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Breakfast frequency inversely associated with BMI and body fatness in Hong Kong Chinese children aged 9–18 years

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Abstract

The present study assessed the relationship between breakfast frequency and measures of obesity in Hong Kong Chinese children aged 9–18 years. A total of 11 570 children (50 % boys) underwent anthropometric measurements and completed a simple self-administered dietary behaviour questionnaire. Their parents completed a questionnaire providing demographic information. Breakfast frequency was assessed by a single question, 'How many days over the past week did you have breakfast?' Children were categorised into three groups: skippers (ate breakfast 0–2 times/week); semi-skippers (ate breakfast 3–4 times/week); non-skippers (ate breakfast 5–7 times/week), to assess all associated characteristics. Of the 3644 primary and 7926 secondary school students, 8 % (8·7 % of boys and 6·9 % of girls) and 14 % (14 % of boys and 15 % of girls), respectively, were breakfast skippers. The prevalence of obesity among breakfast skippers, semi-skippers and non-skippers was, respectively, 9·8, 10·6 and 3·8 % ($P < 0·001$) for primary school students and 3·9, 3·1 and 2·4 % ($P < 0·001$) for secondary school students. The 12 % of Hong Kong children aged 9–18 years who skipped breakfast had higher BMI, BMI *z*-scores and percentage of body fat (PBF) than their counterparts. The dose effects of breakfast frequency (unstandardised regression coefficient, $P < 0·001$) on BMI and PBF were, respectively, $-0·125\,kg/m^2$ and $-0·219$ % for boys and $-0·165\,kg/m^2$ and $-0·353$ % for girls, adjusting for physical activity per additional breakfast meal per week. Further study is recommended to elucidate whether regular breakfast consumption may have a role in the prevention of childhood obesity.

Key words: Breakfast frequency: BMI: Body fatness: Children: Adolescents

Obesity, with its increasing prevalence and associated morbidity and mortality, is a global concern[1]. A recent study of Hong Kong children has shown increasing rates of obesity from 1993 to 2005/6[2]. Various reasons contribute to this phenomenon, but unhealthy food behaviour is considered one of the most important causes[3–5]. Breakfast, long viewed as the most important meal of the day[6–9], may protect against obesity. Cross-sectional studies have reported a negative association between breakfast frequency and fatness[10–13], although not consistently[5,6,14,15]. A recent cross-sectional prospective study showed inverse associations between breakfast frequency and BMI at two time points that remained largely independent of all confounding and dietary factors[16]. However, BMI does not distinguish among increased lean mass, bone or fat, whereas the percentage of body fat (PBF) might better reflect obesity. In the present study, we used both BMI and a previously described PBF-based definition of obesity in children[17] to evaluate their relationships with self-reported breakfast frequency and food consumption behaviours in a large representative population sample of Hong Kong Chinese children aged 9–18 years.

Materials and methods

Sampling method

A two-stage cluster sampling method was used, as described previously[2,17]. Data from the Department of Education were used to compile a sampling frame of all schools in Hong Kong. In the first stage, one primary school and one secondary school were selected from each of the eighteen districts in Hong Kong. In the second stage, two classes in each grade were randomly selected from the schools. All students in the selected classes were invited to join the study.

Data collection

The parents of all the participants were invited to complete a questionnaire providing demographic information.

Abbreviation: PBF, percentage of body fat.

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The students were asked to complete a Rapid Dietary Behaviour Assessment questionnaire. The questionnaire represented daily and weekly dietary behaviours and was validated against the 24 h recall nutrient intake data of 235 adolescents. The percentage agreement between the questions and the dietary recall ranged from 73 to 95 %. Spearman's correlation coefficient *r* between food intake estimated from the 24 h recall and the questionnaire was 0·63 ($P=0·004$)[18]. Breakfast frequency was assessed by a single question, 'How many days over the past week did you have breakfast?' Responses ranged from 0 to 7. Physical activity was assessed by two questions: (1) Do you currently take any regular exercise training class other than school physical education class? (2) If yes, please tick the frequency of training: once, twice, equal or above 3 times/week. When answering these questions, the children were shown a detailed list of typical extramural exercise activities and classes available in Hong Kong. These two questions were designed based on the physical activity guidelines for adolescents issued from the international consensus conference in 1994[19].

