Watching What You Eat: a snapshot of food marketing and availability in New Zealand schools

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Abstract

Background

The increasing prevalence of childhood obesity has many implications on future health risks. Marketing of calorie–dense, nutrient-poor foods to children has been identified as a significant factor in the rise of childhood obesity. In addition, the availability of food in the environment is positively associated with intake. Few studies have objectively identified food marketing in availability in schools. This study is an analysis of objective Kids'Cam data using photos from cameras worn by children in New Zealand schools to measure the nature and content of availability and marketing of food in schools.

Method

This study is a secondary analysis of the data from the Kids'Cam Project, a unique study in which four days in the lives of 169 children aged 11–15 years were recorded using wearable automated cameras that took photographs of children's environments every seven to ten seconds. The study aims to examine the school food environment, specifically; the frequency, duration and nature of children's exposure to food and beverage marketing and availability within the school environment.

Findings

The proportion of non-core food available in a school day is approximately half of the total available (45·3% CI ± 2·9%). The results also found children from this sample were expected to experience on average 9·47 (CI ± 3·40) non-core marketing exposures in the school day. Of the non-core foods that children were exposed to, the most commonly marketed were sugary drinks (34·3% CI ± 9·3%) and snack foods (33·0% CI ± 9·0%). Children in this sample were expected to have on average 7·27 (CI ± 0·79) non-core food items available in the school day. The most common of these was snack foods (42·2% CI ± 2·9%). An additional finding of our study was an indication that Maori and Pacific children have higher exposure to non-core items in terms of both food availability and marketing.

Interpretation

The availability of non-core food and exposures to food marketing in the school in the environment are unacceptable based on comparisons with international recommendations and guidelines.

Funding

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Introduction

Globally, the prevalence of overweight and obese children has increased significantly since 1980 with around 23% of boys and girls being overweight or obese in 2013.[1] Childhood obesity has detrimental effects on future risk of cardiovascular disease, diabetes and orthopaedic problems in addition to increased social discrimination, poor self-esteem and depression.[2] It is also estimated that obese individuals have 30% higher medical costs compared to those of normal weight.[3] Under the United Nations Convention on the Rights of the Child, nations are obligated to create an environment where adequate, healthy nutrition is available in keeping with the best interests of the child.[4]

It has been unequivocally shown that food and beverage marketing have a large influence on the diets, food and brand preferences and behaviours of children and youth.[5,6] Moreover, advertising has shown a predominance for calorie-dense, nutrient deficient foods that vastly outweigh the advertising for healthy foods.[6] Limiting the exposure of children to marketing of unhealthy foods, such as sugar-sweetened beverages has been recommended by the World Health Organization as a strategy for ending childhood obesity. [7]

Food and drink consumed by children at schools forms a major part of their diet.[8] The school represents not only a potential obesogenic environment but also a setting for obesity prevention and health education.[7] Availability of foods in the environment has also been shown to have a positive association with intake and interventions targeting the availability in schools have shown promising success. [8—11]

Self-reported questionnaires have been used in quantitative studies to measure availability and accessibility of food in schools.[12,13] But there appears to be limited real time research on the nature and extent of availability and marketing of food in the school environment.

In New Zealand, Food and Nutrition Guidelines for children encourage intake of fruit and vegetables and other core foods while limiting consumption of foods with high fat and sugar,[14] yet one in three children aged 2–14 are overweight while one in nine children are considered obese.[15] This paper reports on data from Kids'Cam, innovative research[16] that uses automated cameras to objectively record the child's viewpoint every ten seconds.

The objective of this study is to analyse data from the Kids'Cam project and measure the nature and extent of availability and marketing of foods in schools. In addition, we aim to see if there is any influence by school decile and ethnicity.

Methods

This study is a secondary content analysis of the Kids'Cam Project image and GPS data (HRC Programme Grant #13/724). The Kids'Cam Project was funded to study children's exposure to food and non-alcoholic beverage marketing. We were granted ethical approval by the University of Otago Human Ethics Committee (Health) (13/220) to analyse the Kids'Cam dataset for any public health issue relevant to children. Kids'Cam participants wore automated cameras that photographed their environment every seven to ten seconds, from their perspective, allowing the researchers to objectively view their environments and day–to–day life.[16-18] Initial findings from a scoping study using the Kids'Cam Project dataset indicated that it is a rich source of objective data on children's exposure to food and non-alcoholic beverage marketing, from which to address the research questions.

