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Socio-cognitive and nutritional factors associated with body mass index in children and adolescents: possibilities for childhood obesity prevention

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Abstract

A large national study of schoolchildren aged 6–18 years was conducted to assess nutritional and socio-cognitive factors associated with body mass index (BMI). A questionnaire was used to assess nutritional quality of breakfast, importance of physical activity and food variety score, among 4441 students from randomly selected schools in all states and territories of Australia between September and December 2000. Height and weight were measured. Nutritional knowledge, dietary self-efficacy and dietary locus of control were also assessed among adolescents. School socio-economic status (SES) was derived from parental income. The factors were modelled using multiple linear regression to determine significant predictors of BMI. Dietary self-efficacy, nutritional quality of breakfast and SES were found to be the principal predictors of BMI in addition to the expected biological factors of age, gender and height. Furthermore, low SES was found to contribute to high BMI, mediated by the low nutritional quality of breakfast. Food variety was positively associated with high BMI and this was mediated by dietary self-efficacy. Nutrition knowledge and dietary locus of control were not associated with BMI. These results suggest that breakfast programmes for low-income children may be an effective measure in the prevention of childhood obesity.

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Introduction

Child obesity prevention is developing as one of the most important contemporary issues in health education today and it is particularly relevant to school-based health education. Child obesity has increased significantly over the past 3 decades and this global trend shows no signs of abating in the near future. Health educators including health education bureaucrats, school staff, teachers, community health educators, nurses and nutritionists are currently being asked to become involved in child overweight prevention programmes [1], yet many remain largely uninformed of the most relevant and effective areas to target in health and nutrition education for weight control.

An analysis of the most salient socio-cognitive and nutritional factors associated with obesity in children and adolescents would assist health educators in the design and implementation of health education programmes aimed at child obesity prevention. Socio-cognitive and nutritional factors and theoretical propositions behind them are reviewed here, including dietary choice and food variety, breakfast quality and consumption patterns, nutritional knowledge, dietary self-efficacy, dietary locus of control and the impact of socio-economic status (SES) upon these factors. Data on these factors are available as part of a large, national survey of nutrition and health among Australian schoolchildren, providing an opportunity for empirical study of the relationships between them and body mass index (BMI).

Poor dietary choices, including high consumption of soft drinks, sweets, snack foods, take-away

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foods and large food portions have been associated with a high BMI in adults, children and adolescents [2]. In particular, regularly missing breakfast [3, 4] and poor nutritional quality of breakfast [5, 6] have both been shown to be associated with higher BMI and overweight particularly among adolescents and this trend increases with age [4, 7].

Studies of the relationship between nutritional knowledge and body weight have been mostly undertaken among adults and the majority of studies has not found a strong relationship between these two variables [8, 9]. A recent study of obese and non-obese children and adolescents aged 8–15 years [10] found no relationship between the degree of overweight and the children's nutrition knowledge and concluded that the 'similar nutritional knowledge of obese and non obese children points to genesis of obesity in childhood not caused by lack of knowledge' [10]. Similar results were found by Thakur and D'Amico [11] in their study of obese and non-obese 9th–12th grade adolescents in the United States.

Other studies largely from Western countries, such as the United Kingdom, the United States and Australia, have found an association between the weight, BMI and risk of overweight among adults, children and adolescents and SES [4, 12, 13]. A large study of 1131 Australian schoolchildren found a strong association between low SES and overweight in both boys and girls and this trend was most pronounced in the 12- to19-year age groups [5]. In that study, adolescents of low SES were more likely than their middle or high SES peers to be overweight and to skip breakfast, suggesting an important interaction between these two variables in adolescents.

While no studies of which the authors are aware of to date have reported a relationship between dietary self-efficacy, dietary locus of control and weight status in children or adolescents, several studies have reported these two variables as being of importance to other factors known to effect weight status, including healthy eating for weight loss [14], self-care behaviours [15], physical activity and dietary fat reduction [16]. The study of Gracey *et al*. [17] found dietary self-efficacy and locus of control were positively associated with adolescents' self-reported behaviour to eat healthy foods.