Measurement of growth parameters

A team of eight trained research staff visited the selected schools on a pre-arranged date to collect the anthropometric data. All instruments were standardised before the examination, and the balances were zero calibrated. Standing height without shoes was measured twice using a Harpenden Stadiometer (Holtain Limited, Crymych, Pembs, UK), and body weight and PBF were measured using a portable Tanita body fat monitor/scale (Tanita BF-522; Tanita Corporation, Tokyo, Japan) as described previously[2,17]. The bioimpedence analysis for the estimation of body fat has been validated in local Chinese children by the study team using a Tanita scale[20].

Table 1. Weight status, exercise frequency and breakfast frequency by primary or secondary school group and sex (Number of students and percentages)

		Boys		Girls		Total		
Group		*n*	%	*n*	%	*n*	%	*P* (boys *v.* girls)
Primary								
	Weight status*							
	Not overweight	1355	72·2	1512	85·5	2867	78·7	<0·001
	Overweight†	404	21·5	209	11·8	613	16·8	
	Obese†	117	6·2	47	2·7	164	4·5	
	Exercise frequency per week							
	None	822	43·8	882	49·9	1704	46·8	<0·001
	Once	537	28·6	467	26·4	1004	27·5	
	Twice	256	13·6	265	15·0	521	14·3	
	Three times or above	261	13·9	154	8·7	415	11·4	
	Breakfast frequency per week							
	None	84	4·5	62	3·5	146	4·0	0·378
	1 d	26	1·4	22	1·4	48	1·4	
	2 d	53	2·8	36	2·1	89	2·5	
	3 d	54	2·9	62	3·5	116	3·2	
	4 d	61	3·2	57	3·2	118	3·2	
	5 d	108	5·8	120	6·8	228	6·3	
	6 d	111	5·9	129	7·3	240	6·6	
	7 d	1379	73·5	1280	72·4	2659	73·0	
Secondary								
	Weight status*							
	Not overweight	3207	82·6	3610	89·3	6817	86·0	<0·001
	Overweight†	528	13·6	364	9·0	892	11·2	
	Obese†	148	3·8	69	1·7	217	2·7	
	Exercise frequency per week							
	None	2342	61·1	2959	73·2	5301	67·3	<0·001
	Once	636	16·6	550	13·6	1178	15·1	
	Twice	456	11·9	340	8·4	796	10·1	
	Three times or above	399	10·4	194	4·8	593	7·5	
	Breakfast frequency per week							
	None	244	6·4	198	4·9	442	5·6	0·148
	1 d	107	2·8	133	3·3	240	3·0	
	2 d	195	5·1	255	6·3	450	5·7	
	3 d	203	5·3	251	6·2	454	5·8	
	4 d	218	5·7	255	6·3	473	6·0	
	5 d	483	12·6	550	13·6	1033	13·1	
	6 d	360	9·4	408	10·1	768	9·7	
	7 d	2023	52·8	1993	49·3	4016	51·0	

* Weight status was assessed according to the International Obesity Task Force (IOTF)[21].
† IOTF cut-off points for BMI for overweight and obesity by sex between 2 and 18 years, defined to pass through BMI of 25 and 30 kg/m^2 at the age of 18 years.

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Statistical analysis

As it was expected that secondary school adolescents would differ from primary school students in their eating behaviours and physical activities, these age as well as sex differences were also explored. Breakfast frequency was categorised into three groups to facilitate comparisons among skippers (ate breakfast 0–2 times/week), semi-skippers (ate breakfast 3–4 times/week) and non-skippers (ate breakfast 5–7 times/week) in univariate analyses for demographic data, personal characteristics and unhealthy food consumption behaviours[5]. The differences among groups were assessed by χ^2 tests and ANOVA for categorical variables and continuous variables respectively. The primary comparison (between two groups) was made at a significance level of 0·05. The secondary comparisons (among three groups) were made at the significance level of 0·017, using Bonferroni's correction. To further assess the relative strength of association, we used linear regression models with BMI and PBF as the dependent variables and breakfast frequency (0–7 times/week) as the independent variable. Age, sex and exercise frequency were treated as potential confounders in the models. SPSS for Windows version 14 (SPSS, Inc., Chicago, IL, USA) was used in the analysis; all *P* values were two sided.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects/patients were approved by the Joint Chinese University of Hong Kong and New Territories East Cluster Clinical Research Ethics Committee and the

Table 2. Students following less healthy food behaviours by breakfast frequency and sex
(Number of students and percentages)