Participants

Year eight children (aged 11–14·9 years, mean 12·6 years) from the Wellington region, equally distributed by ethnicity were randomly-selected to participate. Sampling for Kids'Cam was conducted in two stages. Schools were stratified into three tertile groupings: low (deciles 1–3), medium (deciles 4–7) and high (deciles 8–10). All subsequent sampling steps were performed separately for each decile grouping. Schools were selected on the basis of probability–proportional–to–size sampling methods within a given tertile. Sampling of schools was performed separately for each ethnic group (Māori, Pacific, European) in each of the three tertile groups, giving a maximum of 12 schools (four for each ethnicity) within each tertile and thus an absolute maximum of 36 schools for the entire sample. Twenty–eight schools were then approached and a total of 17 schools consented to participate in the study. Participant and parental written consent was required, with failure to provide this means for exclusion. Children who were unable to collect data and deal with the demands of the study due to disability or circumstance were also excluded. Children (n=169; M:80, F:89) were recruited from a total of 16 schools, with at least four children randomly selected from each school.

Data Collection

Participants wore an automated camera that took pictures every seven to ten seconds for four consecutive days: Thursday, Friday, Saturday and Sunday (Four participants data was collected over Friday, Saturday, Sunday and Monday). Data collection was conducted over a year long period to balance for seasonal differences.

Protocol

In this observational study, all participants' image data for Thursday was selected from the dataset and bespoke computer software developed using Django by Dublin City University (DCU; Kids'Cam collaborators) was used to code the images and produce outputs for statistical analysis (four participants data for Monday was used instead). Thursday was chosen because it was likely to reflect a typical day of exposures and consumption of food and non-alcoholic beverages. Each image was systematically examined for the wearer's exposure to food and beverage marketing and availability as per the guidelines set out in Appendix 1. Each image was first coded according to one of four settings (school, not school, tuck shop or no setting). Secondly, images were analysed for marketing and/or availability. Marketing was defined as "any form of commercial communication or message that is decided to, or has the effect of, increasing recognition, appeal and/or consumption of particular products and services",[19] and availability was defined as "When a food or drink product is clearly identified in an image. A food or drink product may only be coded once regardless of how many times it reappears in subsequent images". Marketing was coded for the medium used (e.g. product packaging, merchandise or sign) and then the product category. These categories were based on a nutrient profiling system adapted from two established profiling models.[20,21] Availability was coded according to the product category alone. Annotations were stored in a MySQL database.
Inter-coder reliability testing was conducted before annotation could be commenced, with each annotator having to achieve a minimum of 90% concurrence with model answers on a test dataset.

Statistical analysis

The statistical package "R"[22] with the plug-in ggplot2[23] was used for the data processing and statistical analysis.

Only photos with the settings "school" or "tuck shop" were used in the analysis. To account for the clustered sampling in the study initially the child-level results were combined at the cluster-level. The rate of exposure was generated by summating the total number of images with the "exposure" from a cluster (either "Core Marketing", "Non-core Marketing", "Core Availability", or Non-Core Availability"), and then dividing this number by the total number of images from a cluster. This rate of exposure was then multiplied by the number of images expected in a six hour school day, to give "encounters". Duration data was derived by considering the average length of a photo exposure to be 8 seconds, and the rules for duration coding (discussed in Appendix 1) were applied, the settings "not school" and "no setting" were considered when determining the end of a marketing exposure.

The clusters were then analysed with a factorial linear model, where the impact of ethnicity and school tertile on the number of encounters was considered independently. If the omnibus test yielded a p-value of >0.05 no further comparison between the groups was considered. If the omnibus test was significant at $p<0.05$ then comparisons were corrected for with the Bonferroni-Holm method. Graphically the data was displayed with the means and standard error with the clusters considered as independent samples, a study wide total as well as totals at the individual ethnicity and tertile were displayed.

Results

Baseline characteristics of the groups

As shown in Table 1 there is a relatively even balance of sex, age, and BMI across the tertiles and ethnicities. Of note, as expected there was a general upward trend in deprivation (measured by NZiDep) as the school tertile fell (2·2 in the least deprived schools and 4·8 in the most deprived schools).

