Children with Intellectual Disability Are Vulnerable to Overweight and Obesity

Wang, Jingjing; Gao, Yang; Kwok, Heather H M; Huang, Wendy Y J; Li, Siuting; Li, Liping

Published in:
Childhood Obesity

DOI:
10.1089/chi.2018.0015

Published: 01/07/2018

Document Version:
Peer reviewed version

Title: Children with intellectual disability are vulnerable to overweight and obesity: a cross-sectional study among Chinese children

Running head: Overweight and obesity in children with ID

Authors: Jingjing Wang, PhD,[1] Yang Gao, PhD,[2#] Heather H.M. Kwok, Med,[2] Wendy, Y.J. Huang, PhD,[2] Siuting Li, MEd,[3] Liping Li, PhD[4]

[1] *Mass Sports Research Center, China Institute of Sport Science, Beijing, China*

[2] *Department of Physical Education, Faculty of Social Sciences, Hong Kong Baptist University, Hong Kong, China*

[3] *Caritas Lok Jun School, Hong Kong, China*

[4] *Injury Preventive Research Center, Shantou University Medical College, Shantou, China*

Authors' emails:

Jingjing Wang: wangjingjing@ciss.cn

Yang Gao: gaoyang@hkbu.edu.hk

Heather H.M. Kwok: heatherk@hkbu.edu.hk

Wendy, Y.J. Huang: wendyhuang@hkbu.edu.hk

Siuting Li: lst98@caritaslokjun.edu.hk

Liping Li: lpli@stu.edu.cn

corresponding author

Address correspondence to: Yang Gao, Department of Physical Education, Shek Mun (Shatin) Campus Centre, Hong Kong Baptist University, 8 On Muk Street, Shek Mun, Shatin, N.T., Hong Kong, China. Email: gaoyang@hkbu.edu.hk. Tel: (852) 3411 3082. Fax: (852) 3411 5757.

Conflict of interest

None

Funding

This research was supported by the Health Care and Promotion Fund (HCPF) of Hong Kong (Ref. No.: 01170068).

Author contributions

YG conceived of and designed the study. HK, WH, and SL contributed to the data collection. JW performed the statistical analysis and drafted the manuscript. LL and YG contributed to the interpretation of results. All authors were involved in writing and revising the manuscript and approved the final version of the manuscript.

Children with intellectual disability are vulnerable to overweight and obesity: a cross-sectional study among Chinese children

Abstract

Objectives: The epidemic of childhood obesity has been well documented in typically developing child populations, while situations among children with intellectual disabilities (ID) remain unclear.

Methods: A cross-sectional study was conducted among 524 Chinese children with ID (males: 68.9%, mean age: 12.2 years) in Hong Kong in 2015. Children's height and weight were measured at school. Parents, in the presence of their children, completed a self-administered questionnaire at home about the children's physical activity (PA), eating habits, and sleep duration in a typical week as well as parenting practices regarding children's eating and PA, and their socio-demographic characteristics.

Results: Of the participants, 31.3% were overweight or obese, which was higher than their typical counterparts (18.7%-19.9%). Multivariate logistic regression analyses revealed that overweight and obesity in children with ID were linked to their co-morbidity with autism, maternal overweight and obesity, parenting practices with less pressure to eat more, children having shorter sleep duration, longer periods of sedentary behavior, and higher intake frequencies of sweetened food, fried food, and meats, fish, and eggs.

Conclusions: Children with ID are vulnerable to being overweight or obese. Identified risk factors in this study highlight a multifaceted approach to the involvement of parents

as well as the modification of some children's questionable behaviors to help them achieve a healthy weight.

Keywords: prevalence, risk factors, obesity, children with disability

Introduction

Overweight and obesity in children are a looming crisis for public health and has attracted much attention in the past decades.[1] Those with childhood obesity are more likely to suffer from developmental problems, such as poor cognitive function, psychological disorders, altered timing of puberty, and physical health issues (e.g., type 2 diabetes mellitus, hypertension, asthma, and musculoskeletal disorders).[1] Childhood obesity can also lead to adult obesity, elevated risks for cardiovascular and metabolic diseases in adulthood, and even mortality.[2]