	Breakfast frequency											
	Skippers				Semi-skippers				Non-skippers			
	Boys		Girls		Boys		Girls		Boys		Girls	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Primary school												
I eat more than two cookies/sweet biscuits daily	57	34·7	42	34·5	39	34·3	35	29·5	555	34·7	609	39·8
I eat sweet cakes or cream cakes daily*†	19	11·7	4	3·6	12	10·8	17	14·3	88	5·5	109	7·1
I eat instant noodles daily or almost every day*†	59	35·9	28	22·7	37	32·4	33	28·3	248	15·5	171	11·2
I eat candies or chocolates almost every day*†	65	40·0	58	47·3	41	36·3	49	41·5	484	30·3	549	35·9
I eat potatoes or other crisps daily or almost every day*†	59	35·9	34	28·2	36	31·4	41	35·2	312	19·5	271	17·7
I eat sweetened carbonated drinks daily or almost every day*†	72	44·1	41	33·6	49	43·1	38	32·1	398	24·9	306	20·0
I eat sugar-added sweetened non-carbonated drinks almost every day†	85	52·4	72	59·1	70	61·8	75	63·8	794	49·7	769	50·3
I drink more than one glass of fruit juice per day	40	24·8	22	18·2	30	26·5	43	36·8	415	26·0	372	24·3
I eat deep fried food more than twice a week*†	78	47·9	44	36·4	40	35·3	45	38·7	447	28·0	381	24·9
I eat fast food from a restaurant more than twice a week*†	49	29·9	25	20·9	31	27·5	23	19·8	252	15·8	205	13·4
I eat white bread and never eat whole-wheat bread	32	19·4	30	24·8	34	29·4	30	25·5	355	22·2	359	23·5
I eat meats with visible fat or poultry with skin more than three times per week*	37	22·9	14	11·8	28	24·5	15	13·2	251	15·7	128	8·4
Secondary school												
I eat more than two cookies/sweet biscuits daily†	122	22·5	132	21·8	102	23·5	122	25·2	726	25·0	868	29·4
I eat sweet cakes or cream cakes daily	33	6·1	55	9·0	30	6·9	44	9·1	195	6·7	201	6·8
I eat instant noodles daily or almost every day*†	137	25·2	124	20·4	84	19·2	89	18·3	508	17·5	319	10·8
I eat candies or chocolates almost every day†	177	32·5	292	48·2	130	29·9	240	49·5	833	28·7	1287	43·6
I eat potatoes or other crisps daily or almost every day*†	107	19·7	148	24·4	80	18·5	108	22·2	418	14·4	452	15·3
I eat sweetened carbonated drinks daily or almost every day*†	240	44·1	220	36·3	184	42·2	145	29·8	1002	34·5	593	20·1
I eat sugar-added sweetened non-carbonated drinks almost every day†	345	63·4	375	61·8	290	66·6	314	64·8	1754	60·4	1615	54·7
I drink more than one glass of fruit juice per day	111	20·4	124	20·5	88	20·2	106	21·9	590	20·3	502	17·0
I eat deep fried food more than twice a week*†	273	50·2	307	50·7	215	49·5	241	49·7	1269	43·7	1199	40·6
I eat fast food from a restaurant more than twice a week*†	238	43·7	264	43·6	199	45·7	219	45·1	1074	37	998	33·8
I eat white bread and never eat whole-wheat bread	142	26·1	179	29·6	137	31·6	157	32·4	781	26·9	835	28·3
I eat meats with visible fat or poultry with skin more than three times per week†	173	31·8	141	23·2	107	24·5	86	17·8	831	28·6	493	16·7

* Values were significantly different for skippers from those of non-skippers (boys, $P<0·001$).
† Values were significantly different for skippers from those of non-skippers (girls, $P<0·001$).

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Ethics Committee of the Department of Health of the Hong Kong Government. Parents were informed about the study by a letter distributed through the school, together with a fact sheet explaining the study purpose and procedures. Parents were informed that any report of the survey would not include any personal details of individual children, and that all information would be grouped together for analysis. They were told that all children who take part in the study would be given a record of their body measurements, and that children with high blood pressure or other abnormal findings would be given a letter to a doctor at a nearby hospital for re-assessment. Verbal consent was obtained from all subjects before data collection.