The design of the current study is informed by the Social Cognitive Theory [18] and the Theory of Planned Behaviour [19, 20] which postulate that people will engage in health behaviours if they have the necessary skills and the capability of performing the tasks required to undertake the behaviour. In this study, we postulate that self-efficacy related to the child's ability to select a healthy diet will largely influence their actual body weight. In other words, if the students feel able to select a healthy diet, and if they have access to a healthy diet, their risk of overweight ought to be lower than those who feel unskilled in choosing healthy foods and drinks. Similarly, the theoretical approach encompassing locus of control emphasizes the importance of how a person perceives their internal control over food selection.

Social Cognitive Theory also posits that we need to examine and understand the relationships between the participant's actual behaviours, personal factors and cognitions and environmental influences in order to change their behaviour. Hence, in keeping with this theoretical framework, we investigate the association and interaction between the students' BMI and their nutritional behaviours (breakfast consumption patterns, nutritional quality of breakfast, food variety), personal factors and cognitions (nutritional knowledge, dietary self-efficacy, dietary locus of control, age, gender) and environmental factors (SES).

The aim of the current study was to examine the socio-cognitive and nutritional factors associated with BMI in children and adolescents and to specifically examine the associations and interactions between BMI and nutritional knowledge, dietary self-efficacy, dietary locus of control, food variety, breakfast consumption and SES.

Methods

A large-scale, national, cross-sectional survey of Australian children and adolescents was conducted utilizing questionnaire data and anthropometric measurement.

Study design and participants

Children in school years 2–12 (aged 6–18 years) participated from schools randomly selected from lists of all state and territory's schools in Australia in September–December 2000. Public (Government), Private and Catholic schools, in both rural and urban areas were represented. Two of the originally invited schools were unable to participate due to time constraints. Schools were categorized as being of low or middle/high SES based on a direct federal government measurement of parental income [21].

Parental consent was obtained and the study protocol was approved by the Human Ethics Committee. Written approval was also obtained from the research section of each of the eight states and territory Departments of Education and from the school principals.

A pilot study to examine the reading level, content validity and face validity of the questionnaire was conducted among 383 students aged 6–18 years at five randomly selected schools prior to the main study. Minor changes to clarify and simplify the language of the questionnaire were implemented.

Instruments

A questionnaire was used to assess nutritional quality of breakfast, importance of physical activity and food variety score. Height and weight were measured. Nutritional knowledge, dietary self-efficacy and dietary locus of control were also assessed among adolescents. Demographic questions assessed student's age (in years and months), gender and school year; and SES was based on the school's determination of total parental income after having all families complete an income assessment [21]. Schools with total parental income in the lowest 20% of each state are classified nationally as low-income, 'disadvantaged' schools. Students at these schools are categorized as low SES and other students are categorized as middle/high SES.

Height and weight were measured without shoes and in light summer school uniform in a private room by the first author and trained research assistants. Height was measured to the nearest 0.5 cm using a portable stadiometer. Weight was measured to the nearest 0.1 kg using portable Soenle digital scales with a range of 0–200 kg. BMI was calculated from the students' height and weight. The BMI of children in our study ranges from 12–42 in keeping with the normal range findings from other studies. A greater BMI value indicates a greater tendency towards overweight, depending on the child's gender, age, height and stage of pubertal development. In the current study, BMI was used in analyses as a continuous variable to indicate a tendency towards overweight after controlling for gender, age and height. Overweight and obesity were defined using the international standard [22].

Nutritional knowledge was measured using an eight-item multiple choice nutritional knowledge test previously developed and described in detail by Gracey *et al*. [17]. The eight test questions ask students to identify foods that are high in fat, carbohydrate, dietary fibre and iron and also ask students to choose the lowest fat take-away and home-cooked meal choices and low fat snacks from a varied selection of possible choices. The nutritional knowledge score was calculated from the eight questions with a possible total score of 40. Internal reliability for this scale was high in both the pilot test ($\alpha = 0.83$) and in the main study ($\alpha = 0.89$).