The rapid increase in the prevalence of childhood overweight and obesity has been observed globally, including Asia, where people have commonly been deemed to be less affected by the obesity epidemic compared to those living in the Americas, Europe, and Oceania. For example, in some well-developed urban areas of China, the overweight and obesity rates were 32.6% for boys and 19.1% for girls in 2010, which are similarly high to the rates in Western countries.[3] In Hong Kong, the overweight and obesity rates for primary students increased from 11.2% in 1995 to 18.7% in 2015.[4]

Children with intellectual disabilities (ID) are those with significantly reduced ability to understand new or complex information, learn new skills (impaired intelligence), and cope independently (impaired social functioning), which starts before the age of 18 years and has a lasting effect on development.[5] People with ID account for approximately 1 to 4% of the entire population worldwide.[6] The highest prevalence is seen in children and adolescents. In Hong Kong, the latest data reveal that there were 8,141 intellectually disabled youths aged 15-24 years in 2012, which is about 0.90% of the whole population in this age group.[7]

Children with ID might be more vulnerable to overweight and obesity compared to other children, as they tend to be less active and less empowered to choose and adopt healthy behaviors.[8] Although the obesity epidemic among children in general has been well documented, knowledge about overweight and obesity in children with ID is scarce. In addition, the limited studies show mixed results. Some studies observed higher prevalence in children with ID than non-ID peers, while others did not.[9-13] The conflicting evidence may be due to small samples and biased populations in some studies, as well as significant differences in the participants' characteristics across the studies, such as the severity level of ID or comorbidities (e.g., Down Syndrome, autism).[10,11,14] Furthermore, children's gender, age, ID level, genetic syndrome, and medication use might be associated with overweight and obesity in children with ID.[11] McGillivray and colleagues[15] also summarized parental factors that are associated with obesity among children with disability, including family socioeconomic status, parental body mass index (BMI), perception and attitudes towards their children's weight and physical activity (PA), and the PA levels of both parents.

The disease burden and economic costs to people with ID are huge, as they affect the individual, the immediate family, and the community where they live.[16] Overweight and obesity in people with ID exacerbate their limitations resulting from the disability and deteriorate their health status, consequently hindering their maximal integration into society.[17] ID usually emerges from an early age with high co-morbidity and involves the utilization of a large amount of public health resources.[18] People with ID have the right to attain optimal health like the rest of the population. They should be given priority to eliminate existing health inequities.[16]

The prevalence of overweight and obesity differed between Asian and Caucasian typical children, partially attributable to different eating culture and PA habits.[19] Thus, findings from western countries on obesity in children with ID may also not be suitable to apply to China and other Asian countries. To our knowledge, there is only one study reporting the prevalence of overweight and obesity in Chinese children with mild ID in 2006.[9] No study has investigated the associated modifiable factors. To fill this knowledge gap, this study investigates the prevalence of overweight and obesity among Chinese children with mild and moderate ID and its associations with the background characteristics of parents and children, parenting practices, and the children's obesity-related behaviors.

Methods

Study design and sample

This cross-sectional study was conducted from June to November 2015 with focuses on children with mild and moderate ID (intelligence quotient (IQ) ranges: 50-69 for mild and 35-49 for moderate ID).[5] The majority of intellectually disabled children study in special schools in Hong Kong.[20] As of September 2014, there were 5,118 students with mild and moderate ID in 31 special schools.[20] A cluster sampling method was adopted to recruit participants. First, we sent invitation letters to all 31 schools, of which 12 consented to participate. Second, all eligible students in the 12 participant schools were invited to the study. Students who provided written consent forms with parental consents were finally included in the study. Ethical approval was obtained from the Ethic Committee on the Use of Human and Animal Subjects in Teaching and Research of Hong Kong Baptist University.

Measures and data collection

Overweight and obesity in children

Trained research assistants measured the children's height and weight at school in the morning using standard procedures. BMI values (kg/m^2) were calculated. Children were then classified into four body weight groups (underweight, normal, overweight, and obesity) using international age- and gender-specific criteria on BMI cut offs recommended by Cole et al.[21,22] This variable was regrouped into two categories (non-overweight vs. overweight and obesity) for further data analyses.

Background characteristics of parents and children

Information on parental education, occupation, marital status, and height and weight was collected with questionnaires. Parental BMI was then calculated and classified into a non-overweight group (< 25.0 kg/m^2) and an overweight and obesity group (≥ 25.0 kg/m^2) according to the international classification criteria for adults.[23] In addition, the children's ID level, birth place, boarding status, diagnosed comorbidities (e.g., Down syndrome, autism, epilepsy, and attention deficit hyperactivity disorder (ADHD)) were also reported by their parents.

