1)	**0.001**	**0.72 (0.55, 0.95)**
Eats fried potato products ≥3/week	12.8 (11.0, 14.9)	7.9 (5.5, 11.1)	**0.011**	0.69 (0.43, 1.12)
Eats confectionery ≥3/week	33.3 (30.7, 36.1)	26.4 (22.9, 30.2)	**0.004**	**0.76 (0.63, 0.91)**
Eats ice cream/ice blocks ≥3/week	43.6 (38.8, 48.4)	31.6 (28.3, 35.0)	**<0.001**	**0.59 (0.46, 0.77)**

	Survey year			2010 vs 2015
Weight related behaviors	**2010**	**2015**	**p-value**	**AOR (95%CI)***
Eats breakfast daily	87.3 (86.2, 88.2)	84.8 (80.1, 88.5)	0.229	**0.66 (0.47, 0.90)**
Eats dinner in front of the TV ≥5/week	17.8 (16.6, 19.0)	18.3 (15.4, 21.5)	0.775	1.10 (0.88, 1.37)
Eats fast food ≥1/week	24.0 (20.9, 27.4)	20.4 (16.4, 25.2)	0.206	0.92 (0.69, 1.23)
Parent usually rewards child's good behavior with sweets	12.6 (11.7, 13.6)	7.9 (6.4, 9.8)	**<0.001**	**0.59 (0.47, 0.74)**
Screen time				
Child has TV in bedroom	21.6 (17.8, 25.8)	13.1 (9.8, 17.1)	**0.004**	**0.65 (0.43, 0.96)**
No limits on child's screen-time	8.2 (7.4, 9.0)	6.1 (4.5, 8.1)	0.057	1.28 (0.90, 1.81)
Meets ST recommendation on weekdays	64.3 (59.5, 68.9)	65.5 (61.2, 69.5)	0.72	0.91 (0.69, 1.19)
Meets ST recommendation on weekend days	21.7 (19.5, 24.0)	19.7 (17.5, 22.1)	0.246	0.84 (0.69, 1.04)
School travel (5 days/week)				
Driven to school	52.6 (41.7, 63.2)	59.8 (53.4, 65.8)	0.278	1.43 (0.85, 2.40)
Driven home from school	54.2 (43.7, 64.3)	57.5 (51.4, 63.5)	0.599	1.21 (0.73, 2.01)
Walked to school	19.9 (13.5, 28.2)	16.0 (11.9, 21.0)	0.372	0.76 (0.43, 1.34)

	Survey year			2010 vs 2015
Weight related behaviors	**2010**	**2015**	**p-value**	**AOR (95%CI)***
Walked home from school	18.6 (13.0, 26.0)	16.6 (12.5, 21.7)	0.622	0.83 (0.47, 1.46)
Mixed travel modes to school	19.7 (16.1, 23.9)	20.1 (17.1, 23.5)	0.886	1.03 (0.73, 1.44)
Mixed travel modes home from school	19.6 (16.0, 23.8)	20.7 (17.5, 24.3)	0.694	1.07 (0.76, 1.52)
Parental knowledge and awareness				
Knows the ST recommendation	11.1 (9.8, 12.5)	14.8 (12.4, 17.6)	**0.008**	**1.36 (1.06, 1.73)**
Knows the PA recommendation	18.5 (17.3, 19.7)	29.9 (26.2, 34.0)	**<0.001**	**1.72 (1.40, 2.10)**

AOR= adjusted odds ratio, covariates = sex, residence, SES tertile, language background; ST = screen time; PA = physical activity

Table 4 The adjusted odds ratio of engaging in unhealthy weight-related behaviours in 2015, by socio-demographic characteristics (AOR, 95%CI)

	Residence			Socioeconomic status			Language background		
Weight related behaviours	**Urban (ref) (%)**	**Rural (%)**	**AOR (95%CI)***	**High (ref) (%)**	**Low (%)**	**AOR (95%CI)***	**English-speaking (ref) (%)**	**NESB (%)****	**AOR (95%CI)***
Dietary patterns and behaviors									
Does not meet recommend daily vegetable serves	97.8	97.0	0.73 (0.33, 1.61)	97.3	97.9	1.27 (0.40, 4.01)	97.9	96.4	0.59 (0.19, 1.83)
Does not meet recommend daily fruit serves	22.3	15.7	**0.65 (0.42, 0.98)**	21.8	20.9	0.95 (0.62, 1.47)	19.8	24.4	1.49 (0.89, 2.48)
Does not meet recommend daily vegetable serves	97.8	97.0	0.73 (0.33, 1.61)	97.3	97.9	1.27 (0.40, 4.01)	97.9	96.4	0.59 (0.19, 1.83)
JFIM -highest tertile	17.9	14.8	0.79 (0.46, 1.36)	15.5	25.2	**1.84 (1.10, 3.08)**	15.9	23.5	**1.62 (1.16, 2.28)**
Does not eat breakfast daily	16.7	9.4	**0.52 (0.30, 0.91)**	15.1	25.6	**2.88 (1.66, 5.01)**	12.2	33.3	**3.50 (2.25, 5.44)**

Weight related behaviours	**Residence**			**Socioeconomic status**			**Language background**		
	Urban (ref) (%)	**Rural (%)**	**AOR (95%CI)***	**High (ref) (%)**	**Low (%)**	**AOR (95%CI)***	**English-speaking (ref) (%)**	**NESB (%)****	**AOR (95%CI)***
Eats dinner in front of the TV ≥5/week	19.9	11.8	**0.54 (0.39, 0.74)**	19.3	21.2	1.13 (0.77, 1.65)	17.1	25.4	**1.68 (1.16, 2.44)**
Eats fast food ≥1/week	20.8	19.0	0.89 (0.52, 1.55)	15.8	34.5	**2.80 (1.65, 4.77)**	18.6	30.4	**1.94 (1.28, 2.94)**
Parent usually rewards child's good behavior with sweets	8.3	6.3	0.74 (0.39, 1.40)	8.6	9.5	0.90 (0.53, 1.52)	7.6	10.0	1.38 (0.79, 2.41)
Screen time and behaviours									
Child has TV in bedroom	12.9	13.6	1.06 (0.51, 2.21)	8.5	19.9	**2.69 (1.44, 5.01)**	13.5	11.3	0.82 (0.45, 1.49)
Rarely/never put limits on child's screen-time	6.0	6.5	1.10 (0.50, 2.39)	4.5	4.2	0.92 (0.47, 1.79)	6.1	5.8	0.89 (0.37, 2.16)
Does not meet ST recommendation on weekdays	34.4	35.0	1.03 (0.64, 1.64)	30.2	47.1	**2.09 (1.40, 3.11)**	34.4	36.0	1.14 (0.78, 1.66)

