Prevalence of overweight in Hong Kong Chinese children: Its associations with family, early-life development and behaviors-related factors

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ABSTRACT

Background: Childhood overweight is a crucial public health concern. Recognizing its associated factors can facilitate the establishment of effective prevention strategies. The aim of the present study was to examine the prevalence of overweight in Hong Kong Chinese children and explore its influential factors in relation to family, early-life development and behavior-related issues.
Methods: A cross-sectional study was conducted in 894 primary school students aged 9-12 years (50.4% boys). Self-reported information on family background (parental body weight, education, employment status, household income, living space, and bedroom situation), early-life developmental variables (birth weight, gestational age and feeding pattern), and children's lifestyle factors (sleep, various eating behaviors and physical activity) were collected with a questionnaire. A logistic regression was performed to test the associations.
Results: The overweight prevalence in Hong Kong children was 19.9%. Compared to the girls, the boys were more overweight (23.5% vs. 16.3%). Overweight was linked to paternal overweight, maternal overweight, lower maternal education, less monthly household income, and shorter sleep duration. Compared to the breast-fed children, those who were not breast-fed were more likely to become overweight, with marginal significance.
Conclusion: The present study revealed a high prevalence of overweight in Hong Kong pediatric population and demonstrated the family resemblance in weight status. Further interventions and promotions should involve parents and consider the family as a unit to tackle childhood overweight.

1. Introduction

Childhood overweight and obesity have important consequences for health and well-being, both in the short[1] and the long terms.[2] Overweight during adolescence was associated with an 8.5-fold increase in hypertension, a 2.4-fold increase in the prevalence of high total serum cholesterol levels, a 3-fold increase in high low-density lipoprotein cholesterol levels, and an 8-fold increase in low high-density lipoprotein cholesterol levels in adults from 27 to 31 years of age.[3] There is strong evidence that childhood obesity track into their adulthood and suffer related health problems as a result.[4]

An increase in the prevalence of childhood overweight has been demonstrated around the world.[5] By 2005, the overall prevalence of childhood overweight was 17.8% in Hong Kong, which represents an approximate increase of 1.5-fold over 10 years.[6] The overweight and obesity rate of Hong Kong primary students was reported to be 18.7% in 2014/2015.[7] The rising prevalence of childhood overweight and obesity poses a major public health challenge by increasing the burden of chronic, non-communicable diseases.

Overweight and obesity among children are likely to be the results of complex interactions between genetic and environmental factors.[8] Family factors, early life development, and children's lifestyles are the important environmental factors that can be modified. Recognizing the associations between these modifiable factors

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and children's weight status is a basic step to designing further effective interventions to tackle the prevalence of childhood overweight and obesity. Previous studies in Hong Kong Chinese children examined associations between family factors (e.g., maternal education level),[9] developmental factors (e.g., birth weight and feeding pattern[10]), and behavioral factors (e.g., sugar-sweetened beverage intake,[11] physical activity,[12] and sleep duration[13]). However, many have primarily focused on one or two aspects of these factors[9–18] and the results are mixed. The studies taking family, early life development and behavior-related factors into consideration would provide an update on their associations with childhood overweight. Therefore, we preformed this study to measure 1) the prevalence of overweight in a study sample of Hong Kong children, and 2) the associations between family factors, early life development and behaviors with childhood overweight.

2. Methods

2.1. Design and sample

The present cross-sectional study was conducted from May to September 2015 in two geographic regions of Hong Kong. Five Hong Kong primary schools that consented to participate in the study were recruited. Students with any physical disease (e.g., heart, lung, liver, kidney, other vital organ, and endocrine disease) who may have been receiving medication and experiencing drug side-effects were excluded. Three classes from Grade three to five in each school were randomly selected; hence, students in 15 classes from five schools were recruited. The study information was delivered to these students by their physical education teachers. A total of 945 students returned the consent forms with their parent's consent and the overall response rate was 74.9%. The study obtained ethical approval from institutional Committee on the Use of Human and Animal Subjects in Teaching and Research.