Results

A total of eighteen primary and eighteen secondary schools (15% government, 60% aided and 25% private schools), one from each of the eighteen Hong Kong districts, participated in the study. This reflected the overall distribution of school types for Hong Kong[2]. All children in the present study were Chinese. The sample consisted of 3644 primary grade 4–6 students (52% boys) and 7926 secondary grade 1–7 students (49% boys) aged 9–18 years. There was an approximately equal distribution by age and sex in each grade, except the final two secondary years had fewer students. Of the primary and secondary school students, 7% (*n* 520) 10% (*n* 880), respectively, did not participate in the study, mainly as a result of being absent from school, reflecting response rates of 93 and 90%; respectively. The students' overweight and obesity status was calculated according to the International Obesity Task Force BMI reference[21]. The rates of overweight and/or obesity were greater in boys than those in girls across the entire age range (Table 1).

Food consumption behaviour

The overall eating behaviours of the breakfast skippers appeared to follow a pattern that would be considered less healthy than that of the non-skippers, e.g. the skippers showed a greater consumption of instant noodles, candies or chocolates, sweetened carbonated drinks and deep-fried foods (Table 2). Girls from both primary and secondary schools reported a higher intake of candies or chocolates than did the boys. These food behaviours also showed significant associations with weight status (Table 3).

Breakfast frequency

The characteristics of the subjects in relation to breakfast frequency are shown in Table 4. Of the primary and secondary school students, 8% (8·7% of boys and 6·9% of girls) and 14%

Table 3. Children's eating habits by International Obesity Task Force cut-offs

(Number of students and percentages)

	Normal weight (*n* 2867)		Overweight (*n* 613)		Obese (*n* 164)	
Primary school	*n*	%	*n*	%	*n*	%
I eat more than two cookies/sweet biscuits daily†	1783	62·2	406	66·3	118	72·1
I eat sweet cakes or cream cakes daily	2658	92·7	582	95·0	155	94·3
I eat instant noodles daily or almost every day	2414	84·2	520	84·8	136	82·9
I eat candies or chocolates almost every day*†	1829	63·8	453	73·9	117	71·4
I eat potatoes or other crisps daily or almost every day	2259	78·8	505	82·4	130	79·3
I eat sweetened carbonated drinks daily or almost every day†	2162	75·4	473	77·2	105	64·3
I eat sugar-added sweetened non-carbonated drinks almost every day	1419	49·5	280	45·6	77	47·1
I drink more than one glass of fruit juice per day†	2145	74·8	447	73·0	129	78·6
I eat deep fried food more than twice a week†	2041	71·2	457	74·5	110	66·9
I eat fast food from a restaurant more than twice a week†	2408	84·0	517	84·4	132	80·6
I eat white bread and never eat whole-wheat bread†	2228	77·7	460	75·1	118	71·7
I eat meats with visible fat or poultry with skin more than three times per week	2506	87·4	525	85·7	140	85·6
	Normal weight (*n* 6817)		Overweight (*n* 892)		Obese (*n* 217)	
Secondary school						
I eat more than two cookies/sweet biscuits daily*†	4970	72·9	717	80·4	170	78·4
I eat sweet cakes or cream cakes daily*†	63·6	92·5	857	96·1	212	97·5
I eat instant noodles daily or almost every day	5760	84·5	727	81·5	182	83·8
I eat candies or chocolates almost every day*†	4131	60·6	672	75·3	164	75·5
I eat potatoes or other crisps daily or almost every day*†	5631	82·6	787	88·2	195	89·7
I eat sweetened carbonated drinks daily or almost every day†	4758	69·8	640	71·8	143	65·7
I eat sugar-added sweetened non-carbonated drinks almost every day	2761	40·5	391	43·8	79	36·3
I drink more than one glass of fruit juice per day	5515	80·9	714	80·0	181	83·3
I eat deep fried food more than twice a week*†	3722	54·6	556	62·3	143	66·0
I eat fast food from a restaurant more than twice a week*†	4186	61·4	612	68·6	145	67·0
I eat white bread and never eat whole-wheat bread†	4908	72·0	647	72·5	138	63·5
I eat meats with visible fat or poultry with skin more than three times per week*	5167	75·8	723	81·1	163	74·9

* Values were significantly different between normal weight and overweight ($P < 0·01$).
† Values were significantly different between normal weight and obese ($P < 0·01$).