Weight related behaviours	Residence			Socioeconomic status			Language background		
	Urban (ref) (%)	Rural (%)	AOR (95%CI)*	High (ref) (%)	Low (%)	AOR (95%CI)*	English-speaking (ref) (%)	NESB (%)**	AOR (95%CI)*
Does not meet ST recommendation on weekend days	79.8	82.2	1.17 (0.72, 1.88)	79.3	79.8	1.04 (0.75, 1.45)	82.0	69.3	**0.52 (0.34, 0.79)**
School travel (5days/week)									
Driven to school	59.6	60.3	1.03 (0.57, 1.87)	55.1	74.5	**2.38 (1.23, 4.61)**	58.8	66.2	1.35 (0.78, 2.36)
Driven home	57.0	59.7	1.12 (0.61, 2.06)	53.3	70.4	**2.09 (1.12, 3.89)**	56.6	63.9	1.36 (0.81, 2.30)
Active transport to school	18.3	6.6	**0.32 (0.17, 0.61)**	20.3	8.2	**0.35 (0.18, 0.69)**	15.9	17.6	1.12 (0.60, 2.08)
Active transport home	19.1	6.5	**0.30 (0.16, 0.54)**	21.2	9.5	**0.39 (0.21, 0.71)**	16.2	19.8	1.29 (0.73, 2.28)
Parental awareness of health recommendations									
Does not know ST recommendation	85.4	84.1	0.91 (0.56, 1.48)	82.5	86.5	1.36 (0.86, 2.13)	83.8	91.7	**2.07 (1.08, 3.98)**

Weight related behaviours	Residence			Socioeconomic status			Language background		
	Urban (ref) (%)	Rural (%)	AOR (95%CI)*	High (ref) (%)	Low (%)	AOR (95%CI)*	English-speaking (ref) (%)	NESB (%)**	AOR (95%CI)*
Does not know the PA recommendation	71.1	66.2	0.80 (0.55, 1.17)	67.2	75.8	1.53 (0.91, 2.57)	67.2	85.0	**2.67 (1.59, 4.48)**

ref = reference group; * = adjusted for sex; **NESB = non-English-speaking backgrounds; ST = screen time; PA = physical activity

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-8
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	17 (Table 1)
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	17 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18-25 (Tables 2,3,4)
		(*b*) Report category boundaries when continuous variables were categorized	6-8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Descriptive epidemiology of changes in weight and weight-related behaviors of Australian children age 5 years: Two population-based cross-sectional studies in 2010 and 2015

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Descriptive epidemiology of changes in weight and weight-related behaviors of Australian children age 5 years: Two population-based cross-sectional studies in 2010 and 2015

Louise L Hardy PhD,[1, 2] Louise A Baur MD, PhD,[1,2 3] Li Ming Wen MD, PhD,[2, 3, 4] Sarah P Garnett PhD,[2,5] Seema Mihrshahi PhD[1,2,3]

[1] Prevention Research Collaboration, Sydney School of Public Health, Charles Perkins Centre D17, Level 6, The Hub, The University of Sydney, Australia, NSW 2006.

[2] Sydney Medical School, The University of Sydney Australia, NSW 2006

[3] NHMRC Centre for Research Excellence in The Early Prevention of Obesity in Childhood, Charles Perkins Centre D17, Level 6, The Hub, The University of Sydney, Australia, NSW 2006

[4] Health Promotion Unit, Sydney Local Health District, NSW Australia 2050

[5] Institute of Endocrinology and Diabetes and Kids Research Institute at the Children's Hospital at Westmead, Australia

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RUNNING TITLE: Weight-related behaviors of 5-year old children.

ADDRESS CORRESPONDENCE TO:

Dr Louise L Hardy

Charles Perkins Centre D17 | Level 6, The Hub | THE UNIVERSITY OF SYDNEY | NSW | 2006 | **T:** +61 2 86271846 | **F:** +61 2 8627 1602 | **E:** louise.hardy@sydney.edu.au |

Abstract

Objective: Over the past 10-15 years there has been substantial investment in New South Wales (NSW, Australia) to reduce child obesity through interventions in children age 0-5 years. We report changes in weight and weight-related behaviors of 5-year old children.

Design: Cross-sectional surveys conducted in 2010 and 2015.

Setting: NSW schools (2010 n=44; 2015 n=41)

Participants: Australian children in Kindergarten (2010 n=1,141 and 2015 n=1,150).

Outcome measures: Chane in anthropometry and indicators of diet, screen-time, school travel, and awareness of health recommendations. Additionally, we examined 2015 differences in weight-related behaviors by socio-demographic characteristics.

Results: Prevalence of overweight/obesity was 2.1% lower (AOR 0.83 95%CI 0.67, 1.04) and abdominal obesity 1.7% higher (AOR1.35 95%CI 0.93, 1.98) in 2015 than 2010. Significant improvements in multiple weight-related behaviors were observed among children in the highest tertile of junk food consumption (AOR 0.63, 95%CI 0.50, 0.80), rewarded for good behavior with sweets (AOR 0.59, 95%CI 0.47, 0.74) and had a TV in their bedroom (AOR 0.65, 95%CI 0.43, 0.96). In 2015, children from low socioeconomic neighborhoods and non-English speaking backgrounds were generally less likely to engage in healthy weight related behaviors than children from high SES neighborhoods and from English-speaking backgrounds. Children in these demographic groups were less likely to eat breakfast daily, have high junk food intake, and eat fast food regularly. Children from rural areas tended to have healthier weight-related behaviours than children from urban areas.