2.2. Measures

Information on the personal characteristics of the students, including their age, sex, physical activities, eating behaviors, and sleep duration and quality, was collected using the student questionnaire. Family factors and children's early-life developmental factors were collected using the parent questionnaire. A pilot study was conducted in 16 pairs of students and parents. Test-retest reliability of the questionnaire was assessed in a 2-week interval with an acceptable average Kappa of the items at 0.71.

2.2.1. Student demographic characteristics and behavioral factors

Dietary questions were adopted from the food frequency questionnaire.[19] It consisted of six items in a 5-point Likert scale. The frequencies with which they consumed breakfast and key food items during the last week (i.e., fruit, vegetables, milk, fried foods away from home and sugar-sweetened beverages) were evaluated. The possible responses were "never," "1-2 days per week", "3-4 days per week", "5–6 days per week," and "everyday". The responses to questions on these eating behaviors were further categorized into dichotomous variables for analysis representing having/not having the study eating behaviors (i.e., daily breakfast, fruit, vegetables, and milk intake, never/at least one day of intake for fried foods away from home and sugar-sweetened beverages).

The participants' physical activity was assessed by the valid Chinese version of the Physical Activity Questionnaire for Older Children (PAQ-C).[20] The scale in this sample presented good internal consistency ($\alpha = 0.81$). The children's PAQ-C score ranged from 1 to 5 with a higher score indicating a higher physical activity level. The students were asked to report their bedtimes and wake-up times during weekdays and weekends. Their average nocturnal sleep duration was calculated. The children's sleep quality was assessed using the statements "very good", "good", "fair", "poor", and "very poor".

2.2.2. Family factors and children's early-life developmental factors

Parents who agreed to participate in the study received a parent questionnaire from their child. Data on both paternal and maternal heights, weights, highest education attained, and employment status as well as monthly household income, average living space per person, and whether a single bedroom was provided for their child were collected. The parents' BMIs were calculated and classified into non-overweight and overweight groups according to the international classification of overweight in adults (≥ 25.0 kg/m^2).[21]

The children's early-life developmental information on their birth weight (kg), gestational age (premature baby or not), feeding pattern (breastfeeding or not), and breastfeeding duration (month) were also collected through the parent questionnaire.

2.2.3. Body weight status

Student weights and heights were measured by the physical education teachers during the study period. The heights were measured to the nearest 0.1 cm and the weights were measured to the nearest 0.1 kg. Body mass index (BMI, kg/m^2) was calculated as the weight in kilograms divided by the height in meters squared. According to international age- and sex-specific cutoff points, the body weight statuses of participating children were classified into non-overweight, overweight and obesity based on their BMI values.[22] The overweight and obesity groups were combined as overweight group for further analyses.

2.2.4. Questionnaire administration

To minimize expenses and classroom disruption, school physical education teachers administered the questionnaires to the students. The parent questionnaire was delivered to the parents by their child. Each student returned two sets of questionnaires upon completion, within a week. For students who did not hand in the questionnaires, the school teacher made 2 additional contacts with them. The participants who did not respond to the second contact were considered as incomplete to the study.

2.3. Statistical analysis

Chi-square analyses were performed to examine the differences in the prevalence of overweight across sex and age groups. The associations between family, early-life development and behavior-related factors and overweight were assessed using binary logistic regression models. The odd ratios (ORs) and 95% confidence intervals (CIs) were first performed in a univariate logistic regression analysis. The adjusted ORs (AOR) were subsequently calculated adjusting for the children's age and gender. Considering the progressive influences among the independent study variables (i.e., family, early-life development and behavior-related factors), an addition of family-related factors that were found to have a p < 0.10 for AOR were adjusted for the analysis on early-life developmental variables. Likewise, the family and early-life development-related factors with a p < 0.10 for AOR were adjusted for the analysis on the children's behavioral variables. A full model by using hierarchical logistic regression was subsequently conducted to estimate adjusted OR for multiple variables (ORm). Sex and age groups were forcedly entered in model. Family-related variables were forward selected in Block 2, children's early-life development-related variables were forward selected in Block 3, and children's behavioral variables were forward selected in Block 4. The model was set with P = 0.10 and P = 0.15 as entry and removal criteria respectively. The

