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Is Food Intake Associated with Pre-Adolescent Obesity? An Observational Study in Metromanila, Philippines

[1,2]C. Gonzalez-Suarez, [2]K. Grimmer-Somers and [2]A. Worley
[1]College of Rehabilitation Sciences, University of Santo Tomas,
Espana St., Manila, Philippines
[2]International Centre for Allied Health Evidence, University of South Australia,
Adelaide, Australia

Abstract: There are reports of increasing prevalence of overweight and obesity in Asian children and adolescents. This has been linked to the increasing availability and affordability of fast foods in place of traditional diets. A well-powered sample of pre-adolescent children was randomly selected from public and private schools in Metromanila, Philippines. Their height and weight were measured using standard protocols. Body mass index was calculated and International Obesity Taskforce age-gender-specific classifications were applied to classify normal weight, overweight and obesity. Children completed a Filipino-validated version of the Health Behaviour in School Aged Children-Food Frequency Questionnaire for the previous week. Food group choices and frequency of intake were evaluated using a new weighted composite score. Prevalence of overweight and obesity in this sample was higher than the Filipino national figures. More girls than boys were classified as having normal weight. There was no age influence on food group choices; however girls ate significantly more fruit and vegetables than boys. Normal weight children consumed significantly more milk and milk products than fatter children. This is the first known report on the association between food intake and obesity in Filipino pre-adolescents, measured using a Filipino-specific rule. Understanding the relationship between food choices and childhood fatness is an important step in combating Filipino childhood obesity.

Key words: Childhood obesity, food frequency questionnaire, milk and milk products, Philippines, nutritional intake

INTRODUCTION

Childhood obesity is a precursor for adult obesity. Adult obesity is associated with high levels of chronic disease such as diabetes, heart and other vascular diseases, high blood pressure and stroke (Demerath *et al*., 2003; Freedman *et al*., 1997; Young *et al*., 2000). There have been consistent reports over the past decade in the Western world of the increasing prevalence of childhood fatness, related to lifestyle choices and changing family and community structures. The alarm raised by increasing childhood fatness has spurred remedial health promotion initiatives to increase regular exercise and eat healthier foods (Caballero *et al*., 2003; Coleman *et al*., 2005; Danielzik *et al*., 2007; Sahota *et al*., 2001).

Corresponding Author: Dr. Consuelo B. Gonzalez-Suarez, Centre for Research on Movement Science, Thomas Aquinas Research Complex, University of Santo Tomas, Espana St., Manila 1008, Philippines

Concerningly, there have been similar reports from South East (SE) Asian countries in which the prevalence of childhood overweight and obesity has gone from single-digit figures 30 years ago (Lobstein *et al*., 2004a; Sahota *et al*., 2001) to double-digit figures in the past decade (Langendijk *et al*., 2003; Zaliah *et al*., 2006; Food and Nutrition Research Institute, 2003; Lim *et al*., 2003; Irei *et al*., 2005). This highlights an urgent need to control emergent childhood obesity in SE Asia so that future generations are healthier and the impact of obesity-related adult diseases is minimized.

Childhood obesity is associated with cultural and environmental influences, which are believed to interact with biological determinants of obesity (Kumanyika, 2008). Over the past 20 years, most SE Asian countries have experienced a nutritional transition from a diet of simple, traditional, fiber rich and low fat foods, to one of more processed foods, hydrogenated fats, simple sugars and animal sourced foods (Popkin *et al*., 2002). This correlates with economic transition, in which a country shifts from its traditional economy (generally agricultural) to one which is more industry-based, with increasing internationalization and commercialization of the food trade. In the Philippines, the economic transition has been evidenced by a marked change in metropolitan eating habits, from traditional rice, meat, fish, vegetables and fruit to a more Western diet of manufactured foods containing higher fats and sugars (Espiritu, 2005).

There has been increasing international research into food intake and obesity, however equivocal associations have been consistently reported between eating different types of food and adult and child obesity. An example is the unclear association between soft (fizzy) drinks and obesity, where there are positive reports of association (St-Onge *et al*., 2003; Ludwig *et al*., 2001; Mrdjenovic and Levitsky, 2003) and studies reporting no association (Novotny *et al*., 2004; Berkey *et al*., 2004). Methodological differences underpin these contradictions, for instance variable definitions, sampling frames, sample sizes and methods of recording measures of intake. Thus, it remains unclear what the food intake correlates are for childhood obesity.