Table 4. Characteristics of the children according to breakfast frequency
(Mean values, standard deviations, number of students and percentages)

	Breakfast frequency											
	Skippers (*n* 1435)				Semi-skippers (*n* 1180)				Non-skippers (*n* 8955)			
	Mean	SD	*n*	%	Mean	SD	*n*	%	Mean	SD	*n*	%
Primary school												
Continuous variables												
Age (years)	10·9	1·2			11·1	1·1			10·8	1·0		
Height (cm)	144·3	9·2			145·1	9·0			143·6	9·1		
Weight (kg)	41·2	11·3			40·5	10·1			37·3	9·8		
Waist circumference (cm)	64·3	9·4			62·7	8·4			60·3	8·0		
Waist:height ratio*	0·4	0·1			0·4	0·1			0·4	0·0		
Body fat (%)*	22·3	8·0			20·9	7·3			18·8	6·6		
BMI *z*-score*	0·7	1·1			0·6	1·1			0·3	1·0		
Categorical variables												
Boys			163	56·9			114	49·0			1599	51·0
Exercise frequency												
None*			97	34·0			91	39·5			948	30·3
Once			78	27·2			54	23·5			857	27·4
Twice			90	31·6			67	29·2			938	30
Three times or above*			19	6·7			18	7·8			385	12·3
Obese (IOTF)*			28	9·8			24	10·6			119	3·8
Secondary school												
Continuous variables												
Age (years)	15·2	1·8			15·5	1·8			15·3	2·0		
Height (cm)	161·7	8·9			161·4	8·6			161·7	8·8		
Weight (kg)	53·6	11·7			53·3	12·0			52·4	11·3		
Waist circumference (cm)	65·6	8·1			65·2	8·2			64·7	7·7		
Waist:height ratio*	0·4	0·0			0·4	0·0			0·4	0·0		
Body fat (%)*	22·3	7·1			22·5	7·3			21·3	7·0		
BMI *z*-score*	0·3	1·0			0·2	1·0			0·2	1·0		
Categorical variables												
Boys			546	48·0			423	46·0			2904	50·0
Exercise frequency												
None			777	67·6			643	69·9			3789	64·7
Once			176	15·3			124	13·5			896	15·3
Twice			122	10·6			95	10·3			703	12·0
Three times or above			75	6·5			58	6·3			468	8·0
Obese (IOTF)*			45	3·9			29	3·1			141	2·4

IOTF, International Obesity Task Force.
* Values were significantly different for skippers from those of non-skippers ($P<0·001$).

(14% of boys and 15% of girls), respectively, were breakfast skippers (ate breakfast 0–2 times/week). Breakfast skipping was more common among secondary students ($P < 0·001$). Based on the International Obesity Task Force criteria[21], the prevalence of obesity among breakfast skippers, semi-skippers and non-skippers, respectively, was 9·8, 10·6 and 3·8% ($P<0·001$) for primary school students and 3·9, 3·1 and 2·4% ($P<0·001$) for secondary school students. There was not only a larger percentage of primary children defined as being obese on the International Obesity Task Force cut-offs, but also a substantial BMI difference between primary breakfast skippers and semi-skippers compared with non-skippers. The differences in the BMI *z*-scores and PBF according to breakfast frequency are shown in Figs. 1 and 2. The BMI and PBF of the breakfast skippers were significantly larger than those of their non-skipping counterparts ($P < 0·001$). The estimated effects of breakfast frequency on BMI and PBF by sex were assessed by multiple linear regression (Table 5). The dose effects of breakfast frequency on BMI and PBF were, respectively, −0·125 and −0·219 for boys and −0·165 and −0·353 for girls per additional breakfast meal per week, i.e. the BMI and PBF of a boy who skips breakfast are higher than his non-skipping counterparts by 0·9 kg/m^2 and 1·5%, respectively, and by 1·2 kg/m^2 and 2·3%, respectively, for girls.

Exercise frequency

Exercise frequency categorised into four groups (none, once, twice and three times or above a week) showed the non-skippers to be more active (Table 4). The effects of exercise frequency on BMI and PBF were assessed by multiple linear regression, and PBF was found to be inversely associated with exercise frequency among the secondary students for both boys and girls (Table 5).