Table 1. This table shows the distribution of the baseline characteristics of the children sampled, stratified by tertile and then by ethnicity. Both the total number of children and the numbers of clusters are included. Results are displayed as means with the lower and upper quartiles included as an indication of spread. BMI, NZiDep, and Age represent direct summations of the characteristics of the individual children within the sample. The Proportion Male is calculated first at the cluster level and then the mean and quartiles of the clusters were derived. A different approach was taken in the case of proportion male as it is a binary characteristic at the individual level.

Tertile	Children	Clusters	BMI	NZiDep	Age	Proportion Male
High	51	9	21.5 (18.0, 24.3)	2.2 (1, 3)	12.6 (12.4, 12.9)	47.1% (28.6%, 66.7%)
Medium	56	10	21.3 (17.9, 23.2)	2.6 (1, 4)	12.5 (12.3, 12.7)	50.0% (33.3%, 55.4%)
Low	62	12	22.7 (18.9, 26.5)	4.8 (2, 4)	12.6 (12.2, 12.9)	44.5% (16.7%, 57.5%)
Ethnicity	-	-	-	-	-	-
European	60	9	20.2 (17.5, 22.8)	3.7 (1, 3)	12.6 (12.4, 12.8)	56.7% (40.7%, 74.1%)
Māori	67	10	22.3 (18.7, 25.1)	3.0 (1.5, 4)	12.5 (12.1, 12.9)	43.3% (24.3%, 55.0%)
Pacific	42	12	23.9 (20.4, 26.6)	2.8 (2, 4)	12.6 (12.4, 12.9)	35.7% (17.5%, 55.4%)

Response rate

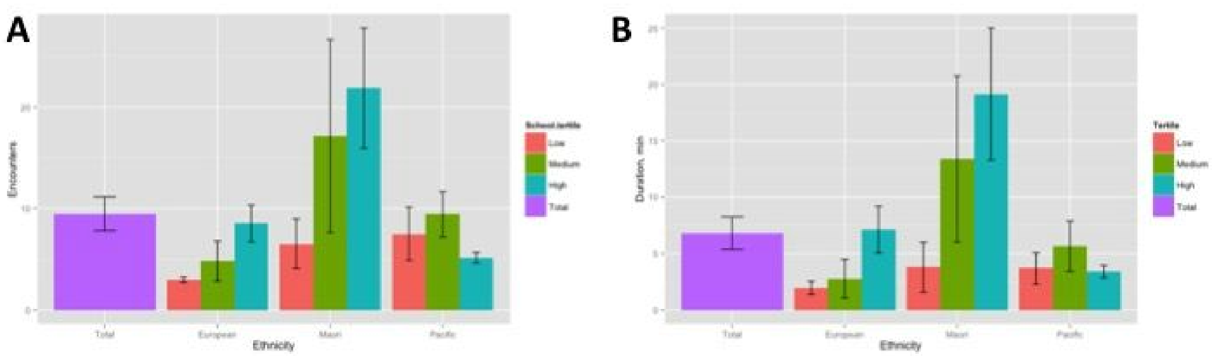
As displayed in table 2 out of the 28 schools contacted, 16 participated in the study (57%). Of all of the children and their parents asked the total participation rate was 197 out of 460 (42·8%). Of significance when the response rates in the subgroups of the study were considered they were relatively close to the total response rate (ranged from 31·5% to 58·6%). While selection bias of the overall study cohort must be considered this means that differential rates of participation between the groups are unlikely to have a substantial effect. Of those who agreed to participate 169 were chosen to take part (as described in Methods).

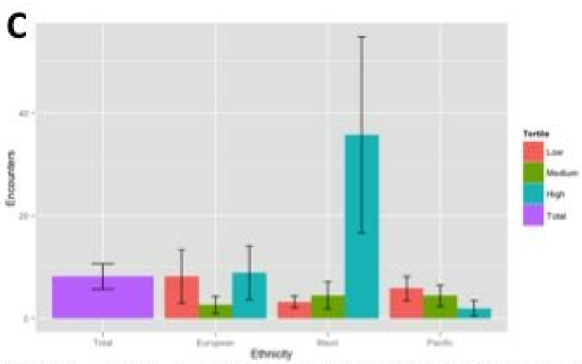
Table 2. This table shows the response rates of study participants stratified by ethnicity and tertile. In total 28 schools were contact, 16 of which agreed to participate (57.1%). From these schools 460 children were contacted, of which 197 consented (42.8%). 169 children were selected (36.7% of total children contacted).