Most studies of children's nutritional choices and eating behaviors have used either a food recall or a food frequency questionnaire. Both methods can be flawed. Food recall incurs recall bias (Biro *et al*., 2002) as young participants often have difficulty remembering the kinds of food eaten within one to three days. This is more pronounced in children younger than 10 years (Prochaska *et al*., 2001; Vereecken and Maes, 2003). Children who are overweight are also likely to under-report the food that they consume (Heitmann and Lissner, 1995; Lobstein *et al*., 2004a; Newby, 2007). A food frequency questionnaire only records when a certain food is consumed within a given time period and does not measure the amount eaten, or portion size. For instance, Janssen *et al*. (2005) found that the frequency of sweets intake was lower in overweight than normal weight children. They explained that this may be due to underreporting by overweight children and the possibility of children eating sweets less often, but in larger quantities. Quantifying the amount of food eaten by children is also difficult. There are many ways of quantifying food portions, such as comparing them to objects of varying sizes such as a match box, tennis ball, palm of the hand, cups and bottles (Biro *et al*., 2002). However, children have different perceptions of the size of these objects, leading to unreliable estimates of the amount of food they have eaten. Food preparation (for instance steaming, boiling, frying, or baking) may also contribute to variation in energy intake, energy density and macronutrient composition, modifying the effect of food on body weight (Tohill *et al*., 2004). To date, this has not been well considered in research.

This study reports on the prevalence of overweight and obesity in a sample of metropolitan Filipino pre-adolescents and the association between fatness and food type choices.

MATERIALS AND METHODS

Ethical Approval

Provided by the University of South Australia Human Research Ethics Committee and the National Institutes of Health-Ethical Review Board.

Study Design

A cross-sectional observational study design was the most feasible way in which to capture current food intake related to children's current overweight and/or obese status. We assumed that recent reports of usual food intake could be considered as a proxy measure for usual eating behaviors.

Study Population

Randomly-selected Filipino 11-12 year old children attending public or private schools in San Juan, Metromanila, Philippines during 2006. All 11-12 year old children were eligible to participate if they were at school on the day of testing. Adolescents are considered to be between 10-19 years, however we nominated 11-12 year olds as pre-adolescent as they were classified in the Philippines as elementary school attendees, pre-teenage (World Health Organization, 2009).

Sample Size

Students were best captured in their school class, thus classes were the unit of randomization, rather than individual children. Therefore cluster effects (correlations within similar groups of students) were taken into account when calculating sample size. There was an estimated population of 2,300 boys and 2,300 girls (total 4,600) aged 11-12 years in the sixteen elementary schools (eight private and eight public) in San Juan in Metromanila in 2006. A conservative prevalence of 6.7% for overweight and obesity was estimated on current SE Asian literature (Langendijk *et al*., 2003; Zalilah *et al*., 2006; Food and Nutrition Research Institute, 2003; Lim *et al*., 2003; Irei *et al*., 2005) with a worst acceptable prevalence of 13.3% (α = 5%, power = 80%). Class clusters were assumed to be correlated in effect (ICC = 0.5), thus the computed design effect was 7.87 (calculated using formulae by Lohr (1999)). On this basis, the minimum study sample was 308.

Sample Selection

All 16 elementary schools (eight private and eight public elementary schools) in the San Juan district, Metromanila were invited to participate in the study and five private schools (62.5% response) and four public schools (50% response) agreed. Children attending these schools reflected mixed-race Asian, including Filipino, Chinese, Malay and Spanish ethnicity. After collating a list of names from the Grade 5 and 6 class lists of consenting schools (reflecting 11 and 12 year olds), 610 children were invited to participate by letters sent to parents by school principals.

Investigators

The research team comprised interns at the College of Rehabilitation Medicine, University of Santo Tomas lead by CG-S. Investigators underwent a rigorous training program prior to data collection and were required to demonstrate consistency in repeated measures of children's height and weight before working on the study.