Table 1
Characteristics of the children (N = 894).

	n	Mean	SD
Height (m)	894	140.5	8.9
Weight (kg)	894	35.7	9.6
BMI (kg/m^2)	894	17.9	3.3

	n	% overweight	χ^2 (p)
Overall	894	19.9	
Sex			**7.37 (0.007)**
Male	451	23.5	
Female	443	16.3	
Age (yrs)			4.31 (0.229)
9	249	17.3	
10	308	19.5	
11	249	24.1	
12	88	17.0	

Note: Chi-square value with p<0.05 was bold.

data were analyzed with SPSS 20.0 and the statistical significance was defined as a 2-tailed p-value of <0.05.

3. Results

Fifty-one students and their parents (5.4%) did not return the questionnaires, resulting in a final sample of 894 primary students aged 9-12 years (mean age: 10.2 ± 0.9 years). The study sample consisted of 451 boys (50.4%) and 443 girls (49.6%) with a mean BMI of 17.9 (SD: 3.3) kg/m^2. The prevalence of overweight was 19.9%

including 4.6% obese respondents. The boys had a much higher proportion of overweight participants (23.5%) than the girls (16.3%) (χ^2 = 7.37, p = 0.007). No significant difference in the overweight rate was found across the children's age groups (Table 1).

Table 2 presents the associations between family-related variables with child overweight. Of the parents, 27.1% and 9.2% of fathers and mothers were overweight, respectively. Fathers who were overweight were more likely to have overweight children compared to those with normal or thin body weights (AOR: 1.72, 95% CI: 1.18-2.52). The same and stronger trends were also detected for the mother's body weight status (AOR: 3.19, 95% CI: 1.94-5.22). The mothers' education level was significantly related to childhood overweight. Compared to those who did not attain tertiary education, mothers who graduated from college or above were significantly likely to have non-overweight children (AOR: 0.57, 95% CI: 0.36-0.88). The median monthly domestic household income for 2015 in Hong Kong was $24, 500.[23] A lower rate of overweight children was observed in families with higher incomes than the median in comparison to those that did not reach the median level (AOR: 0.65, 95%CI: 0.45-0.95). No significant association was found between other family factors and child overweight.

The associations between children's early-life developmental factors and overweight in children are shown in Table 3. The significant family factors mentioned above (i.e., paternal and maternal body weight statuses, maternal education, and family income) were adjusted in the analysis as well as the children's sex and age. Children who were not breast-fed were more likely to become overweight than their counterparts, which was of marginal

Table 2
Associations of family-related factors and overweight in children.

	N	% Overweight children	OR (95%CI)	AOR (95%CI)
Paternal body weight status				
Non-overweight	486	17.1	1.00 (ref)	1.00 (ref)
Overweight	242	25.2	**1.64 (1.13, 2.38)**[*]	**1.72 (1.18, 2.52)**[**]
Undisclosed	166	20.5	1.25 (0.80, 1.95)	1.20 (0.76, 1.88)
Maternal body weight status				
Non-overweight	657	17.5	1.00 (ref)	1.00 (ref)
Overweight	82	39.0	**3.02 (1.85, 4.91)**[***]	**3.19 (1.94, 5.22)**[***]
Undisclosed	155	20.0	1.18 (0.76, 1.83)	1.13 (0.72, 1.77)
Paternal highest education attained				
Below college	519	21.4	1.00 (ref)	1.00 (ref)
College or above	265	17.4	0.76 (0.53, 1.13)	0.76 (0.52, 1.12)
Undisclosed	110	19.1	0.87 (0.52, 1.46)	0.81 (0.48, 1.36)
Maternal highest education attained				
Below college	575	22.1	1.00 (ref)	1.00 (ref)
College or above	205	14.1	**0.58 (0.38, 0. 90)**[*]	**0.57 (0.36, 0.88)**[*]
Undisclosed	114	19.3	0.84 (0.51, 1.40)	0.79 (0.47, 1.31)
Paternal employment status				
Full-time	720	19.9	1.00 (ref)	1.00 (ref)
Others (e.g., househusband, part-time, unemployed and retired)	174	20.1	1.02 (0.67, 1.54)	0.97 (0.64, 1.47)
Maternal employment status				
Full-time	407	20.4	1.00 (ref)	1.00 (ref)
Others (e.g., housewife, part-time, unemployed and retired)	487	19.5	0.95 (0.68, 1.32)	0.92 (0.66, 1.28)
Monthly household income (HKD)				
<25, 000	261	24.9	1.00 (ref)	1.00 (ref)
≥25, 000	487	17.5	**0.64 (0.44, 0.92)**[*]	**0.65 (0.45, 0.95)**[*]
Undisclosed	146	19.2	0.72 (0.44, 1.18)	0.70 (0.42, 1.16)
Average living space per person (sq ft)				
Below 179	513	20.5	1.00 (ref)	1.00 (ref)
Over 179	226	18.6	0.89 (0.60, 1.32)	0.88 (0.59, 1.32)
Undisclosed	155	20.0	0.97 (0.62, 1.52)	0.94 (0.60, 1.47)
Single bedroom for the index child				
No	350	20.3	1.00 (ref)	1.00 (ref)
Yes	455	20.2	0.99 (0.70, 1.41)	0.98 (0.69, 1.39)
Undisclosed	89	16.9	0.80 (0.43, 1.47)	0.77 (0.42, 1.43)