Conclusions: There were significant positive changes in 5-year old children's weight-related behaviors but children from low socioeconomic neighborhoods and from non-English-speaking backgrounds were more likely to engage in unhealthy weight-related behaviors than children from high socioeconomic neighborhoods and English-speaking backgrounds. The findings indicate that there is a need to enhance population-level efforts and ensure community programs are targeted and tailored to meet different sub-population.

Strengths and limitations of this study

- Data come from two cross-sectional state population health surveys with high response rates, measured anthropometry, and validated measures of weight-related behaviours.
- Although there is no international consensus for dietary cut points which has led to considerable variation across studies, our cut points were based on dietary guidelines to represent a lower frequency or 'limiting' consumption of discretionary foods.
- Parents completed the questionnaire and may be influenced by social desirability bias given the increasing role of social media in shaping community perceptions and public discourse on obesity.

Introduction

Children who are obese during childhood are five times more likely to be obese in adulthood compared with non-obese children.[1] The evidence also shows that obesity-related behaviours including poor diet quality, decreased physical activity, increased sedentary behaviours and decreased sleep duration are established in, and track from, early childhood.[2] Together these findings suggest investment to promote healthy lifestyle behaviors during childhood may play a particularly strategic role in population obesity prevention.

Within a socio-ecological framework, the home environment exerts the most significant influence on children's acquisition of weight-related behaviours however, as children grow the early childcare setting also has an important role in the development of young children's weight-related behaviours. In 2014, in New South Wales (NSW, Australia) about 21% of <2-year-olds, 58% of 2-3 year-olds, and 44% of 4-5-year-olds attended some form of formal child-care services,[3] showing that these services are pivotal in reaching large numbers of children and their parents.

Over the past 10-15 years there has been substantial investment in NSW to reduce child obesity through a succession of state plans, policies, and programs to support the healthy development of children from birth to 5 years. The overarching strategy is a whole of government framework to encourage and support opportunities for the community to be healthy through the delivery of evidence-based, interactive, and relevant programs. These initiatives include professional development programs for the early childcare sector,[4] supported playgroups,[5] web-sites (e.g., www.healthykids.nsw.gov.au), health screening programs for 4 year olds,[6] and telephone-based support services for parents of children age 0-2 years. To date a summary of the net effects of investment in early childhood obesity prevention in NSW is yet to be examined.

There is, however, clear evidence that the distribution of child obesity is unequal across population groups. The population distribution of child obesity is higher among children from lower socioeconomic backgrounds status, internationally[7] and in Australia.[8] Similarly the prevalence of child obesity can be higher among children from culturally and linguistically diverse (CALD) communities. In 2016, almost half the Australian population were born overseas or have at least one parent born overseas and 21% spoak a language other than English at home.[9] Language spoken at home is a recognised indicator of CALD background and people who speak a non-English language at home tend to be recent immigrants who may be disadvantaged in health literacy and health care access.[10 11] These reasons underpin the importance of examining health outcomes by sub-population groups to identify whether there are any apparent or emerging health inequalities among children from disadvantaged backgrounds.

The purpose of this study was to use cross-sectional surveillance data collected in 2010 and 2015 to examine changes in weight and weight-related behaviours of children in the first year of school. The assumption is that changes in the weight and weight-related behaviors of children entering school reflects the *overall* investment in early childhood by different stakeholders through multiple programs and in different settings. We also examined weight-related behaviours by socio-demographic characteristics to identify sub-populations of children who may require greater support to change weight-related behaviours.

Methods

Data come from the 2010 and 2015 NSW Schools Physical Activity and Nutrition Survey, a representative cross-sectional population survey of weight and weight related behaviours of children age 5-16 years conducted every five years. This study examined only data from children in Kindergarten age approximately 5 years. Detailed descriptions of the survey methodology are published elsewhere.[12] Briefly, the surveys are designed to be representative of school age children in terms of type of school, residence and socioeconomic status. Sample size was based on detecting a difference of 10% in the prevalence of overweight/obesity between boys and girls within each year group, with 80% power and alpha=0.05. The surveys are school-based and use comparable sampling frames that are based on a two-stage probability sample (school and student). The probability of school selection was proportional to size of the school enrolment. Schools were sampled from each education sector (government, independent, Catholic) proportional to enrolment in that sector and all students from two randomly selected classes were invited to participate. The study protocols were comparable for each survey year and data were collected in schools by trained field teams during February–April of each survey year. Informed consent from each child's parent/carer was a requirement for participation. Ethics approvals were granted by the University of Sydney Human Research Ethics Committee, the NSW Department of Education and Training and the NSW Catholic Education Commission.

Measures

Parents completed the self-administered questionnaire for their child at home at time of consent. Socio-demographic information included the child's sex, date of birth, language spoken most often at home, and postcode of residence. Postcode of residence was used as proxy measure of socioeconomic status (SES) using the Australian Bureau of Statistics' Socioeconomic Index for Areas (SEIFA) Index of Relative Socioeconomic Disadvantage.[13] SEIFA scores from the 2011 Census were used to rank students into low, middle, and high SES neighborhoods. Postcode of residence was also used to determine residential locality using the Accessibility/Remoteness Index of Australia in 2010 and the Australian Statistical Geography Standard in 2015[14] and children were categorized as living in urban or rural areas. Language spoken most often at home was used to categorize children into English speaking or non-English speaking backgrounds.[15]