Discussion

In a large representative sample of Hong Kong primary and secondary school children, we showed that breakfast eating patterns varied with age, with secondary school adolescents being more likely to skip breakfast than younger

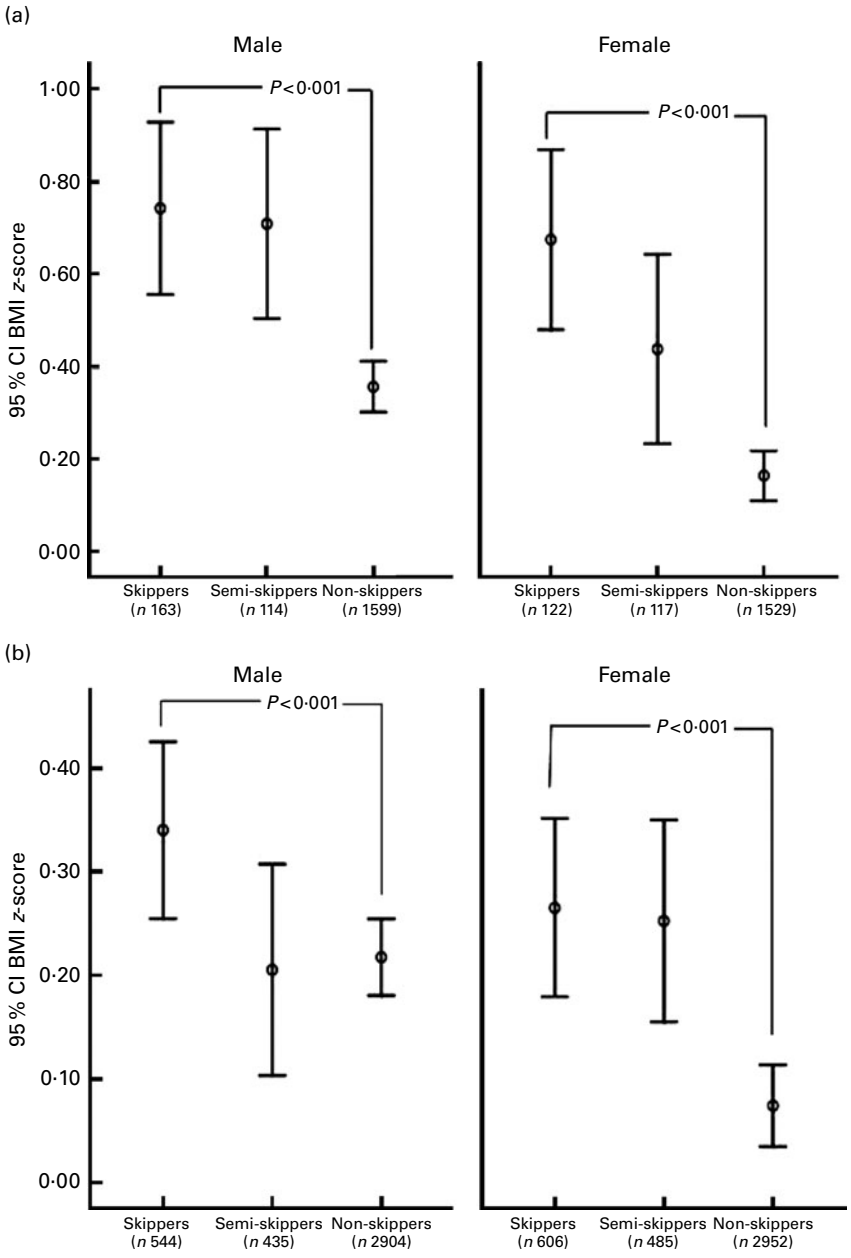

Fig. 1. BMI *z*-score with breakfast frequency by sex. (a) Primary school children and (b) secondary school children.

primary school-aged children. This is consistent with previous observations[12,22–24]. We also showed that BMI, as well as PBF, had inverse associations with breakfast frequency. This association between PBF and breakfast frequency has been reported in a New Zealand study of 5–11-year-old multiethnic children, which included 3% Chinese children[25]. Breakfast eating has also been found to be negatively associated with visceral adiposity in overweight Latino youth[26]. This negative association between BMI and PBF with breakfast frequency suggests that regular breakfast consumption could result in, or, alternatively, just reflect a healthier lifestyle. Exercise frequency was inversely associated with PBF but was not associated with BMI (Table 5). We have previously reported that both systolic and diastolic blood pressure in these children were decreased with increased exercise frequency[27]. This beneficial association of exercise with PBF but not with BMI could indicate that PBF better reflects adiposity and an unhealthy lifestyle than does BMI.