Table 1: List of foods provided in the Filipino-modified World Health Organization Cross National Health Behaviour of School aged Children (HBSC)

No.	Provided food	No.	Provided food
1	Fruits	9	Cheese
2	Vegetables	10	Milk products
3	Cereals	11	Potato chips or other chips
4	White bread pandesal	12	French fries
5	Rice	13	Candies or chocolate
6	Wheat bread, brown rice	14	Soft drinks
7	Skimmed milk	15	Hamburger, hot dogs
8	Whole fat milk	16	Cakes or pastries

Overweight and Obesity

Weight was measured with children in light weight sports clothes as agreed with their school principal, without shoes using an electronic weighing scale (Asuki Electronic Scales Ltd, Japan) recorded to the nearest ±0.05 kg. Height was measured using a stadiometer (Detecto) to the nearest ±0.01 centimeter. Body Mass Index (BMI) was calculated using the formula: weight (kg) divided by height (m)^2. Overweight and obesity cut-offs were applied using age and gender-specific BMI cut-off points set by the International Obesity Taskforce (IOTF) (Cole *et al*., 2000).

Food Intake

Food intake was measured using the Filipino-modified and validated Food Frequency Questionnaire (FFQ) from Question 19 of the World Health Organization Cross National Health Behaviour of School Aged Children (HBSC) (Inchley *et al*., 2001). The parent FFQ has 16 questions, each with seven response categories, asking respondents in the past week how frequently they consumed different types of foods. Responses range from never (scored as 0) to more than once per day (scored as 7). It has sound psychometric properties and is widely used internationally. Filipino foods replaced Western examples in the culturally-modified questionnaire (Gonzalez-Suarez and Grimmer-Somers, 2008). An example of food substitution was complex carbohydrate foods, where rice and pandesal replaced the Western example of bread and potatoes. The Filipino foods in the 16 food categories are outlined in Table 1.

Analysis of Food Intake

Using the HBSC-FFQ, food intake is usually calculated by summing the ordinal scores to the 16 questions. However, this approach is simplistic and provides little information about the balance of foods in the diet, as children could obtain the same score if they ate good foods with low frequency and bad foods with high frequency, or vice versa. To overcome this, a novel approach was developed to specify the relationship between obesity and broad food-group intake, using a generalized linear modeling approach described by McCullagh and Nelder (1983) and operationalized by D'Espaignet *et al*. (1990).

Step 1

Allocated children to high or low fatness status, using a binary division of BMI (21), underpinned by the IOTF classifications of normal and overweight children aged 11-12 years (Lobstein *et al*., 2004a,b).

Step 2

Considered each child's food intake in the main food groups of the food pyramid (Speck *et al*., 2001). The frequency of intake of each main food-group was summed and reported as equal interval scores.

Table 2: Components of each food group and their intake descriptor

Food group	Component items	Intake descriptor	Active binary division (1)	Comparison binary division (0)
Milk and milk products	Skim milk, full cream milk, cheese and other milk products	Once per day for each food choice (possible total intake = 28)	1 = Greater than 20	0 = Equal to, or less than 20
High sugars and fats	Chips, soft drinks etc.	No more than once a week (possible total = 42)	1 = Less than, or equal to 18	0 = Greater than 18
Fiber-rich food	Rice, cereals, bread	At least 5-6 days per week (possible total 14)	1 = Equal to, or greater than 10	0 = Less than 10
Fruit and vegetables	Any	At least once a day every day (possible total 14)	1 = Equal to, or greater than 12	0 = Less than 12

Step 3

Placed binary divisions in the scores for food-group frequency of intake on *a priori* grounds, where 1 indicated desirable intake of each food group (Table 2).

Step 4

Univariate logistic regression models were developed to test associations between the BMI categories and the binary divisions of each food group score. The probability that good consumption of each food group was associated with high BMI was reported as Odds Ratios (OR) (95% Confidence Intervals [CI]). Where the 95% CI did not encompass 1, the association was significant ($p<0.05$).

Step 5

A multivariate stepwise logistic regression predictor model was constructed to incorporate all food groups, based on the strength of their univariate associations. Low intake of the high fat, high sugar food group was the default comparator. This model weighted the importance of frequency of intake of each food group with respect to individual probability of having a high BMI. Using the log Odds Ratios (weightings) produced by this model, a new equal interval outcome variable was constructed, which weighted individual intake of the food groups. Thus a child who had high intake of milk and milk products, low intake of high sugars and high fats, a high intake of fiber-rich foods and a high intake of fruit and vegetables would have a food intake score predicted by the equation:

$$\text{Food intake score} = A+B_1*1+B_2*1+B_3*1+B_0*0$$

Where:

A = Intercept
B0 = The default value of 0 applied to high fat, high sugar foods
B1 = Milk and milk product intake
B2 = Fruits and vegetable
B3 = Fiber rich food. B0-3 are the food-group-specific parameter estimates (weightings) from the multivariate regression equation

To assist in ready application of this scoring system, the intercept (A) was set at 0 and all food group weightings were multiplied by 100. Thus, the default category (low intake of high fats, high sugar foods) was scored 100 (1*100) and so on.