Ethnicity	European (n=152)	Māori (n=162)	Pacific (n=146)
Consented	89 (58.6%)	62 (38.2%)	46 (31.5%)
Participated	67 (44.0%)	59 (36.4%)	43 (29.4%)
Tertile	Low (n=168)	Medium (n=152)	High (n=140)
Consented	60 (35.7%)	73 (48%)	64 (45.7%)
Participated	58 (34.5%)	59 (38.8%)	52 (37.1%)

Marketing Exposure

The exposure to non-core marketing was measured in two ways, firstly the number of "encounters" was considered as described in the methods (Figure 1A). Secondarily the duration of time, as a total, the children were exposed to marketing was determined (Figure 1B). Children in this sample were exposed to 9.47 ± 3.40 (±95% confidence interval) non-core marketing encounters per school day (6 h) with an average duration of marketing of 6.80 min ± 1.44 min per school day. A linear model found a statistically significant pattern of association in the duration of non-core marketing (*p* = 0·027) but not in the number of marketing encounters (*p* = 0·069). When individual comparisons were assessed in the duration of non-core marketing no significant associations were found once multiple comparisons were corrected for (Bonferroni-Holm correction). Core marketing was also quantified in Figure 1C. The mean exposure in this sample was 8.12 ± 5.0, with no statistically significant pattern of association (*p* = 0·027). While not statistically significant the exposure of Maori and Pacific was higher than that of NZ European for both measures of non-core marketing (Figure 1D).





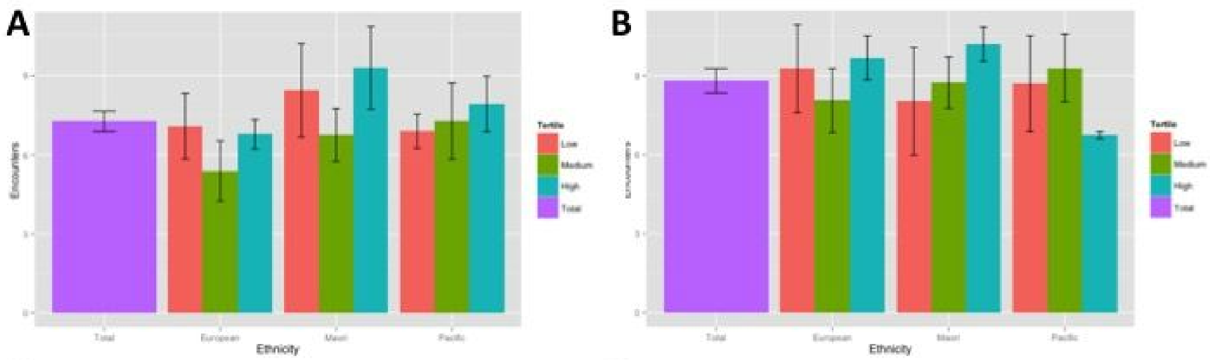
D

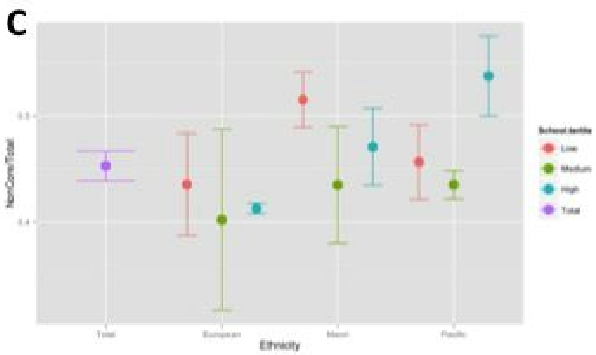
Non-core encounters	Absolute difference (± 95% CI)
Māori	9.4 ± 7.7
Pacific	3.2 ± 7.9
Low Tertile	-6.8 ± 7.8
Medium Tertile	-2.0 ± 8.1
Non-core duration	**Absolute difference (± 95% CI)**
Māori	7.8 ± 6.3
Pacific	1.4 ± 5.6
Low Tertile	-7.3 ± 6.5
Medium Tertile	-3.0 ± 6.7

Figure 1. A and B, show the number and duration of non-core marketing encounters by ethnicity and tertile. Linear modeling revealed no statistically significant differences between the groups in the number of encounters, *p* = .069, but a difference was found in the duration of exposure, *p* = .027. On direct comparison of the duration of exposure between the groups no significant differences persisted after a correction for multiple comparisons. C, shows the number of core marketing encounters, again no significant difference was found between the groups, *p* = .15. D, a table detailing the predictions from the linear model of the effect of ethnicity and tertile on non-core marketing exposure and duration. NZ European and High tertile are the reference groups. Error bars are standard error.