Height (m), weight (kg) and waist circumference (cm) were measured over one layer of light clothing during the school visit by field staff. Body mass index was calculated (kg/m^2) and children categorized as thin, healthy weight, overweight and obese using the International Obesity Task Force age-sex adjusted cut-points.[16] Waist-to-height ratio (WtHR), an indicator of abdominal obesity, was calculated as waist circumference (cm) divided by height (cm) and dichotomized as <0.5 or ≥0.5.[17]

Indicators of dietary intake were collected using a validated short food frequency questionnaire specifically developed for population surveillance surveys.[18] Parents reported the usual frequency their child consumed fruit, vegetables (Doesn't eat fruit/vegetables, <1serve/day, 1 serve/day, 2 serves/day, 3 serves/day, 4 serves/day, 5 serves/day, 6 or more serves/day); fried potato products, salty snack foods, snack foods, confectionery and ice cream (never/rarely, 1-2 times/week, 3-4 times/week, 5-6 times/week, 1 time/day, 2 times/day). For the analysis, fruit and vegetable intakes were dichotomized according to daily recommended serves for children age 5 years.[19] Discretionary foods (i.e., fried potato products, salty snack foods, snack foods, confectionery, ice cream) are not necessary for a healthy diet and the guidelines recommend limiting these foods.[19] For the analysis, 'limited' was defined *a priori* as less than three times a week and discretionary foods were dichotomized as <3 or ≥3 times/week. Additionally, because discretionary foods are rarely eaten in isolation we examined total consumption using a junk food intake measure (JFIM).[20]

Information on eating behaviours included the frequency of eating breakfast, eating dinner in front of the TV, and eating meals or snacks from fast-food outlets (never/rarely, <1/week, 1–2 times/week, 3–4 times/week, 5–6 times/week or every day). For the analysis, breakfast was dichotomized according to dietary guidelines as daily or not daily.[19] There is no consensus how often children should eat in dinner front of the TV or eat fast foods, however other research indicates that eating dinner in front of the TV five or more times/week is associated with poor diet quality and overweight in children[21], hence eating dinner in front of the TV was dichotomized as <5 or ≥5 times/week. Eating fast foods one or more times a week is associated with increased BMI in children[22], so we dichotomized fast-food as <1 (infrequent) or ≥1 time/week (frequent). Parents also reported how often they offered sweets to their child for good behavior (rarely/never, sometimes, or usually) and these were dichotomized for the analysis as rarely/never or sometimes/usually, based on dietary guidelines which recommend limiting discretionary foods.

Information about the home screen environment (TV, videos/DVDs, computer, smart phone, tablets, e-games) included whether their child had a TV in the bedroom (yes or no); limiting their child's screen-time (rarely/never, sometimes or usually) and these were dichotomized for the analysis as rarely/never or sometimes/usually. Time spent on screen devices was collected by questionnaire[23] and time dichotomized for the analysis according to screen-time recommendations: <2 hours/day or ≥2 hours/day. [24]

Parents reported how their child usually travelled to and from school separately for each school day, options included walk, cycle, skateboard or scooter, car, bus, train or ferry/boat. Parents could report more than one travel mode for each trip. For the analysis, children's travel modes were classified as 'inactive travelers' if driven to and from school 5-days/week and 'active travelers' if they walked, cycled, used a skateboard or scooter to travel to and from school 5-days/week. Children who used multiple transport modes to travel to and from school were classified as 'mixed travelers'. Because active travel is considered a healthy behavior and sitting time in car travel is considered less healthy, we only examined children who were active or inactive travelers.

Parents' awareness of national recommendations for children's physical activity and screen-time was assessed by two questions; *How many minutes of physical activity is it recommended that school age children do each day?* and *Up to how many hours of television, video, DVD or computer games is it recommended that school age children watch each day?* The response options were to report the time or check 'Don't know'. Parents who reported the correct times were deemed to know the recommendations and parents who reported the incorrect time or 'don't know' were classified as not knowing the recommendation. Information on the child's physical activity was collected only in 2015 using a single item question recommended for estimating physical activity in child surveys. The question was *Over the past 7 days, on how many days was your child engaged in moderate to vigorous physical activity for at least 60 minutes?*. Response categories were 0 to 7 days, with a response of 7 days indication meeting the physical activity recommendations.

Statistical analyses

Data were analyzed in June 2017 using SPSS Complex Sample Analysis (version 22 for Windows; IBM, Chicago, IL, USA) to account for the complex sampling design. Post stratification weights were calculated to account for variations in response rates, along with cluster and stratification variables to account for the complex sampling design and weighted prevalences are presented. Missing values were not replaced (<5% of data). Categorical differences between 2010 and 2015 were first assessed using chi-square statistic, and ANOVA was used for continuous variables. Logistic models were used to assess change between survey periods in weight outcomes, dietary patterns and habits, screen-time, school travel and parent's awareness of national recommendations for physical activity and screen-time. Covariates included sex, age, residence, SES tertile and language background.

Policy and decision makers require up-to-date evidence to guide the development of intervention and health promotion activities. Given the established evidence on sociodemographic differences among children's weight and weight-related behaviours, we report outcomes from the most recent survey (2015) to identify whether sub-groups of children may require greater or more targeted intervention. We examined differences between children from rural and urban residences, low and high SES neighborhoods and from non-English-speaking backgrounds and English-speaking backgrounds using logistic regression, controlling for sex. We present the odds ratios and their corresponding 95% confidence intervals for each independent variable. The significance level was set at $p \leq 0.05$.

Results

The 2010 survey comprised 1,141 children in Kindergarten from 44 schools (response rate 62%) and the 2015 survey 1,150 children in Kindergarten from 41 schools (response rate 70%). Table 1 shows there were no significant difference in the children's socio-demographic characteristics between surveys. At both survey, the majority of children were from English-speaking backgrounds and resided in urban areas. The prevalence and adjusted odds ratios of overweight, obesity, overweight-obesity combined and WtHR≥0.5, stratified by sex are presented in Table 2 and show there were no statistically significant changes between survey years. In 2015, approximately one in six children were overweight/obese and had WtHR≥0.5.