Statistical Analysis

SAS Version 8.2 was used for the calculation of the new food group intake score and all comparative analyses. On an assumption of non-normal distribution, median and 25th-75th% values described the frequency of age, height, weight, BMI, waist circumference and scores for intake of different food groups. Percentages (95% confidence intervals) described the prevalence of fatness categories (IOTF overweight and obesity classifications). The Kruskall-Wallis test for non-parametric data was applied to determine significant differences between groups. The differences of food intake for girls and boys aged 11 and 12 years in fatness categories was analyzed using Analysis of Variance models. In all instances, significance was set at $p<0.05$.

RESULTS

Sample

The response rate was 62.3% (380 children recruited). This exceeded the minimum estimated sample size (308) with a sampling error of approximating 5%. No child was excluded from testing.

Subject Profile

Table 3 reports subject profiles. Girls and boys had similar characteristics except for height (where the girls were significantly taller ($p<0.05$) than boys). The food-group intake scores were similar for boys and girls, except for intake of fruits and vegetables, which was significantly higher for girls than boys ($p<0.05$).

Measures of Fatness

Overall, the prevalence of obesity was 8.7% and overweight was 18.7%. The prevalence of overweight and obesity by gender is reported in Fig. 1. In the 11 year olds, a smaller percentage of girls than boys were overweight (15.7% (95% CI: 8.9, 22.6) vs. 25.5% (95% CI: 16.9, 34.1)) and obese (9.3% (95% CI: 3.8, 14.7) vs. 13.3% (95% CI: 6.6, 20.0)). While this trend continued for obese 12 year old boys (4.8% (95% CI: 0.7, 8.9) vs. 7.2% (95% CI: 1.1, 13.4)), it was reversed for overweight, with a larger percentage of girls than boys being overweight (18.1% (95% CI: 10.7, 25.5) vs. 14.5% (95% CI: 6.2, 22.9). However, there was no significant difference between the percentage of overweight and obesity for age groups of the different genders. The prevalence of overweight and obesity in the sample population was higher compared to the national survey conducted by the Food and Nutrition Research Institute (2003) which was 4.9% for children aged 11-12 years.

Table 3: Subject profile: anthropometric measures and food scores (Median scores (25th-75th%))

Parameters	Males (n = 167)	Females (n = 213)	Significance
Weight (kg)	39.45 (32.65, 47.20)	40.1 (33.95, 48.40)	NS
Height (m)	1.45 (1.38, 1.53)	1.48 (1.42, 1.55)	$p<0.05$
BMI (kg m^{-2})	18.3 (16.06, 21.40)	18.3 (16.22, 21.10)	NS
Waist circumference (cm)	65.0 (59.0, 75.5)	65.0 (59.0, 71.5)	NS
Food scores			
Fruits and vegetables	8 (6,9)	9 (15,24)	$p<0.05$
Fibre rich food	11 (9,12)	11 (9,12)	NS
Calcium rich food	13 (10,17)	13 (10,20)	NS
High sugar, high fat	20 (16,25)	19 (15,24)	NS

NS: Not significant

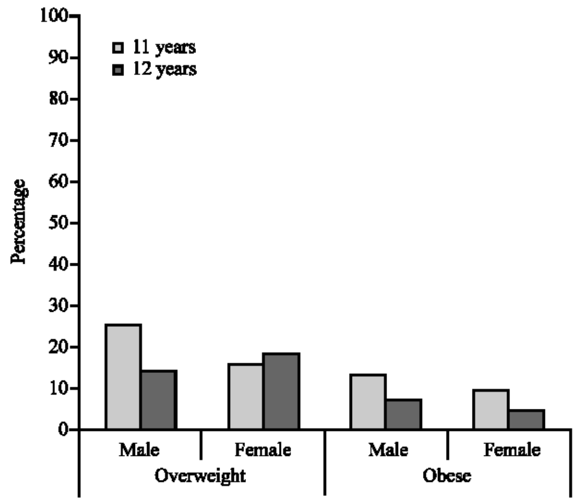

Fig. 1: Relative percentages of girls and boys in overweight and obese classifications