A recent US study suggested that regular breakfast consumption might be protective against childhood obesity[8]. However, the important, yet unanswered, question is whether the inverse relationship between regular breakfast consumption and unhealthy weight and eating behaviours is causal. Although breakfast has long been considered 'the most important meal of the day', it is conceivable that overweight children, perhaps with the support of their parents, may

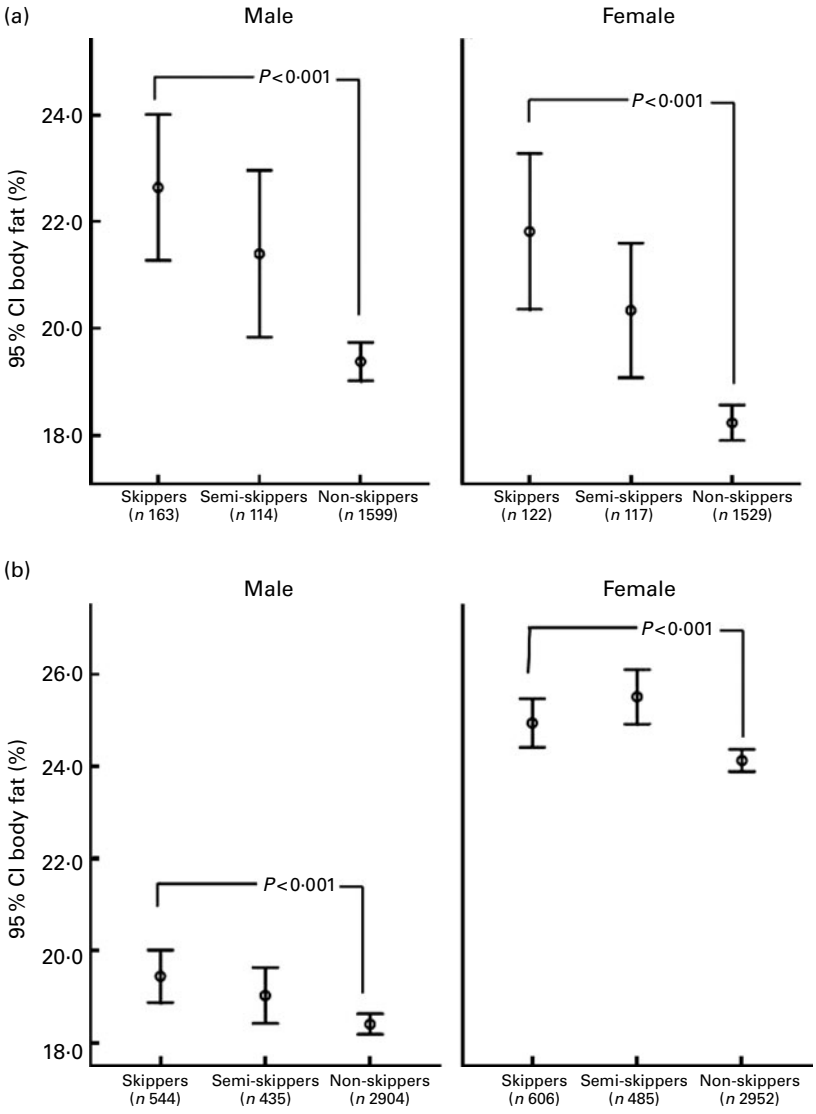

Fig. 2. Percentage of body fat with breakfast frequency by sex. (a) Primary school children and (b) secondary school children.

consciously skip breakfast to reduce food consumption. Conversely, regular breakfast consumption could have genuine health benefits. The importance of breakfast has been addressed by a number of studies[7,8,16,28]. It has been suggested that skipping breakfast may lead to reduced satiety later in the day with resultant overeating and/or increased consumption of more energy-dense unhealthy foods[29]. In addition to potential nutrition benefits, regular breakfast consumption has been shown to improve students' attendance, attentiveness and achievement, and to reduce discipline problems in school[9,30,31]. Children who skip breakfast were less able to distinguish among similar images, showed increased errors, had slower memory recall and lower scores on cognitive tests[32–35]. However, a number of other studies have reported no such beneficial effects[36–38]. As suggested in the present study, skipping breakfast may also be associated with poorer overall nutritional choices. A number of observational studies have shown that compared with skippers regular breakfast eaters have a higher diet quality with an increased intake of fibre, Ca, vitamins A and C, riboflavin, Zn and Fe, and a decreased intake of energy, fat and cholesterol[39]. Despite these potential benefits, breakfast is the most commonly skipped meal[24,40]. The provision and quality of breakfast is potentially under greater parental control than lunch, and therefore could be an important focus for improving the nutritional quality of children's diets.