Note: 1 USD = 7.78 HKD at the time of survey. HKD, Hong Kong dollars; USD, US dollars.
OR, univariate odds ratios; AOR, adjusted odds ratio, odds ratios adjusted by children's sex and age.
OR and 95%CI of variables with p < 0.05 were bold.
[*]p < 0.05, [**] p < 0.01, [***] p < 0.001.

Table 3
Associations between children's early-life development-related factors and overweight in children.

	N	% Overweight children	OR (95%CI)	AOR (95%CI)
Birthweight				
Normal (2.5~4.0kg)	601	20.0	1.00 (ref)	1.00 (ref)
Low (<2.5kg) or high (≥4.0 kg)	99	23.2	1.21 (0.73, 2.02)	1.26 (0.74, 2.13)
Undisclosed	194	18.0	0.88 (0.58, 1.34)	0.82 (0.47, 1.44)
Premature baby (gestational age < 37 weeks)				
No	706	19.7	1.00 (ref)	1.00 (ref)
Yes	63	20.6	1.06 (0.56, 2.00)	1.05 (0.54, 2.05)
Undisclosed	125	20.8	1.07 (0.67, 1.71)	1.34 (0.59, 3.06)
Feeding pattern				
Breastfeeding	280	19.3	1.00 (ref)	1.00 (ref)
Not Breastfeeding	490	20.8	1.10 (0.76, 1.59)	1.30 (0.97, 2.04)†
Undisclosed	124	17.7	0.90 (0.52, 1.56)	0.80 (0.33, 1.95)
Breastfeeding duration				
≥6 months	148	18.2	1.00 (ref)	1.00 (ref)
<6 months	622	20.7	1.17 (0.74, 1.86)	1.12 (0.69, 1.81)
Undisclosed	124	17.7	0.97 (0.52, 1.80)	0.75 (0.29, 1.94)

Note: OR, univariate odds ratios; AOR, adjusted odds ratio, odds ratios adjusted by children's sex and age and family-related variables with p < 0.10 listed in Table 2.
†p < 0.10.

significance, with an OR at 1.30 (95% CI: 0.97, 2.04). The other study factors were not associated with the children's body weight status.

Table 4 presents the associations between the children's behavioral factors and their body weight status. The appropriate sleep duration for school-aged children is between 9 and 11 hours.[24] The study found that children with shorter sleep durations were significantly likely to be overweight (AOR: 1.94, 95% CI: 1.36, 2.75) when adjusting for the family and early-life development-related factors, at p < 0.10. A significant association with child overweight was not identified either with eating behaviors relating to breakfast, fruit, vegetables, milk, fried foods away from home and sugar-sweetened beverages, or with the physical activity score.

Results of hierarchical logistic regression for multiple variables are present in Table 5. The associated factors (i.e., paternal and maternal body weight status, maternal highest education attained, and children's sleep duration) remained significant with similar magnitudes in a full model. However, monthly household income became non-significant.