Table 4: Median food frequency scores (25th-75th%) for the food categories for normal, overweight and obese children

Categories	Normal (n = 276)	Overweight (n = 71)	Obese (n = 33)	p-value
Milk and milk products	13 (10,18)	13 (10,17)	11 (7,13)	p<0.005
Fats and sugars	20 (16,25)	20 (15,25)	17 (14,21)	NS
Fruits and vegetables	8 (6.5,10)	8 (7,10)	8 (9,12)	NS
Fiber rich foods	11 (9,12)	11 (7,10)	10 (9,12)	NS

NS: Not significant

Table 5: Univariate odds ratios of food intake and BMI>21 compared to normal BMI

Food categories	Odds ratio (95% CI)
High intake fats, sugars (default comparison)	OR 1
High milk and milk products intake	OR 0.4 (95% CI 0.2-0.9)
High intake of fruit and vegetables	OR 1.1 (95% CI 0.6-2.0)
High intake fiber rich foods	OR 1.1 (95% CI 0.7-1.9)

Food Categories and BMI Classifications

Applying the usual method of calculating food intake scores from the FFQ, there was no significant difference in the median scores for children in the normal, overweight and obese categories regarding the frequency of consumption of fats and sugars, fruit and vegetables and fiber-rich foods (Table 4). Children within categories of normal or overweight BMI consumed significantly more milk and milk products compared with obese children.

Predicting High BMI from Univariate Models of Food Intake

High intake of milk and milk products was significantly protective of a BMI >21, compared with high fats, high sugar intake. Fruit and vegetable intake and fiber-rich food intake was not significantly associated with high BMI. The OR and 95% CI are listed in Table 5.

New Food Score Calculation

The adjusted intercept and the probability estimates from the new predictive food-intake model were:

Table 6: Median score new food frequency classification (25th-75th%) for normal, overweight and obese children

	Normal (n = 276)	Overweight (n = 71)	Obese (n = 33)	p-value
New food score	13 (0,100)	13 (13,113)	32 (13,113)	$p<0.05$

Probability of BMI >21 = 0 + (-87)*high milk and milk products (1,0) intake + 13*high fiber-rich food intake (1,0) + 6*high intake of fruits and vegetables (1,0) + 100*high intake of high fats, high sugars (1,0)

The weighted per-child food intake score from this model had a median value of 13 (25th-75th% range 0-18). Thus for a child who ate less than the median intake of milk and milk products (score = [-87]*0), a fiber-rich food intake greater than the median (13*1), less than the median score for fruits and vegetables (6*0) and above the median value of sugars and fats (100*1), their food intake score would be 113, which placed the child in the at-risk category for obesity. There was a significant difference in the new food intake score for classifications of normal, overweight and obese children, with the obese children obtaining the highest median score of 32 (25th-75th% range, 13 -113) ($p<0.05$). The median values of the new food intake variables (25th%, 75th%) are reported in Table 6, for normal, overweight and obese children.

DISCUSSION

This study provides the first known information into food choices and fatness in Filipino pre-adolescent children and presents a novel way of considering food group choices relative to the food pyramid and to obesity. Overweight and obesity had a higher prevalence for both boys and girls than the national figures published five years earlier (Food and Nutrition Research Institute, 2003). It was also higher than a study in a similar geographic area in Cebu 6 years earlier (Lim *et al.*, 2003) (4% overweight and 2.7% obese vs. 8.7% overweight and 8.7% obese). The increased prevalence identified in this study thus validates the importance of this research and the need to understand the relationship between food choices and increasing fatness.

This study reports the importance of milk and milk products in the debate about fatness. These findings were similar to those of Kelishadi *et al.* (2007) and Barba *et al.* (2005), which reported an inversely proportional relationship between the frequency of dairy product consumption and BMI. In addition, a longitudinal study by Moore *et al.* (2006) showed that children who had the lowest tertile of dairy intake during preschool (less than 1.24 servings/day and 1.70 servings/day for girls and boys, respectively) had significantly higher gains in BMI (approximately two units higher) and an extra 25 mm increase in subcutaneous fat in early adolescence. However, other studies have shown no association between milk intake and BMI (Newby *et al.*, 2004; Venti *et al.*, 2005).