Dietary self-efficacy was measured using an 11-item scale [17], with a five-point Likert scale ranging from 'not confident at all' (1) to 'very confident' (5). Questions included how confident the student felt they were at choosing healthy foods and drinks when bored, sad or tense; when eating with friends, family, alone, in a hurry or when eating take-away foods; when someone else eats unhealthy foods in from of them. Students were also asked to report how confident they were that they could eat smaller food portions, eat a healthy school lunch from home, use low fat milk and cut down on fried or fatty foods like chips and meat pies. The self-efficacy score was derived from the 11-item scale to produce a score out of 5 with a high score indicating high self-efficacy related to healthy eating. Internal reliability coefficients for this scale were high ($\alpha = 0.87$) in the pilot study and high ($\alpha = 0.90$) in the main study.

Dietary locus of control [17] was measured using an eight-item scale with a five-point Likert scale ranging from 'never' (1) to 'always' (5). Questions included how often students had control over food purchase, preparation, individual food choices, quantity of food eaten, consumption of breakfast and types of food chosen for school lunch and foods eaten away from the home. The locus of control score was calculated from the eight-item scale to produce a score out of 5 with a high score indicating high locus of control related to food consumption. Internal reliability coefficients for this scale were acceptable ($\alpha = 0.75$) for the pilot study and for the main study ($\alpha = 0.76$).

The food variety score was measured using a food frequency questionnaire consisting of 35 common foods representing the five food groups (fruit, vegetables, grains and cereals, milk and dairy foods and meats and meat substitutes). Students were asked to report if they had consumed any of the foods in the 3 days prior to the study. The numbers of foods reported were summed to produce a score out of 35 with a high score indicating high food variety as a measure of nutritional quality. Internal reliability coefficients for this scale were high for the pilot study ($\alpha = 0.81$) and high for the main study ($\alpha = 0.82$).

The nutritional quality of breakfast score was produced by first asking students to report everything that they had eaten and drunk for breakfast (before 10.00 a.m.) on the morning of the study. Each student's breakfast was then scored by the first author using a scale from 0–10 with a high score indicating greater nutritional quality. A score of 0 was given to those students who had nothing to eat or drink for breakfast; a score of 1 was given for students who had consumed only non-nutritious fluids such as soft drink, tea, coffee, cordial or water (not juice or milk); scores of 2–10 were given for graded variations of combinations of the five food groups with a score of 10 given for a breakfast consisting of grain or cereal food plus a meat/meat substitute/protein food plus a fruit/vegetable food plus a dairy/calcium food plus a low fat selection.

Importance of physical activity was self-reported by students using a 1–5 Likert scale (very unimportant = 1 to very important = 5).

Procedure

Students in the participating schools volunteered to complete the questionnaire and had their height and weight measured in a private room during regular class times. No students refused to complete the questionnaire. A total of 13 students refused to have their weight measured, but all of them participated in the height measurements. The questionnaires were administered by the first author and trained research assistants. Group administration and one on one administration of the questionnaire were used among younger children in the sample where necessary. Questionnaire data were entered into a SPSS 11.0 database and the data were cleaned, checked and edited before analyses.

Statistical analysis

Exploratory Data Analysis using SPSS was completed. The natural log of BMI scores was created as a variable to fulfil requirements for parametric statistical analysis.

Linear multiple regression was used to examine the predictive power of the variables in relation to BMI. BMI was entered as the dependent variable and all other variables were entered as independent variables.

The data modelling procedure was conducted as follows:

(i) Enter regression of BMI on all independent variables listed in Fig. 1.
(ii) Remove non-significant ($P > 0.05$) independent variables, one by one, according to the highest P-value. Thus, regression models are repeated with a diminishing number of independent variables until only significant predictors remain.
(iii) Regression analyses of BMI on all significant predictors include correlation and partial correlation statistics, casewise diagnostics, multicollinearity diagnostics and residual analysis and plots that were used to confirm that the statistical assumptions of linear regression were fulfilled.