4. Discussion

Childhood overweight and obesity were world widely prevalent. This study examined the prevalence of childhood overweight in Hong Kong, a region that includes both melting Eastern and

Table 4
Associations between children's behavioral factors and overweight in children.

	N	% Overweight children	OR (95%CI)	AOR (95%CI)
Sleep variables				
Daily sleep duration (hours/day)				
9.0~11.0	464	15.1	1.00 (ref)	1.00 (ref)
< 9.0	422	25.4	**1.91 (1.37, 2.68)*****	**1.94 (1.36, 2.75)****
> 11.0	8	12.5	0.80 (0.10, 6.64)	0.80 (0.09, 6.98)
Sleep quality				
Good/very good	496	19.8	1.00 (ref)	1.00 (ref)
Bad/very bad/general	398	20.1	1.02 (0.73, 1.42)	0.95 (0.68, 1.34)
Eating behaviors				
Breakfast (daily intake)				
Yes	734	18.9	1.00 (ref)	1.00 (ref)
No	160	24.4	1.38 (0.92, 2.07)	1.27 (0.83, 1.94)
Fruit (daily intake)				
Yes	393	20.4	1.00 (ref)	1.00 (ref)
No	501	19.6	0.95 (0.68, 1.32)	0.81 (0.57, 1.15)
Vegetables (daily intake)				
Yes	663	20.5	1.00 (ref)	1.00 (ref)
No	231	18.2	0.86 (0.59, 1.26)	0.77 (0.51, 1.15)
Milk (daily intake)				
Yes	194	20.6	1.00 (ref)	1.00 (ref)
No	700	19.7	0.95 (0.64, 1.40)	0.92 (0.61, 1.39)
Fried foods away from home				
No	395	20.3	1.00 (ref)	1.00 (ref)
Yes (≥1 day)	499	19.6	0.96 (0.69, 1.34)	0.90 (0.64, 1.27)
Sugar-sweetened beverages				
No	236	18.6	1.00 (ref)	1.00 (ref)
Yes (≥1 day)	658	20.4	1.12 (0.76, 1.63)	0.95 (0.64, 1.41)
	N	Mean (SD)	OR (95%CI)	AOR (95%CI)
Physical activity	893	2.53 (0.64)	1.00 (0.77, 1.29)	0.95 (0.73, 1.23)

Note: OR, univariate odds ratios; AOR, adjusted odds ratio, odds ratios adjusted by children's sex, age, and family and development-related variables with p < 0.10 listed in Tables 2 and 3. OR and 95%CI of variables with p<0.05 were bold.

Table 5
Hierarchical logistic regression for factors associated with overweight in children.

	OR$_m$ (95% CI)	P
Family-related factors		
Paternal body weight status		
Non-overweight	1.00 (Ref)	
Overweight	**1.82 (1.07,3.10)**	0.028
Undisclosed	2.16 (0.71, 6.60)	0.176
Maternal body weight status		
Non-overweight	1.00 (Ref)	
Overweight	**3.29 (1.63, 6.65)**	0.001
Undisclosed	0.70 (0.18, 2.67)	0.599
Maternal highest education attained		
Below college	1.00 (Ref)	
College or above	**0.52 (0.29, 0.93)**	0.026
Undisclosed	2.30 (0.47, 11.27)	0.305
Children's behavioral factors		
Daily sleep duration (hours/day)		
9.0~11.0	1.00 (ref)	
< 9.0	**1.96 (1.24, 3,14)**	0.014
> 11.0	0.75 (0.12, 6.23)	0.099

Hierarchical logistic regression was performed to estimate adjusted OR for multiple variables (OR$_m$). Sex and age group were forcedly entered in model. Family-related variables in Table 2 were forward selected in Block 2, children's early-life development-related variables in Table 3 were forward selected in Block 3, and children's behavioral variables in Table 4 were forward selected in Block 4. The model was set with P = 0.10 and P = 0.15 as entry and removal criteria respectively. OR and 95%CI of variables with p<0.05 were bold.

Western cultures (e.g., a mixed food culture), and it explored the potential factors in childhood overweight from family, early-life and behavioral aspects.