Dairy foods may influence weight gain using different mechanisms (Huang and McCrory, 2005). Dietary calcium reduces 1,25 dihydroxyvitamin D activity and intracellular resulting, which decreases the fatty acid synthase transcription in adipocytes and decreases the insulin secretion by the pancreas. This results in reduction in lipogenesis, which could enhance lipolysis resulting into a net fat loss (Zennel and Miller, 2004). The whey fraction of milk has a strong angiotensin converting enzyme inhibitory activity which prevents the conversion of angiotensin I to angiotensin II. Angiotensin II causes arteriole constriction and adipocyte lipogenesis. With a decrease in angiotensin II, there is an inhibition of fat deposition and lowering of blood pressure (Pihlanto-Leppala *et al.*, 2000; Mullally *et al.*, 1997). On the other hand, milk has the hormone estrone which has been found to increase body weight among Zucker rats (Remesar *et al.*, 1999), thus the effect of milk and milk products on fat deposition in pre-adolescent Filipino children requires further investigation.

The lack of association between BMI and the remaining broad food groups mirrors equivocal findings from other studies (Field *et al.*, 2003; Kelishadi *et al.*, 2003; Baric *et al.*, 2001; Munoz *et al.*, 1997; Newby *et al.*, 2003; Hanley *et al.*, 2000). This highlights the need for standardization of methodology and data capture methods regarding portion size, frequency of intake and food definitions.

Although not significant, this study showed a lower median score for intake of fats and sugar for children who are obese. This is consistent with other researches (Newby, 2007; Maillard *et al.*, 2000). In the past three decades in the United States, there has been a decreasing trend in the intake of the percentage of calories from fat, with an increasing trend of the intake of carbohydrates from refined grained products and a higher prevalence of childhood obesity (Janssen *et al.*, 2005; Slyper, 2004). Because of this, Slyper (2004) concluded that childhood obesity was related more to the higher intake of simple sugars, rather than an increase in fatty food intake. Furthermore, Berkey *et al.* (2000) found that after one year, there was no relationship regarding change in BMI and dietary fat in children aged 9-14 years.

The possibility of under-reporting food intake by overweight or obese children in our sample should be considered in light of findings of other studies (Ventura *et al.*, 2006; McPerson *et al.*, 2000; Westerterp and Goris, 2002; Kaskoun *et al.*, 1994). Children who under-report food intake usually have a higher weight status compared to plausible reporters and over-reporters (Lobstein *et al.*, 2004a, b; Heitmann and Lissner, 1995; Newby, 2007). Under-reporters tend to be selective of the food groups that they under-report (usually those with higher energy density and lower nutrient density). This may account for the lack of difference in our findings regarding intake of high fat and high sugar foods.

This study reported a novel way of analyzing food group intake from the FFQ to surmount its scoring limitations. The new approach weights the food choices by the importance of the food groups and provides a more sophisticated method of calculating food intake than simply summing up the category frequencies. This new scoring method provides researchers with the opportunity to evaluate individual children's food choices and intake in terms of their BMI, their broad food group choices and the physiological actions of different food groups with respect to weight gain for pre-adolescents. However, there is a continuing limitation of the Filipino-modified FFQ instrument which was not overcome by this analysis, in that the questionnaire does not collect information on portions. Thus, the lack of difference in food frequency intake of different food groups by different weight children may actually be masked by differences in portion sizes. Future studies should attempt to capture the amount of food eaten, as well as its type and frequency, in order to better understand the association between food intake and pre-adolescent overweight and obesity.

CONCLUSION

This study reports a higher than expected prevalence of overweight and obesity in mixed-race Asian pre-adolescent children living in metropolitan Metromanila. The high power of the sample, the defined geographic subregion of the study and the random sampling frame makes the findings externalizable to other pre-adolescent mixed-race Asian children living in metropolitan regions in the Philippines. Children who regularly ate a variety of milk and milk products were protected from being overweight or obese, despite the amounts and types of other foods that they ate. No other food group was strongly associated with overweight and obesity. The potential for under-reporting of food type and frequency and the lack of detail on food portions provided by the Filipino-modified survey instrument (FFQ) precludes a clear understanding of food choice predictors of high BMI in Filipino children. The weighted food choice model provides a new approach to using food frequency recall in the past week to predict the likelihood of high BMI for individual children in clinical and research settings.

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