'Path analysis' using AMOS was used to model associations and interactions in the data. Path

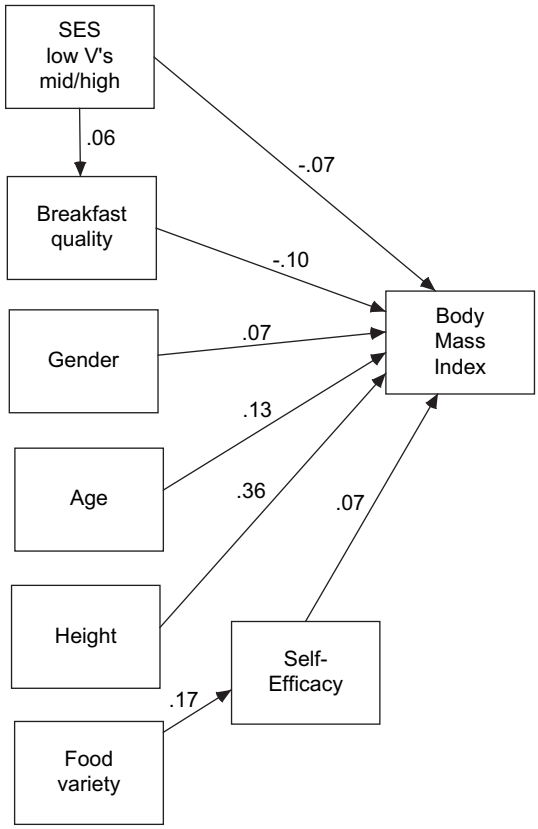

Fig. 1. Path analysis: socio-cognitive and nutritional predictors of BMI among children and adolescents. Coefficients are standardized Beta values and can be interpreted as effect sizes in standard deviations.

analysis tested how other factors mediate the relationship between school SES and BMI. Mediation by all other independent variables was tested. Definitional and analytical issues regarding mediation interactions followed the principles outlined by Baron and Kenny [23]. The final model shows only path coefficients significant at $P < 0.05$. In fact, all the reported path coefficients have a P-value of <0.0001, well within limits set by a Bonferroni correction for multiple analyses. Paths linking variables are denoted with the standardized path coefficient statistics. These coefficients are the equivalent to the Beta statistics from simple linear regression and can be interpreted as standard deviation effect sizes. No cases were excluded from the analyses.

Results

The prevalence of overweight and obesity and the gender and SES differences in these variables are published elsewhere [24]. Children and adolescents at low SES schools were more likely to be overweight (19.0 versus 16.8%) or obese (9.0 versus 5.8%) and this trend was present in males and females.

The type of breakfast consumed on the day of the study was in descending order: cereal and milk 43.2%, nothing or non-nutritious fluids only (soft drink, water, coffee, tea) 23.9%, toast/bread 21.0%, other combination (e.g. leftovers) 8.0%, juice only 2.0% and milk only 1.9%. Male students were more likely than females to choose cereal and milk (52 versus 41.7%) and females were more likely to choose toast (26.7 versus 19%) ($\chi^2 = 89.4$, df = 4, $P = 0.0001$). Low SES students were more likely to consume nothing or non-nutritious fluids compared with middle/high SES students (22.9 versus 15.6%) ($\chi^2 = 47.9$, df = 4, $P < 0.0001$).

The candidate predictors for BMI used in this study are age, height, gender, SES, food variety score, nutritional quality of breakfast, importance of physical activity rating, nutritional knowledge, dietary self-efficacy and dietary locus of control.

Known predictors of BMI were confirmed and these included age ($r = 0.45$, $P < 0.01$) and height ($r = 0.48$, $P < 0.01$); nutritional knowledge ($r = 0.35$, $P < 0.01$) and dietary self-efficacy ($r = 0.07$, $P < 0.01$) which were positively associated with BMI and SES ($r = -0.06$, $P < 0.01$), nutritional quality of breakfast ($r = -0.16$, $P < 0.01$) and food variety score ($r = -0.05$, $P < 0.01$) which were negatively associated with BMI. Gender, importance of physical activity and dietary locus of control were not significantly associated with BMI.