Table 3 shows there were some significant positive changes in behaviors including the lower consumption of junk food, less TVs in children's bedrooms and a higher parental awareness of children's screen-time and physical activity recommendations. Although changes were not statistically significant, the daily consumption of vegetables remained low, with less than 3% of children meeting the recommendation; 15% of children did not eat breakfast daily, one-in-five children regularly ate dinner in front of the TV and ate fast food one or more times a week. Parental awareness of the screen-time recommendation increased between surveys, yet one third of children did not meet the recommendation on school days and four in five did not meet the recommendation on weekend days. There were no changes to children's school travel.

Table 4 shows the odds ratio, adjusted for sex, for unhealthy weight-related behaviours by socio-demographic characteristics in 2015. Children residing in urban areas were less likely to meet recommended daily serves of vegetables, eat breakfast daily and to regularly eat dinner in front of the TV, than children living in rural areas. Compared with children from high SES neighborhoods, children in low SES neighborhoods were generally more than twice as likely to have a high junk food intake; not eat breakfast daily, eat fast food one or more times a week, have a TV in the bedroom, not meet screen-time recommendations on week days and be driven to and from school daily.

Children from non-English speaking backgrounds were more likely to have higher junk food consumption, not eat breakfast daily, regularly eat dinner in front of the TV and eat fast food one or more times a week, than children from English-speaking backgrounds. Parents from non-English speaking backgrounds were more than twice as likely to not know the daily recommendations for screen-time and physical activity than parents from English speaking backgrounds. Compared with children from English-speaking backgrounds, those from non-English speaking backgrounds were less likely to not meet screen-time recommendations on weekend days.

Discussion

This study shows there have been significant, positive changes in weight-related behaviours of 5-year old children between 2010 and 2015 and, although not statistically significant, the prevalences of overweight and overweight-obesity were lower in 2015, than 2010. The higher, but not statistically significant, prevalences of obesity and WtHR≥0.5 in 2015 may indicate that the degree of obesity is increasing. That is, the distribution of BMI is shifting to the right and the prevalence of morbid obesity among children may be increasing; a finding previously reported among Australian children.[25] Although based on cross-sectional data, the sample is representative of the children of NSW and these findings are promising. Understanding the drivers for the changes we observed is difficult because of the complex interacting contexts of obesity prevention. There may well be factors that were not measured such as genetic susceptibility and environmental features such as the food and physical activity environments, which may also be influencing the prevalence. In NSW there has been substantial investment in population obesity prevention since 2002[26-29] and potentially, the changes we observed in some behaviors reflect a compounding effect of continual and multiple investments over the past 10-15 years, so that the children who participated in the 2015 survey will have had greater opportunity to be exposed to obesity prevention programs, compared with the children we measured in 2010. However because of our cross-sectional design no causal relationships can be ascertained, so it cannot be determined whether deficiencies in the type/content of the program or in uptake of the program are the reason for the results.

While there were positive changes in many weight-related behaviours, the prevalence of some behaviours in 2015 remain a concern. The most notable is the very low proportion of children (2.3%) meeting the recommended intake of vegetables, indicating these children are missing the benefits of dietary vitamins, minerals and fibre.[19] This finding is consistent with national surveys [30] and other studies which have shown vegetable intake in Australian children is poor [31]. Conversely, 79% of children met recommended intake of fruit, but adherence was lower among children living in urban areas, than children living in rural areas. Potentially, national school-based fruit and vegetable programs[32] need to focus on promoting vegetables.

Children's consumption of discretionary or 'junk' foods was lower in 2015 than 2010 but the consumption of these foods remains higher than dietary guidelines recommend. Our findings are consistent with national data which estimates that more than one third of energy intake among children age 4-8 years comes from discretionary foods.[33] In 2015, the consumption of discretionary foods was higher among children living in low SES neighborhoods and children from non-English speaking backgrounds, than their peers. A recent systematic review[34] concluded that fast food outlets were more prevalent in low, than middle and high SES neighborhoods, and in areas with high concentrations of ethnic minority groups however further qualitative work is required to determine if factors other than availability influence consumption. Potential promising strategies to reduce children's junk food consumption include limiting the accessibility, availability and advertising of these foods to young children, increasing food literacy among parents, and working with the food industry to improve nutrient profiles of junk foods.[35]

Home-based eating practices associated with overweight/obesity in children include eating breakfast daily, eating dinner in front of the TV, eating snacks/meals from fast food and take-away outlets and parent's rewarding children's good behavior with sweets.[36] Eating a healthy breakfast daily (e.g., whole grains, fresh fruit/vegetables) has been linked to a decrease risk in obesity[37] better nutrient intakes,[38] and improved school attendance, which in turn may improve academic outcomes in school children,[39] yet one-in-seven children in this study did not eat breakfast daily and those children were more likely to live in urban areas, low SES neighborhoods and be from non-English speaking backgrounds.

Parental use of sweets as rewards may adversely impact on children's diet through reinforcing a child's preference and liking for sweet food rewards.[40] We found the proportion of parents using sweets as a reward for good behavior was significantly lower in 2015 which may influence caloric intake and the development of dental caries. Parents can inadvertently promote excess weight gain in childhood through role modeling food routines such as eating in front of the TV and regular consumption of fast foods that establish these behaviours as normal eating routines. One-in-five children in this study frequently ate in front of the TV and this practice was more prevalent among children living in urban areas and from non-English speaking backgrounds. We have no information on the quality of the dinners that were eaten in front of the TV, however other studies suggest children's food choices deteriorated with increased frequency of eating in front of the TV.[41] Qualitative research is required to understand cultural differences in this practice which can then inform health promotion efforts to encourage meals to be eaten without the TV on or other screen devices at a table. Consumption of fast food was two-fold higher among children from low SES neighborhoods and non-English speaking cultural backgrounds, compared with their high SES and English-speaking peers. We did not collect information on the type of fast food eaten but a recent review showed that fast food outlets are more concentrated in lower income neighbourhoods.[42] Hence efforts to reduce fast food consumption need to consider town planning and regulations on the placement of fast food outlets in communities.