Parenting practices regarding children's eating and PA

Parenting practices regarding their children's eating and PA were assessed by the Chinese version of a scale with 17 items rated on a 5-point Likert scale (ranging from 1 = "never" to 5 = "always").[24] Sound validity and reliability were obtained in both Chinese and Caucasian populations.[24,25] It consists of five subscales, including "diet and PA monitoring" (MO, 6 items; e.g., "How often do you keep track of fatty food (such as fried food, sugar-sweetened beverages) that your child eats?"), "restricting access to unhealthy food and sedentary behaviors" (RA, 4 items; e.g., "I limit the amount of his/her intake of snacks"), "pressure to eat more" (PE, 3 items; e.g., "I ask my child to eat more even if he/she says 'I have eaten enough'"), "reinforcement

regarding children's eating and PA" (RF, 2 items; e.g., "I praise my child if he/she eats a healthy snack"), and "using food or sedentary behaviors as rewards" (UR, 2 items; e.g., "I offer sweet snacks (candy, ice cream, etc.) to my child as a reward for good behavior"). The average score for each subscale was computed, with higher values indicating more frequent use of the parenting practice.

Children's lifestyle

A self-administered questionnaire was completed by parents at home with assistance from their children. The information collected consisted of children's lifestyle (including eating habits, PA, sedentary behaviors, and sleep duration), parenting practices, and background characteristics of both parents and children. Children with ID may not be able to understand and respond to the questionnaire independently, and their parents may have limited knowledge about their activities at school.[8] Therefore, this combination of parental proxy reporting and self-reporting was suggested to increase the accuracy of the information collected.[26]

Questions on the eating habits of children were adopted from a dietary practices questionnaire used in a population-based study in Hong Kong.[27] The questionnaire measures the frequencies of food consumption in a typical week, including fruits, vegetable, meats, fish, eggs, fried food, sweetened food, and snacks. In addition, eating habits at breakfast and regular meals were also surveyed.[27] The Chinese version of the Global Physical Activity Questionnaire (GPAQ)[28] was modified to estimate children's PA and sedentary behaviors. Questions about PA at the context of "work" in GPAQ was replaced with "school" to fit the study population, including activity examples. The modified GPAQ asks about the frequency and duration of moderate PA (MPA) and vigorous PA (VPA) in three domains (leisure time, school,

and transport (MPA only)) in a typical week, with an additional question on sedentary behaviors (minutes/day) in a typical day.

The average daily time spent performing moderate to vigorous intensity PA (MVPA) was calculated for the children and used to divide them into two groups (active vs. inactive) according to the WHO recommended PA level for children (60 min/day). For sedentary behaviors, a cut-off point of 4 hours/day was adopted for grouping. Additionally, we added two questions to collect information on children's sleep duration on a typical weekday and during the weekend. The average sleep duration was divided into two groups (sufficient vs. insufficient, cut-off point: 8 hours/day).

Questionnaire administration and quality control

A pilot survey was conducted to test the data collection instruments and the feasibility of the field work procedures. A test-retest evaluation of the questionnaire was administered with 19 students in a two-week interval. The average Kappa of the items was 0.71, indicating acceptable test-retest reliability.

Statistical analysis

Considering that there was large variation in the participation rates by school (range: 15.0 - 54.1%), the schools were grouped into three categories of high (36.5 - 54.1%), middle (25.5 - 28.2%), and low participation rates (15.0 - 17.6%) to examine possible bias due to the different participation rates. Chi-square tests were performed to examine the differences in the prevalence of overweight and obesity by gender and age groups. Student *t* tests were performed to examine differences in continuous variables (i.e., parenting practices) between non-overweight and overweight and obesity groups. Univariate and multivariate logistic regressions were performed to estimate the associations between the studied variables and overweight and obesity

with and without controlling for other influential factors. The odds ratio (OR), adjusted OR (AOR), and their 95% confidence intervals (95% CI) are reported. Gender and age were adjusted for in all analyses.

Considering the progressive influences among each block of the independent study variables, background characteristics that were found to have a $p < 0.10$ for AOR were adjusted for in the analyses to estimate the risks of parenting practices. Likewise, an addition of parenting practices with $p < 0.10$ for AOR was also adjusted for in the analyses of children's lifestyle factors.