One in every five Hong Kong children was overweight. The high prevalence of overweight/obesity (19.9%) in this study was consistent with that in many other studies in Hong Kong, e.g., 18.7% in the Survey of Overweight and Obesity Rate of Hong Kong Primary Students[7] and 20.8% to 25.9% in children aged 9-15 years in the Wellness Population of Youth Study.[25] Data from big cities in China have also reported a similar prevalence of overweight and obesity in primary school children, such as 21.2% in Guangzhou[26] and 20.4% in Beijing.[27] Consistent with the previous studies,[25–27] a higher prevalence of overweight was observed among boys (23.5%) than girls (16.3%), which may have resulted from the influence of socio-cultural (such as the preferred prototype for strong boys and slender girls in Chinese culture), socio-economic, behavioral, and genetic factors.[28] This finding reminds health professionals to adopt different approaches to prevent childhood overweight and obesity between boys and girls.

Parental obesity has been identified as a predominant risk factor for childhood obesity.[29] In line with the demonstrated family resemblance in terms of the weight status, overweight parents were more likely to have overweight children than non-overweight parents in the current study. Our ORs showed a stronger influence from the maternal body weight status than the paternal status on the prevalence of children overweight, which may because the family's food environment and children's eating behaviors are primarily shaped by mothers rather than fathers.[30] The findings indicated that further interventions and promotions should involve parents and consider the family as a unit to tackle childhood overweight.

The inverse association between the family socio-economic status (SES) and adiposity in children has been documented in plenty of previous studies in a review on SES and childhood overweight, even the SES was relatively stable and not easily changed.[31] As noted, a stronger inverse association was found between parental education and adiposity than between parental occupation and adiposity because the occupation could be more liable to

change.[31] In this study, an association was not found with the parental employment status, but mothers who had higher educational attainment were less likely to have overweight children. The fathers' education levels did not play a role in the children's adiposity in this study. This finding may be explained by the common parenting practice in which the mother's education can influence their knowledge and beliefs and these are keys to facilitate children to adopt healthy lifestyles in a family environment when compared to the father's influence. Furthermore, children in families with higher monthly household incomes were less likely to be overweight because the income may relate to access to healthy choices with respect to exercise and diet.[32] However, family household income became nonsignificant when all the family variables were included in a model, which may indicate that the influence of household income was weaker than that of other SES indicators.

The associations between the children's early-life variables with their body weight status are also explored. A higher birth weight increased the risk of child and adolescent overweight[33] and a low birth weight was reported to have an association with adult obesity.[34] The analyses were performed between the high/low birthweight and normal birthweight groups, respectively, and similar findings were found. Given the small proportions of high or low birthweight children, the combined group (i.e., an abnormal birthweight group) was presented. In this study, children with an abnormal birth weight (<2.5kg or ≥ 4.0 kg) were overweight at a higher proportion compared with those with normal birth weights (23.2% vs. 20.0%). However, this association did not reach a significant level. The other important birth-related variable is the gestational age in children. When born small for their gestational age, children tend to develop catch-up growth during the infancy period and become overweight with increasing fat mass in their later life.[35] A previous Chinese study reported a higher risk of being overweight in small-for-gestational-age children.[26] However, we did not observe a significant influence of preterm birth in the children in our study. The breastfeeding benefits for infant nutrition and the protective function of breastfeeding against childhood obesity have been demonstrated.[36] The duration of breastfeeding showed a dose-response pattern with a protective relationship.[37] In this study, the association between the feeding pattern and overweight was observed, and children who were not breast-fed were likely to have a risk of overweight compared to those who engaged in breastfeeding with marginal significance, which might reach significance given a larger sample size. However, prolonged breastfeeding (≥6 months) was not found to have an association with a reduced risk of overweight.