Australia recommends limiting screen-time among 5-year old children to <2-hours a day,[24] yet less than one-in-seven parents in this study knew this recommendation in 2015. Therefore, it is not surprising that one third of children did not meet the recommendation on week days, increasing to four-in-five children on weekend days. Internationally, children's adherence to the screen-time recommendation are low[43] leading to debate on whether the 2-hour limit is relevant, or whether parents need assistance to adhere to the recommendation. Fewer children had a TV in the bedroom in 2015 which may reduce excessive exposure to unhealthy food advertising that targets children[41] however we were unable to ascertain if TVs were replaced with other screen devices. Ascertaining the use of LED screen devices at bedtime is important given the potential deleterious effects on children's melatonin which is associated with harmful effects on children's sleep and well-being.[44]

Ideally, children should accrue at least 60-minutes of moderate-to-vigorous physical activity daily [24] but in 2015 less than one third of parents knew the recommendation, and awareness was low among parents from non-English speaking backgrounds. Active school transport is an opportunity to increase children's daily physical activity, however three-in-five children were driven to/from school and the prevalence of passive school transport was twofold higher among children from low SES neighborhoods than children from high SES neighborhoods. We were unable to determine why children from low SES neighborhoods were more likely to be driven to school however there are a range of factors which may influence young children's active school travel, including distance, parent (and child's) perception of heavy traffic, pedestrian infrastructure, connectivity, and family time constraints.[45] These factors may have greater influence on children's active school transport in low SES neighborhoods, however Australia is increasingly becoming a car-dependent country which may influenced school commuting.[46]

Key strengths of our study include the large representative sample, high response rates, and validated measures of weight-related behaviors but there are limitations to consider. This study was a secondary analysis of two population based surveys. The sample sizes were not large enough to detect a smaller difference in the prevalence of overweight/obesity. For example, to detect 1% or 2% change that is of public health significance at a population level would require a much larger sample size. Our sampling frames were representative of NSW children in terms of type of school, residence and SES, so the findings may not necessarily be generalizable to all Australian children. Survey response rates are often considered an indicator of survey quality yet there is no scientific consensus on a minimal threshold. Response rates >60% are considered acceptable however the representativeness of the sample is potentially of more importance.[47] At age 5-years, children cannot reliably respond to a questionnaire, so parents are viewed as an appropriate alternative. The accuracy of proxy reporting is not known, but parents are potentially more strongly affected by social desirability bias which may have influenced our findings particularly given the rise in information about child obesity and the increasing role of social media in shaping community perceptions and public discourse on obesity.[48] Similarly, the potential for non-responder bias which raises the issue of whether population surveillance surveys which benefit public health should have passive rather than active consent. The lack of international consensus regarding dietary cut points has led to considerable variation across studies and our cut points were based on dietary guidelines to represent a lower frequency or 'limiting' consumption of discretionary foods. Finally, it was not feasible to objectively measure physical activity and while the validated single item question we used to assess children's physical activity is recommended for population surveys it prohibited contextual detail on type and duration of physical activities.

Conclusions

Our findings suggest here have been positive changes in the weight related behaviours of children entering their first year of school following years of child obesity prevention investment. Establishing healthy behaviours in preschool age children may off-set the challenges of changing established unhealthy behaviours in older children and adolescents. It is not possible to attribute the findings to one intervention; rather the changes reflect the sum of the many obesity prevention activities. These 5-year old children have had exposure to a range of obesity prevention programs, including state-wide interventions to up-skill the early childhood sector workforce in the delivery of healthy eating and physical activity activities. We showed that greater investment is required among families living in low SES neighborhoods and areas with high concentrations of families from non-English speaking backgrounds to reduce health inequalities in these children. Qualitative research will assist with determining the needs of families with less social and economic advantage which can then be adapted to the current intervention frameworks so that interventions are targeted and tailored to meet different sub-population needs.

Footnotes

Contributors LLH, LAB, SPG, LMW and SM had equal contributions to this paper. LLH led the writing and conducted the data analysis. LLH had full access to all of the data (including statistical reports and tables) in the study and can take full responsibility for the overall content.

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Table 1 Socio-demographic characteristics of children by survey year* (%; 95%CI)

	2010	**2015**	**p-value**
N	1,141	1,150	
Response rates (%)	62.0	69.7	
Age (years; SE)	5.35 (0.006)	5.39 (0.025)	0.079
Girls (%)	48.3 (47.6, 49.0)	50.2 (46.9, 53.5)	0.274
Residential locality			
Urban	88.5 (82.1, 92.8)	80.0 (64.6, 89.8)	0.168
Socioeconomic status (%)			
Low	30.8 (22.9, 39.9)	21.5 (11.9, 35.7)	
Middle	41.5 (28.9, 55.4)	32.0 (20.1, 46.9)	0.097
High	27.7 (22.9, 33.1)	46.5 (31.8, 61.7)	
Language background (%)			
English-speaking	85.1 (81.6, 88.0)	85.8 (79.2, 90.5)	0.838
Non-English-speaking backgrounds	14.9 (12.0, 18.4)	14.2 (9.5, 20.8)	

* Weighted percentages;

Table 2 Prevalence and change between 2010 and 2015 of overweight, obesity and waist-to-height ratio and adjusted odds ratio (AOR; 95% CI.)[a]