The mean values for predictor scores (excluding age and height) for low and middle/high SES groups by gender are given in Table I. Low SES boys had significantly greater BMI ($P < 0.01$), poorer nutritional knowledge ($P < 0.01$) and poorer

Table I. *Comparison of students' BMI, nutritional indices, nutritional knowledge, dietary self-efficacy and dietary locus of control by gender and school SES*

	Male (n = 2229)					Female (n = 2212)				
	Middle/high SES		Low SES		SES difference	Middle/high SES		Low SES		SES difference
	Mean score	SE	Mean score	SE	T-value, P-value	Mean score	SE	Mean score	SE	T-value, P-value
BMI	19.65	0.09	20.2	0.18	2.95, <0.01	19.76	0.09	20.36	0.19	2.86, <0.01
Nutritional knowledge score/40)	35	0.01	27	0.01	4.68, <0.001	38	0.01	28	0.01	−5.42, <0.001
Dietary self-efficacy (score/5)	2.82	0.03	2.86	0.06	5.96, n.s.	3.13	0.03	2.92	0.06	−3.67, <0.001
Dietary locus of control (score/5)	4.02	0.02	3.99	0.04	−0.75, n.s.	4.11	0.02	4.08	0.04	−0.65, n.s.
Food variety score (score/35)	17.92	0.15	17.74	0.31	−0.55, n.s.	17.17	0.13	16.91	0.27	−0.94, n.s.
Nutritional quality of breakfast (score 0–10)	5.34	0.16	4.92	0.29	2.72, <0.01	4.85	0.15	4.83	0.29	−0.11, n.s.

Nutritional knowledge, dietary self-efficacy and dietary locus of control were only assessed among adolescents aged 12–18 years.

nutritional quality of breakfast ($P < 0.01$) compared with the middle/high SES boys. Low SES girls had significantly greater BMI ($P < 0.01$), poorer nutritional knowledge ($P < 0.001$) and poorer self-efficacy ($P < 0.001$) but there were no other significant differences between low and middle/high SES girls.

Linear multiple regression was used to explore these emerging SES relationships. The results of the final model are given in Table II. Nutritional knowledge and locus of control and importance of physical activity were not significant in this model and were removed. The final model explained 8% of the variance in BMI scores ($r = 0.28$, $r^2 = 0.08$). Residuals were examined for normality, linearity and homoscedasticity and these assumptions were met. The Beta effect sizes for the predictors show height and age to be strong predictors of BMI as expected. Gender and SES effects are also evident, with girls and low SES children and adolescents more likely to have a high BMI. BMI is also seen to increase with increasing dietary self-efficacy. Food variety score and the nutritional quality of breakfast are also significant predictors of BMI, with low scores on these measures associated with higher BMI.

The multiple regression analysis effect sizes are modest but indicate that self-efficacy, food variety and poor breakfast quality are significant predictors of BMI, above and beyond the expected biological effects of age and height and the observed effects of gender and SES.

It is apparent by considering both the SES/gender mean scores in Table I and the results of multiple regression in Table II, that interactions between the candidate predictor variables are likely to occur. Therefore, we undertook a path analysis to examine the possibility of each independent variable exerting a mediating relationship between independent variables and BMI. Figure 1 shows the resulting model. The model showed a good fit with the data ($\chi^2 = 5770$, $P < 0.001$; Normed Fit Index = 0.94; Root Mean square Residual < 0.05).

The path model shows both a direct and indirect effect of SES upon BMI. Low SES children and adolescents are likely to have higher BMI as well as this effect being significantly mediated by the

Table II. *Predictors of BMI among 4441 children and adolescents from linear multiple regression model*

	Unstandardized coefficients		95% CI for B		Standardized coefficients
	B	SE	Lower bound	Upper bound	β
Constant	2.418	0.063	2.296	2.541	
Gender	2.157×10^{-2}	0.007	0.007	0.036	0.063
SES (low versus middle/high)	-3.739×10^{-2}	0.008	−0.053	−0.022	−0.95
Height	2.503×10^{-3}	0.000	0.002	0.003	0.143
Age	1.541×10^{-2}	0.003	0.010	0.021	0.121
Food variety	-1.332×10^{3}	0.001	−0.003	0.000	−0.042
Nutritional quality of breakfast	-4.995×10^{-3}	0.001	−0.007	−0.003	−0.099
Dietary self-efficacy	1.465×10^{-2}	0.004	0.007	0.022	0.080

Dietary self-efficacy was reported only by adolescents.

nutritional quality of their breakfast. The quality of breakfast is negatively related to SES with a lower quality breakfast having a positive association with BMI and vice versa. This means that some lower SES children are more likely to have a high BMI because they receive no breakfast or a breakfast of poor nutritional quality.