Food Availability

On aggregate children in this study encountered 7·27 ± 0·79 non-core foods in a school day (Figure 2A). Statistical analysis found no significant difference in the pattern of exposure to non-core food (p = 0·25). Core found was encountered 8.81 ± 0.93 times a day by children in this study (Figure 2B), no significant differences were found in the data (p = .98). Non-core food was then considered as a proportion of total food encounters, revealing that 45.3% ± 2·9% of the food children in this study encountered at school was non-core (Figure 2C). Statistical analysis again revealed no significant difference by tertile or ethnicity (p = 0·27). However, Maori and Pacific exposure to non-core food was higher than NZ Europeans both as an absolute value and as a proportion, although this was not significant (Figure 2D).





D

Non-core encounters	Absolute difference (± 95% CI)
Māori	1.7 ± 1.9
Pacific	0.9 ± 2
Low Tertile	-0.6 ± 2
Medium Tertile	-1.6 ± 2
Non-core duration	**Absolute difference (± 95% CI)**
Māori	6.1% ± 7%
Pacific	5.0% ± 7.3%
Low Tertile	0.1% ± 7.5%
Medium Tertile	-4.3% ± 7.4%

Figure 2. A and B, show the number of non-core and core food encounters respectively by ethnicity and tertile. Linear modeling revealed no statistically significant differences by ethnicity or tertile in the number of non-core or core encounters, p = .25 and p = .98. C, shows the proportion of available food that was non-core, again no significant difference was found between the groups, p = .27. D, a table detailing the predictions from the linear model of the effect of ethnicity and tertile on non-core food availability and the proportion of non-core availability of total food availability. NZ European and High tertile are the reference groups. Error bars are standard error.

Types of Non-core Products Marketed and Available
The types of non-core products marketed in schools is shown in Figure 3A (see Appendix 1 for details of the categories). The types of exposure were initially aggregated at the cluster level as previously described, then these clusters were treated as independent samples for calculating a mean and measures of spread. The most common non-core foods marketed were “Sugary Drinks and Juices” and “Snack Foods” at 34·3% ± 9·3% (±95% confidence intervals) and 33·1% ± 9·0% respectively.

A comparable analysis was carried out for non-core food availability, shown in Figure 3B. Using the same method as above the most available foods were “Snack Foods”, “Cookies, Cakes, and Pastries”, and “Sugary Drinks and Juices” at 42·2% ± 5·8%, 22·3% ± 3·2%, and 16·5% ± 1·1% (±95% confidence intervals).

School Food Policy
Schools in our sample were contacted regarding whether they had a written policy on what food should be available in schools. Three failed to answer, three did not have a written policy, and the remainder had a policy on food in schools. The presence of a food policy was added to the linear model, where it was included as an independent factor alongside ethnicity and and tertile. In this study a school food policy did not cause a detectable significant difference in either food marketing or availability (*p*-values of 0·58 and 0·40 respectively).