Children's behavioral factors that were modifiable were explored in the study. Participants with shorter sleep durations were more likely to be overweight compared to those with an appropriate sleep duration at the recommended level, with an AOR at 1.94 (95% CI: 1.36-2.75), which was consistent with a previous study in Chinese school-age children at a similar magnitude.[26] It was biologically plausible that sleep curtailment was associated with a decreased leptin level and increased ghrelin levels.[38] Changes in these two appetite regulatory hormones could stimulate appetite and cause more food intake over time. But another study did not find such associations between sleep duration and children overweight as well as that of sleep quality in Hong Kong Chinese children.[13]

Healthy eating, such as increasing fruit and vegetable consumption, milk and dairy products intake, and having breakfast every day, is believed to play a crucial role in promoting health.[39,40] In this study, we did not find a significantly higher prevalence of overweight among children who skipped breakfast, fruit, vegetables, or milk at least one day per week when compared with those

with daily intakes. These findings may be partially attributed to the fact that the eating frequency rather than the intake quantity was measured in this study, which limited the ability to detect potential associations. Further studies to assess the daily amount of fruit, vegetable, and milk intake are needed.

Energy-dense diets and a lack of physical activity are the major culprits in the evolving child obesity epidemic.[41] In this study, we examined two types of energy-dense foods, fried foods away from home and sugar-sweetened beverages. However, no significant association was found between these two energy-dense food intake and overweight children. A longitudinal study revealed that the increasing (over 1 year) consumption of fried food away from home from "never or < 1/week" to "4 to 7/week" was associated with an increasing BMI compared with those children with a low consumption of fried foods away from home at baseline and 1 year later.[42] A positive association between greater intakes of sweetened beverages and weight gain was demonstrated in a review that included both cross-sectional and cohort studies.[43] The inconsistent findings of this study relative to previous studies may be explained by the limitation of the test's power by the dichotomous responses (yes/no) rather than the dose-response (e.g., high intake, low intake, or never).

It is well known that an active lifestyle in childhood plays an important role in optimizing growth and development. Insufficient physical activity and more sedentary behaviors are inversely associated with childhood overweight.[44] However, this study failed to demonstrate a relationship between the PAQ-C score and overweight. The possible reason may be a low physical activity level in the study participants. All the participants presented an average PAQ-C score of 2.53 (SD: 0.64), which is lower than that among different racial groups, such as 3.49 (SD: 0.68) in British samples[45] and 3.37 (SD: 0.69) in African American children.[46] Prevalence of active Hong Kong Chinese children aged 7-12 years was quite low at only 8.3%.[47] Intervention strategies are strongly encouraged to prompt a better physical activity level of Chinese children.

There are several limitations to be warranted. First, the parent questionnaire was delivered by the student participants, and it was returned to the school teacher when completed. This type of self-administered process may not guarantee a high questionnaire response rate (the non-responsive rate for single items ranged from 9.9% to 18.6%). Second, the study diet variables were measured by self-constructed questionnaire. Due to the sample size, all the study variables were categorized into dichotomous responses. The subgroup analysis or dose-response effect cannot be examined in the study. Further study on the quantity of intake is needed. Third, given the inherent limitation of the self-reported PA measure, objective measures such as the use of an accelerometer are suggested to assess the children's physical activity pattern and explore the relationships between such pattern and childhood overweight. Furthermore, there are significant influences of sex groups and puberty status in body composition even boys and girls did not differ in relation to the age distribution.[48] Further studies on the associated factors should be conducted considering puberty status and sex group differences. Additionally, the study sample was recruited from five local schools located in two geographic regions only and the finding may have limitation to generalize to the whole pediatric population in Hong Kong. Lastly, the causal relationships between the factors and child overweight could not be drawn from the present cross-sectional design.

5. Conclusion

In summary, the prevalence of pediatric overweight was relatively high, particularly among the male participants. Child overweight was linked to paternal and maternal overweight, maternal education attainment at below college level, and low monthly household income. This study demonstrated the family resemblance in weight status. Further interventions and promotions should involve parents and consider the family as a unit to tackle childhood overweight. Moreover, short sleep durations were identified as a risk factor in childhood overweight. Children who were not breast-fed as infants were more likely to become overweight, with marginal significance. More risk profiles in this population are further needed to explore in a larger sample and collective evaluation of multiple overweight-related factors should receive more attention to inform the tailored intervention.

Conflict of interest

The authors stated no conflict of interest.

Acknowledgments

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