	Survey year		Change (%)	AOR
	2010	2015	(2010-2015)	(2010 = reference group)
All children (n)*	1,141	1,150		
Overweight (%)	13.9	11.1	-2.8	0.83 (0.67, 1.04)
Obese (%)	5.7	6.3	0.6	1.49 (0.83, 2.68)
Overweight/obese (%)	19.6	17.5	-2.1	0.83 (0.67, 1.04)
WtHR≥0.5†	14.8	16.5	1.7	1.35 (0.93, 1.98)
Girls (n)**	**551**	**577**		
Overweight (%)	15.6	12.6	-3.0	0.83 (0.60, 1.14)
Obese (%)	6.4	6.6	0.2	1.41 (0.83, 2.40)
Overweight/obese (%)	22.0	19.2	-2.8	0.98 (0.73, 1.33)
WtHR≥0.5†	16.7	18.1	1.4	1.30 (0.83, 2.03)
Boys (n)**	**590**	**573**		
Overweight (%)	12.4	9.6	-2.8	0.85 (0.51, 1.40)
Obese (%)	5.0	6.1	1.1	1.77 (0.77, 4.07)
Overweight/obese (%)	17.3	15.7	-1.6	1.11 (0.64, 1.93)
WtHR≥0.5†	13.1	14.8	1.7	1.51 (0.98, 2.32)

[a] weighted prevalences; *AOR adjusted odds ratio, adjusted for age, sex, residence, SES, and language background; **AOR adjusted odds ratio, adjusted for age, residence, SES, and language background; † WtHR = waist-to-height ratio

28 **Table 3** Prevalence of children's weight-related behaviors, by survey year (%, 95%CI)[a]

	Survey year			2010 vs 2015
Weight related behaviors	**2010 (n=1141)**	**2015 (n=1150)**	**p-value**	**AOR (95%CI)***
Dietary patterns and behaviors				
Meets recommend daily fruit serves	73.2 (69.6, 76.5)	79.0 (75.9, 81.8)	**0.013**	**1.32 (1.05, 1.65)**
Meets recommend daily vegetable serves	2.6 (2.1, 3.3)	2.3 (1.6, 3.4)	0.626	0.81 (0.49, 1.34)
Junk food intake measure (JFIM: range 0-25)				
Low tertile (range 0-5)	42.1 (38.9, 45.4)	51.6 (47.5, 55.7)		**1.58 (1.25, 2.00)**
Middle tertile (range 6-8)	33.4 (29.5, 37.4)	31.1 (28.3, 34.1)	**0.002**	0.81 (0.63, 1.03)
High tertile (range 9-25)	24.5 (23.8, 25.3)	17.3 (14.5, 20.4)		**0.63 (0.50, 0.80)**
Eats salty snacks foods ≥3/week	31.6 (30.9, 32.3)	22.7 (18.1, 28.1)	**0.003**	**0.73 (0.61, 0.87)**
Eats sweet/savory snacks foods ≥3/week	56.4 (54.9, 58.0)	49.3 (45.5, 53.1)	**0.001**	**0.72 (0.55, 0.95)**
Eats fried potato products ≥3/week	12.8 (11.0, 14.9)	7.9 (5.5, 11.1)	**0.011**	0.69 (0.43, 1.12)
Eats confectionery ≥3/week	33.3 (30.7, 36.1)	26.4 (22.9, 30.2)	**0.004**	**0.76 (0.63, 0.91)**

Weight related behaviors	Survey year 2010 (n=1141)	2015 (n=1150)	p-value	2010 vs 2015 AOR (95%CI)*
Eats ice cream/ice blocks ≥3/week	43.6 (38.8, 48.4)	31.6 (28.3, 35.0)	**<0.001**	**0.59 (0.46, 0.77)**
Eats breakfast daily	87.3 (86.2, 88.2)	84.8 (80.1, 88.5)	0.229	**0.66 (0.47, 0.90)**
Eats dinner in front of the TV ≥5/week	17.8 (16.6, 19.0)	18.3 (15.4, 21.5)	0.775	1.10 (0.88, 1.37)
Eats fast food ≥1/week	24.0 (20.9, 27.4)	20.4 (16.4, 25.2)	0.206	0.92 (0.69, 1.23)
Parent usually rewards child's good behavior with sweets	12.6 (11.7, 13.6)	7.9 (6.4, 9.8)	**<0.001**	**0.59 (0.47, 0.74)**
Screen time				
Child has TV in bedroom	21.6 (17.8, 25.8)	13.1 (9.8, 17.1)	**0.004**	**0.65 (0.43, 0.96)**
No limits on child's screen-time	8.2 (7.4, 9.0)	6.1 (4.5, 8.1)	0.057	1.28 (0.90, 1.81)
Meets ST recommendation on weekdays	64.3 (59.5, 68.9)	65.5 (61.2, 69.5)	0.72	0.91 (0.69, 1.19)
Meets ST recommendation on weekend days	21.7 (19.5, 24.0)	19.7 (17.5, 22.1)	0.246	0.84 (0.69, 1.04)
School travel (5 days/week)				
Driven to school	52.6 (41.7, 63.2)	59.8 (53.4, 65.8)	0.278	1.43 (0.85, 2.40)

	Survey year			2010 vs 2015
Weight related behaviors	**2010 (n=1141)**	**2015 (n=1150)**	**p-value**	**AOR (95%CI)***
Driven home from school	54.2 (43.7, 64.3)	57.5 (51.4, 63.5)	0.599	1.21 (0.73, 2.01)
Walked to school	19.9 (13.5, 28.2)	16.0 (11.9, 21.0)	0.372	0.76 (0.43, 1.34)
Walked home from school	18.6 (13.0, 26.0)	16.6 (12.5, 21.7)	0.622	0.83 (0.47, 1.46)
Mixed travel modes to school	19.7 (16.1, 23.9)	20.1 (17.1, 23.5)	0.886	1.03 (0.73, 1.44)
Mixed travel modes home from school	19.6 (16.0, 23.8)	20.7 (17.5, 24.3)	0.694	1.07 (0.76, 1.52)
Parental knowledge and awareness				
Knows the ST recommendation	11.1 (9.8, 12.5)	14.8 (12.4, 17.6)	**0.008**	**1.36 (1.06, 1.73)**
Knows the PA recommendation	18.5 (17.3, 19.7)	29.9 (26.2, 34.0)	**<0.001**	**1.72 (1.40, 2.10)**