In the path model, food variety score is shown not to have a direct impact upon BMI. Rather the impact of food variety is mediated by self-efficacy. Self-efficacy has a substantial positive association with BMI. In other words, children with a high variety of foods are also likely to have a high self-efficacy related to eating healthy foods and this self-efficacy has a small but positive association with BMI.

Discussion

The results of the current large study of 4441 schoolchildren confirm that school SES, nutritional factors and socio-cognitive factors are significant in the development of a high BMI and risk of overweight and obesity in children and adolescents and this confirms previous findings [4, 12, 13]. The analyses reported here provide some interesting, although possibly not robust, relationships. In general, the effects reported are of a small magnitude and should be interpreted with caution. Some of the findings are puzzling and surprisingly few mediating interactions were identified.

Our findings do confirm and clarify the impact of SES on BMI with the additional new finding that high BMI in low SES children is related to the poor nutritional quality of their breakfast. The relationship between poor nutritional quality of breakfast among the low SES children and the observed risk of high BMI was identified in the original regression model and it was found among the low SES boys and girls as well as in the final path analysis model. Clearly, there is an important relationship between the child's SES, missing breakfast and the poor nutritional quality of their breakfast, and hence, their likelihood of becoming overweight or obese. The quality of breakfast score included those children who had missed breakfast on the day of the study. These children received a score of 0. Hence, the nutritional quality of breakfast results reflect those children who missed breakfast as well as those who had consumed a nutritionally poor breakfast including those who had consumed nothing more than a non-nutritious drink such as soft drink, water, cordial, tea or coffee. The provision of a nutritious breakfast, particularly to low SES children, is therefore a recommendation to emerge from the findings of the current study. This may be achieved by providing school or community breakfast programmes and having a focus on the encouragement, preparation and consumption of healthy foods and breakfast during lessons in Home Economics and Health Education.

Contrary to our expectations based on the application of health education theories [18–20], dietary self-efficacy was shown to be positively rather than negatively associated with BMI in our regression models. We presumed that having a high self-efficacy related to being able to choose a healthy diet would be associated with a lower BMI and a lower risk of overweight among the adolescents, because it would indicate that the children were more able to consume a healthy, low fat diet. Surprisingly, the opposite occurred and our linear regression results suggest that high dietary self-efficacy contributes to the risk of overweight. What is more puzzling is that in path analysis, the positive impact of food variety upon BMI is mediated by high self-efficacy. In our data, the consumption of a greater variety of foods appears to contribute to higher self-efficacy regarding food, which, in turn, is predictive of increasing BMI. Further research is required to replicate this finding and to examine this possible dynamic in greater detail.

It was interesting to note that dietary self-efficacy related to healthy eating was poor among boys and low-income adolescents suggesting that health educators and parents should encourage the development of healthy food selection and food preparation skills of young people. The dietary self-efficacy of students in this study also included the students' perception that they could choose healthy foods and drinks when feeling bored, sad or tense (otherwise known as emotional eating) and when eating out with peers. Students would therefore benefit from developing awareness about the many factors, which influence their eating habits. These important food preparation and food awareness skills can be developed during school education in Home Economics and Health Education classes by paying particular attention to the social, cultural and psychological influences on food choices. Similarly, the development of food preparation and food label reading skills will help young people become more confident, skilled and health conscious consumers.

In agreement with previous findings among adults [8, 9] and children [10, 11], we found no association between nutrition knowledge and the risk of overweight. While nutritional knowledge was relatively poor among low-income boys and girls, it did not have a statistically significant association with the risk of those children developing a high BMI.