The strengths of the present study include the size and representativeness of the sample[2] and high response rates. Inclusion of PBF measurements enabled the relationship of body fat to be examined with breakfast frequency. In addition, availability of a physical activity measure, an important contributor to weight status[33], enables its use as a covariate in regression analysis. Limitations of the present study include its cross-sectional design. Longitudinal studies are required to better delineate the association between breakfast habits and weight status during the transition from childhood to

Table 5. Estimated effect of breakfast and exercise frequency on body status in multivariate analysis models†
(Unstandardised coefficients and standard errors)

	Boys				Girls			
	BMI		PBF		BMI		PBF	
	β	SE	β	SE	β	SE	β	SE
Overall (5759 boys and 5811 girls)								
Age (years)	0·332*	0·019	−0·109*	0·034	0·411*	0·017	1·013*	0·035
Exercise frequency per week								
None	Reference							
Once	0·353	0·128	0·018	0·238	0·208	0·119	0·107	0·247
Twice	−0·037	0·153	−0·733*	0·285	0·423	0·147	−0·083*	0·306
Three times or above	0·306	0·159	−0·809*	0·296	0·290	0·188	−0·182*	0·391
Breakfast frequency	−0·125*	0·023	−0·219*	0·042	−0·165*	0·020	−0·353*	0·042
R^2	0·069		0·080		0·122		0·164	
Primary school (1876 boys and 1768 girls)								
Age (years)	0·351*	0·084	−1·032*	0·168	0·556*	0·073	0·982*	0·159
Exercise frequency per week								
None	Reference							
Once	0·073	0·217	0·492	0·432	0·011	0·187	−0·408	0·406
Twice	0·188	0·286	1·298	0·569	0·324	0·231	0·664	0·504
Three times or above	0·041	0·283	0·068	0·565	0·122	0·291	0·442	0·634
Breakfast frequency	−0·275*	0·046	−0·528*	0·091	−0·296*	0·042	−0·600*	0·091
R^2	0·033		0·040		0·072		0·058	
Secondary school (3883 boys and 4043 girls)								
Age (years)	0·276*	0·030	0·353*	0·052	0·253*	0·027	0·661*	0·054
Exercise frequency per week								
None	Reference							
Once	0·498	0·159	0·066	0·281	0·261	0·151	0·301	0·308
Twice	−0·163	0·182	−1·193*	0·321	0·356	0·187	−0·260*	0·381
Three times or above	0·414	0·193	−0·887*	0·340	0·252	0·241	−0·294*	0·491
Breakfast frequency	−0·075*	0·026	−0·136*	0·046	−0·106*	0·023	−0·236*	0·048
R^2	0·030		0·022		0·028		0·044	

PBF, percentage of body fat; β, unstandardised coefficient.
* Values were significantly different ($P<0·05$).
† Breakfast frequency ranges from 0 to 7 d.

adolescence, as well as any causal nature of this relationship. The self-reported questionnaire could have introduced biases into the study. The recall period was limited to the past week to try to minimise recall bias, but the study did not explore why or for how long had the children skipped breakfast. Breakfast frequency was defined by a single simple question and was unable to assess the quality and quantity of breakfast. Clearly, such data would be invaluable to better understand the relationships between obesity and breakfast frequency. More detailed information on what children eat for breakfast would be useful in future studies to help answer the question whether the inverse associations identified between BMI/PBF and breakfast frequency are causal. The two simple questions used to assess physical activity give only limited insight into the nature and the intensity of overall activity. The heterogeneous nature of the various activities undertaken by children made it impossible for us to characterise or quantify these activities, but the answers to these questions probably reflect an intention to participate in additional physical activity outside school. Despite the important limitation of the simplicity of the questions on breakfast frequency and exercise, it is also possible that such questions could have utility from a public health perspective if they can be further validated to reflect general behaviours.

Conclusion

Using a simple screening question of the frequency of eating breakfast during the past week, we showed that eating breakfast 2 times/week or less was associated with higher BMI, BMI *z*-scores and PBF in a large population sample of children aged 9–18 years. Breakfast eating may simply be a marker for other behaviours and social/environmental factors associated with overweight and obesity. Alternatively, this association may be causal. Further evaluation is needed to determine whether the successful promotion of a regular healthy breakfast habit could have a beneficial role in combating the obesity epidemic.

Consent

Parents were asked to inform the school if they did not wish their child to participate in the study, and verbal consent was obtained from the children.

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