[a] weighted prevalences; AOR= adjusted odds ratio, covariates = sex, residence, SES tertile, language background; ST = screen time; PA = physical activity

Table 4 The adjusted odds ratio of engaging in unhealthy weight-related behaviours in 2015 (n=1150), by socio-demographic characteristics (AOR, 95%CI)

	Residence			**Socioeconomic status**			**Language background**		
Weight related behaviours	**Urban (ref) (%)**	**Rural (%)**	**AOR (95%CI)***	**High (ref) (%)**	**Low (%)**	**AOR (95%CI)***	**English-speaking (ref) (%)**	**NESB (%)****	**AOR (95%CI)***
Dietary patterns and behaviors									
Does not meet recommend daily vegetable serves	97.8	97.0	0.73 (0.33, 1.61)	97.3	97.9	1.27 (0.40, 4.01)	97.9	96.4	0.59 (0.19, 1.83)
Does not meet recommend daily fruit serves	22.3	15.7	**0.65 (0.42, 0.98)**	21.8	20.9	0.95 (0.62, 1.47)	19.8	24.4	1.49 (0.89, 2.48)
Does not meet recommend daily vegetable serves	97.8	97.0	0.73 (0.33, 1.61)	97.3	97.9	1.27 (0.40, 4.01)	97.9	96.4	0.59 (0.19, 1.83)
JFIM -highest tertile	17.9	14.8	0.79 (0.46, 1.36)	15.5	25.2	**1.84 (1.10, 3.08)**	15.9	23.5	**1.62 (1.16, 2.28)**
Does not eat breakfast daily	16.7	9.4	**0.52 (0.30, 0.91)**	15.1	25.6	**2.88 (1.66, 5.01)**	12.2	33.3	**3.50 (2.25, 5.44)**

Weight related behaviours	**Residence** Urban (ref) (%)	Rural (%)	AOR (95%CI)*	**Socioeconomic status** High (ref) (%)	Low (%)	AOR (95%CI)*	**Language background** English-speaking (ref) (%)	NESB (%)**	AOR (95%CI)*
Eats dinner in front of the TV ≥5/week	19.9	11.8	**0.54 (0.39, 0.74)**	19.3	21.2	1.13 (0.77, 1.65)	17.1	25.4	**1.68 (1.16, 2.44)**
Eats fast food ≥1/week	20.8	19.0	0.89 (0.52, 1.55)	15.8	34.5	**2.80 (1.65, 4.77)**	18.6	30.4	**1.94 (1.28, 2.94)**
Parent usually rewards child's good behavior with sweets	8.3	6.3	0.74 (0.39, 1.40)	8.6	9.5	0.90 (0.53, 1.52)	7.6	10.0	1.38 (0.79, 2.41)
Screen time behaviours									
Child has TV in bedroom	12.9	13.6	1.06 (0.51, 2.21)	8.5	19.9	**2.69 (1.44, 5.01)**	13.5	11.3	0.82 (0.45, 1.49)
Rarely/never put limits on child's screen-time	6.0	6.5	1.10 (0.50, 2.39)	4.5	4.2	0.92 (0.47, 1.79)	6.1	5.8	0.89 (0.37, 2.16)
Does not meet ST recommendation on weekdays	34.4	35.0	1.03 (0.64, 1.64)	30.2	47.1	**2.09 (1.40, 3.11)**	34.4	36.0	1.14 (0.78, 1.66)

Weight related behaviours	Residence			Socioeconomic status			Language background		
	Urban (ref) (%)	Rural (%)	AOR (95%CI)*	High (ref) (%)	Low (%)	AOR (95%CI)*	English-speaking (ref) (%)	NESB (%)**	AOR (95%CI)*
Does not meet ST recommendation on weekend days	79.8	82.2	1.17 (0.72, 1.88)	79.3	79.8	1.04 (0.75, 1.45)	82.0	69.3	**0.52 (0.34, 0.79)**
Physical Activity									
Does not meet the PA recommendation (60 mins/day)	72.0	65.9	0.76 (0.54-1.07)	71.8	79.4	1.45 (0.87-2.39)	69.3	83.2	**1.71 (1.26-2.32)**
School travel (5days/week)									
Driven to school	59.6	60.3	1.03 (0.57, 1.87)	55.1	74.5	**2.38 (1.23, 4.61)**	58.8	66.2	1.35 (0.78, 2.36)
Driven home	57.0	59.7	1.12 (0.61, 2.06)	53.3	70.4	**2.09 (1.12, 3.89)**	56.6	63.9	1.36 (0.81, 2.30)
Active transport to school	18.3	6.6	**0.32 (0.17, 0.61)**	20.3	8.2	**0.35 (0.18, 0.69)**	15.9	17.6	1.12 (0.60, 2.08)

Weight related behaviours	Residence			Socioeconomic status			Language background		
	Urban (ref) (%)	**Rural (%)**	**AOR (95%CI)***	**High (ref) (%)**	**Low (%)**	**AOR (95%CI)***	**English-speaking (ref) (%)**	**NESB (%)****	**AOR (95%CI)***
Active transport home	19.1	6.5	**0.30 (0.16, 0.54)**	21.2	9.5	**0.39 (0.21, 0.71)**	16.2	19.8	1.29 (0.73, 2.28)
Parental awareness of health recommendations									
Does not know ST recommendation	85.4	84.1	0.91 (0.56, 1.48)	82.5	86.5	1.36 (0.86, 2.13)	83.8	91.7	**2.07 (1.08, 3.98)**
Does not know the PA recommendation	71.1	66.2	0.80 (0.55, 1.17)	67.2	75.8	1.53 (0.91, 2.57)	67.2	85.0	**2.67 (1.59, 4.48)**

33 ref = reference group; * = adjusted for sex; **NESB = non-English-speaking backgrounds; ST = screen time; PA = physical activity

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-8
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	17 (Table 1)
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	17 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	18-25 (Tables 2,3,4)
		(*b*) Report category boundaries when continuous variables were categorized	6-8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-10
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.