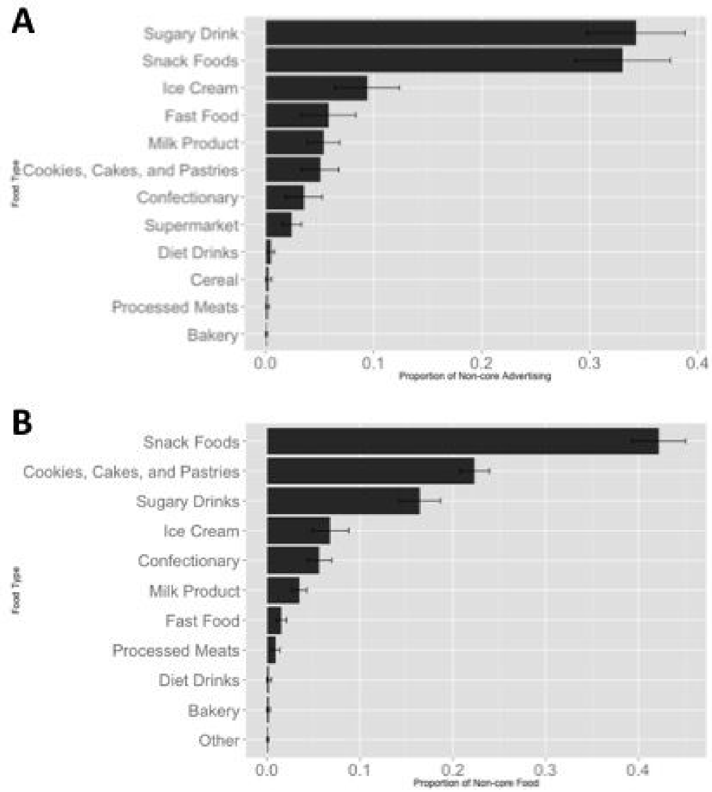


Figure 3. A shows the categories of non-core foods that are marketed in schools and sugar B shows the categories of non-core foods available. Error bars are standard error.

Discussion
This is the first study of its kind to objectively measure the school food environment. Previous studies have relied on subjective measures such as questionnaires[12,13], whereas the KidsCam project provides photographs from the perspective of New Zealand children.

The preliminary findings showed that that the proportion of non-core food available in a school day is approximately half of the total available (45·3% CI ± 2·9%). This finding does not align with New Zealand National Guidelines which recommended intake of high salt, fat and sugar foods to be limited to less that once a week.[14] In addition, this does not align with global nutrition guidelines which state that consumption of free sugars and fats should be less than 10% and 30% of total energy intake respectively.[24] These results also found children from this sample were expected to experience on average 9·47 (CI ± 3·40) non-core marketing exposures in the school day. Of the non-core foods that children were exposed to, the most commonly marketed were sugary drinks (34·3% CI ± 9·3%) and snack foods (33·0% CI ± 9·0%). The latter category encompasses items such as potato chips, muesli bars and jellies. Global WHO guidelines recommend no non-core marketing in school environments. In addition the children in this sample were expected to have on average 7·27 (CI ± 0·79) non-core food items available in the school day. The most common of these was snack foods (42·2% CI ± 2·9%). It should also be noted that core food marketing was observed but it is unclear what the significance of this is and whether it serves to offset and no-core marketing. An additional finding of our study was an indication that Maori and Pacific children have higher exposure to non-core items in terms of both food availability and marketing. While this finding was not statistically significant, it is regardless an important trend to consider, as the burden of obesity in New Zealand falls far greater on these ethnicities than NZ Europeans.

Furthermore, multiple articles in the United Nations Convention on the Rights of the Child are not met by these findings. Firstly, it states that the marketing to children of products including food and drinks high in saturated fats and sugars can have a long term impact on their health.[4] These marketing exposures should therefore be limited, but in this study made up almost 50% of the exposures. Secondly the convention states that children have the right to the provision of adequate nutritious foods and water.[4]

This study had a number of limitations. Firstly there is room for coding error between the sixteen photo annotators. Annotations of the photos was in some ways subjective. For example different users may interpret ambiguous images in different ways. Some users may have chosen to ignore unclear food or marketing while other users may have made an assumption about what to code it with. Furthermore the coders previous marketing knowledge would influence this. Secondly, coders annotated multiple children from the same school. This means that any random errors could have affected more than one child, thus altering the collective results for that school. In future studies this could be overcome by distributing children in a more random manner amongst coders.

A child's exposure to food availability and marketing during school hours is influenced by school policies. For example in a school with healthy food policies, it is plausible that these children would see more core food. Similarly, schools that receive sponsorship from food manufacturers may be exposed to more of the associated marketing. To account for this, we contacted the sixteen schools and asked about: 1) written food and drink policies in place 2) whether the school has a tuck shop and/or external lunch provider 3) rules regarding the contents of drink bottles 4) whether the school receives any sponsorship from food manufacturers. We received response from twelve of the sixteen schools and further exploration of their policies could be used in future research.

While taking photos provides an objective view of what the child is exposed to, it is possible that the child altered their behaviours and eating patterns with the knowledge that they were wearing a camera. To minimise this the children were not specifically told the research questions, but did know that it was about health and so social desirability bias cannot be excluded completely. This could be particularly relevant considering we analysed Thursday, the first day the child wore the camera.