This finding concurs with those of the recent study conducted by Reinehr *et al*. [10] who found no difference in the nutrition knowledge of obese compared with non-obese children aged 8–15 years. The authors of that study state that the similar nutrition knowledge of obese and non-obese children points to the genesis of obesity in childhood not caused by lack of knowledge. A similar point of view implying that simply changing nutrition knowledge is unlikely to effect eating habits or the prevention of obesity has also been made [25, 26]. While our results partially concur with these previous findings, we also note that the poor nutritional knowledge of the low-income children in our study ought to be addressed. We found significantly poorer levels of nutritional knowledge in low-income boys and girls in our study compared with their middle and higher income peers and, clearly, this discrepancy should be rectified to ensure a reasonable level of knowledge among these children. The continuing importance of a sound nutrition knowledge has been recently reviewed [27] and examined in a study by Wardle *et al*. [28] who cite methodological weaknesses in studies which have found no significant correlation between nutrition knowledge and dietary behaviour.

Similar to the surprising findings regarding self-efficacy, our original expectation that dietary locus of control would be associated with BMI and the risk of overweight was not supported, and in fact, our original expectations were contradicted. Dietary locus of control was neither a significant predictor of BMI in our original regression model nor a significant factor among analyses of low and middle/high SES boys and girls with children in both genders and income groups having very similar and relatively high levels of dietary locus of control. Our findings suggest that a high degree of perceived self-control over food among adolescents does not influence or interact with BMI, SES

and the other dietary factors measured including nutritional knowledge, dietary self-efficacy, food variety and nutritional quality of breakfast. It appears from the results of the current study that dietary locus of control among adolescents is not an important influence upon the risk of overweight, but other research suggests that parental control over the child's food supply is an important factor in determining what the child eats and whether or not they become overweight [29–31]. It appears from the results of the current study that the locus of control of adolescents may not be as influential in the prediction of child overweight as the influence of parental control.

The findings of our study are similar to some previous research reports which identify the important role that food choices [2] and the nutritional value of breakfast [3, 5, 6, 17] play in the development of overweight in children and adolescents. Our study expands on these earlier findings by further elaborating on the pattern of interactions between SES, food variety, self-efficacy, the consumption of breakfast and BMI.

The current study design was robust in the inclusion of a randomly selected cross-sectional sample; a very large sample size; a nationally representative sample of schoolchildren; the accurate measurement of height and weight and a varied mix of age groups, ethnicity and gender. The instruments we used had been pilot-tested among children and adolescents of varying ages and had high internal reliability in the current and previous studies [17].

Future research studies should further validate and standardize the instruments against food diaries, which would be useful in the assessment of factors associated with BMI, overweight in children and adolescents. Another limitation of the current study was the use of BMI as a continuous variable and as an indicator of risk of overweight in children and adolescents. The clinical examination and categorization of participants as overweight would have been a more accurate reflection of their actual risk of having weight problems, but such an analysis would have required a much larger sample size, with greater time and costs in order to analyse the data by categories of overweight, gender and SES.

Future studies should attempt to replicate our findings among a large sample of children and adolescents using accurate food diaries, total energy intake, physical activity level, energy expenditure, ethnic breakdown and clinical overweight analysis. A longitudinal study design would enhance the replication of the current results because it would enable researchers to determine if the newly identified interactions between social class, breakfast quality, food variety and self-efficacy actually predict child overweight or weight gain in a long-term, prospective study. Longitudinal study is particularly important in order to establish the robustness of the mediating effects. Multilevel modelling, examining individual, class and school effects upon BMI may also strengthen the design of future studies.

Health educators and those involved in child obesity prevention may use the current findings to justify and implement food programmes and nutrition and health education strategies which incorporate skill development that will help children and adolescents to choose a nutritious breakfast and a variety of nutritious foods. The current findings suggest that such interventions are well overdue among many low-income children.

Finally, we recommend the inclusion of community and school-based physical activity programmes and self-efficacy programmes related to physical activity and movement skills in addition to food selection and food skills development programmes as we are highly cognizant of the many personal, external and environmental factors which influence the current high international prevalence of child obesity.

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Conflict of interest statement

None declared.

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