Furthermore, a hierarchical logistic regression was fitted to estimate AOR for multiple variables (ORm) in a full model. Gender and age groups were forcedly entered in the model. Background variables, including school, children characteristics, and parental characteristics, were forward selected in Block 2; parenting practices (i.e., MO, RA, PE, RF, UR) were forward selected in Block 3; and children's lifestyle variables were forward selected in Block 4. The model was set with $p = 0.10$ and $p = 0.15$ as the entry and removal criteria, respectively. IBM SPSS Statistics 21 was used for data analysis, and statistical significance was defined by a 2-tailed p-value of < 0.05. Bonferroni correction for multiple comparisons was applied for variables having more than two categories.

Results

A sample of 558 participants returned the parental consent forms, and the overall participation rate was 26.9%. Among them, 34 children who did not return the questionnaires were excluded from data analyses. The final sample included 524 children with 361 boys and 163 girls. The average age was 12.1±3.9 years. The overall combined rate of overweight and obesity was 31.3%, including an obesity rate

of 9.2%. Chi-square tests did not reveal significant differences in the distribution of body weight status by gender and age group (Table 1).

Table 2 presents the associations between background characteristics and overweight and obesity in children with ID. Children who had co-morbid conditions with autism were more likely to be overweight or obese (AOR: 1.57, 95%CI: (1.04, 2.38)). An elevated risk of child overweight and obesity was significantly detected in those whose mothers were overweight or obese (AOR: 2.24, 95%CI: (1.48, 3.39)). AOR was 1.58 (95%CI: 0.95, 2.63, p<0.10) for comparison of the prevalence of overweight and obesity between the children born in Hong Kong and those born in other places. Considering the influences of these background variables, we adjusted for them in further association analysis. Table 3 shows the associations between parenting practices and overweight and obesity among children with ID after controlling for gender and age of the children and the background variables with $p < 0.10$. Parents whose children were overweight or obese showed significantly lower use of pressure to eat more (mean ± standard deviation (SD): 2.75 ± 0.62) than those with non-overweight children (mean ± SD: 3.17 ± 0.65). Children were less likely to be overweight and obese if their parents placed more pressure on them to eat more (AOR: 0.35, 95%CI: 0.25, 0.50). No significant associations were found in other subscales of parenting practices.

Table 4 shows the associations between lifestyles and overweight and obesity in children with ID. Elevated risks for overweight and obesity were observed in children who had shorter sleep duration (AOR: 1.96, 95%CI: 1.09, 3.51) and more sedentary behavior (AOR: 1.60, 95%CI: 1.04, 2.45), but not in those with insufficient PA. As for eating behaviors, children who had higher consumption of meats, fish, eggs, fried

food, and sweetened food were more vulnerable to being overweight or obese (AORs ranged from 1.69 to 3.86).

The results of the hierarchical logistic regression showed that the associations of maternal overweight and obesity, parental pressure to eat, birth place, sleep duration, and consumption of meats, fish, and eggs with overweight and obesity in children remained significant with similar magnitudes (Table 5).

Discussion

ID ranks among the top 20 most costly disorders.[29] A child with ID creates a wide set of challenges to the individual, family, and society, and overweight and obesity aggravate those challenges due to the elevated risks for cardiovascular and metabolic-related morbidity and mortality.[17] Studying the related factors could provide insight into the risk factors for overweight and obesity for the design of interventions. This study is the first to describe the prevalence and associated factors of overweight and obesity in a sample of Chinese children with mild or moderate ID who do not have physical disabilities.

Overweight and obesity are prevalent in this population, and nearly one-third the intellectually disabled children (31.3%) were overweight or obese. The prevalence is similar to those found in other ethnic populations, in which pooled prevalence estimates of overweight and obesity were 30% in children and 33% in adolescents.[30] Another study in 2006 reported a lower prevalence (approximately 20%) in Chinese children with mild ID.[31] The different prevalence of overweight and obesity between two studies might reflect a possible rising trend in this special population during the past decade, as observed in other studies.[11]

A meta-analysis found adolescents with ID to have 1.54 times greater risk of overweight and obesity than typically developing adolescents.[30] In Hong Kong, the prevalence of overweight and obesity in children with ID is consistently around 1.60 times higher than that among their counterparts (18.7% [4] to 19.9%[32]). The higher prevalence and increasing trend of overweight and obesity among this population deserves attention. There is an urgent need to address obesity in children with ID. Unlike previous studies on typically developing children,[32] we did not find gender and age discrepancies in the body weight status of intellectually disabled children. Due to the small sample size, the prevalence of overweight and obesity across age groups rather than age years was examined. Further studies recruiting larger samples are encouraged to investigate whether overweight and obesity rates tend to change with age in this population.