Overall, the use of cameras is a good method to objectively measure the school environment however it is possible that exposures could be missed. The photos only provide an accurate image of what is directly in front of the child. Exposures that are further away from the camera, or not clearly visible are therefore missed, when in reality, the child can see them. The interval between photographs was set to ten seconds, however we observed some variation in this. Therefore, in cases where the frequency is decreased, data is missing.

Although our results are indicative of the NZ school environment we advise caution in generalising our results. The sixteen schools sampled are all urban and therefore the food environment may different in rural communities. Generalisability is further reduced by the fact that we only annotated one school day and cannot guarantee that this is representative of the average school week. In addition, we excluded photographs that occurred outside of the school gates and stopped coding if, for example, the child visited the dairy during lunchtime. This means that marketing and food availability exposures in these time slots are missed. This limits the amount of exposure to food availability and marketing thereby limiting statistical power. Future investigations could look at several days, or extend the day to outside of school hours.

This study also had a number of strengths. As stated above, it is the first study of its kind to objectively and directly measure the school food environment. Previous studies have relied on subjective measures such as questionnaires. The subjects involved were informed that the study was looking at health, but were unaware of the specific intentions. This partial subject blinding minimised the likelihood that the children would alter their eating habits in response to being observed. In order to ensure consistency between researchers analysing the data, each underwent an extensive and comprehensive training programme as outlined in the methods section. At the conclusion of this, each coder completed an inter reliability test as outlined in the methods section. The minimum mark achieved in the test was 90%. This mitigated some of the limitations around subjectivity and prior knowledge of branding.

When analysing the collected data, we consistently applied strategies that favoured underestimating the true exposure to food marketing. This was in order to ensure that the true prevalence of marketing in schools was guaranteed to be higher than our calculated results, and thus means that any findings will carry more weight in their influencing of future policy making decisions.

The sampling process ensured that sufficient numbers of Maori and Pacific children took part in the study. This allowed us to overcome the problem of low response rates amongst these ethnicities, and ensure we could collect relevant data about them. Although this weighting reduced the statistical power of our analysis, we felt that low response rates were a more important issue.

Given that the school food environment is not in keeping with either national or global guidelines,[14, 20] this study would suggest that policy changes regarding the school food environment are needed. Reimplementation of the National Administration Guidelines requiring schools to only provide healthy foods to children in 2008 would be a simple and effective measure to reduce the availability of unhealthy foods in NZ schools. The most common non-core food that children were exposed to was within the snack food category. This includes items such as potato chips, muesli bars and jellies, each of which usually have readily identifiable, clear product packaging. In addition to this, our finding that Maori and Pacific children experienced a higher exposure to non–core food and its associated marketing suggests that policies specifically targeting these ethnic groups could be effective in addressing the unequal distribution of obesity and its associated effects that exists in New Zealand.

As the exposures to unhealthy food we observed largely involved food brought in from home, another solution could be to implement food services within schools that provide nutritious food to children. Restrictions could be put in place to limit the foods children are allowed to bring in from home, such as placing a ban on confectionery and fizzy drinks in the school environment. Food services in the school could limit or ban snack foods and cookies and cakes as these were the two groups of non-core food with the highest exposure at 42·2% and 22·3% respectively.

As discussed in the above limitations, this study only examined one day in a child's average week. Further studies that examine exposure to food and its associated marketing across a number of school days would allow researchers to make stronger statistical statements. In addition to this, the school environment is just one setting in which children are exposed to food and marketing. The Kids'Cam project involves photos across four entire days for the children involved and so a further study involving both school and non-school exposures would give a more balanced and realistic picture of the food environment for New Zealand Children.

Conclusion

It is now accepted that children who are overweight and obese is a growing problem in New Zealand and around the world. This research provides a snapshot of the availability and marketing in the school environment. This study has provided evidence of the scale of junk food in schools with approximately half (45·3% CI ± 2·9%) of food available in schools being non-core food and an average 9·47 (CI ± 3·40) non-core marketing exposures during the course of a school day. These levels of exposure are unacceptable when compared to international guidelines published by the World Health Organization and the United Nation's. The problem of childhood obesity is not that of schools, parents, or governments alone but should be approached in a collaborative way by all of these groups.

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