High co-occurrence of psychiatric disorders (30-50%) has been reported among children and adolescents with ID.[33] In this study, 58.5%, 34.0%, 8.8%, and 8.5% of the participants had comorbidities of autism, ADHD, Down syndrome, and epilepsy, respectively. A higher risk was observed in children with co-morbidity of autism, suggesting further action to improve the influential risks of psychiatric disorders may also be helpful to manage overweight and obesity in children with ID.

Family resemblance was found between maternal body weight status and their children's status. Participants whose mothers were overweight or obese presented higher likelihood of being overweight or obese, which may be explained by the fact that the family's food environment and eating behaviors are primarily shaped by the parents at home, especially by mothers.[34] The involvement of mothers should be strongly recommended in interventions to reduce child overweight and obesity.

The role of parents as the main caregivers of children with ID has been highlighted.[35] Beyond the parental background characteristics, parenting practices regarding children's lifestyles were examined since children's health-related habits are highly dependent on their parents' attitudes and practices.[36] No significant relationship was found between all parenting practice subscales except for pressure to eat more, which—to our surprise—was significantly and negatively associated with overweight and obesity of children. It was hypothesized that parental pressure to eat more would increase the energy intake of children and therefore increase the risk for obesity. In addition, previous studies also indicated that higher parental pressure and control might increase the likelihood of children's consumption of unhealthy food[25] and decrease healthy food intake,[37] which also contribute to the development of childhood obesity. However, an inverse association was observed in this study, which is congruent with results from another study using the same scale among typically developed Chinese children.[24]

It is unclear why higher parental pressure to eat more is linked to decreased risks for childhood obesity in Hong Kong. One possibility is that the participating parents whose children were obese might have been well equipped with appropriate knowledge (e.g., eating too much is a risk factor for obesity). As a result, they were less likely to ask their children to eat more. This possibility is supported by the fact that in the past two decades, the Hong Kong government and various organizations have been successfully implementing several region-wide programs to halt the rise of childhood obesity, such as "EatingSmart@school.hk" and "Healthy Schools Award Schemes".[38] It is also possible that parents in this study may have given higher pressure to their children to eat more if they thought children were too slim or ate too little, which may also have contributed to the negative association between pressure to

eat and obesity. The reference group of non-overweight (n=360) included 70 children with underweight, whose mean for pressure to eat more was significantly higher than those with normal weight in an independent-samples *t* test (3.40 vs.3.11, p=0.011), partially supporting this possibility. Further studies are warranted to investigate the potential mechanisms underpinning the inverse relationship between parental pressure to eat more and childhood obesity. Furthermore, as we did not find any parenting practices that show promise in reducing childhood obesity, efforts for future preventions could emphasize ways to empower parents with effective parenting methods.

Children's modifiable factors in relation to sleep, PA, and eating habits were examined in this study. Compared to the children who had sufficient sleep duration, children with shorter sleep durations had higher risk of being overweight or obese. The magnitude (OR: 1.96) was similar to that in previous studies on both intellectually disabled children[39] and typically developing counterparts.[32] No significant association was found between PA level and obesity, which may be attributed to a very low proportion of active children (MVPA $\geqslant$ 60 min/day) in this study (6.3%, Table 4). That further resulted in insufficient statistical power for this test. Furthermore, an elevated risk was significantly detected in children who spent more time on sedentary behaviors, which likely contribute to overweight and obesity because they displace other activities that require greater energy expenditure and has been associated with snacking and increased exposure to advertisements that promote foods of limited nutritional value.[40] Individuals with ID tend to lead sedentary lives and are vulnerable to being physically inactive.[41] Efforts are needed to help children with ID reduce sedentary behaviors and promote PA levels.

In addition to sedentary lifestyle, unhealthy eating habits are another main driver of the current overweight and obesity epidemic. The findings of this study provided evidence of associations between unhealthy eating habits on energy-dense food intake (i.e., fried food and sweetened food) and childhood overweight and obesity . In line with the findings of previous studies,[42,43] energy-dense food intake was documented to have a negative role in the evolving childhood obesity epidemic. Furthermore, higher risk of overweight and obesity was observed in children who had more intake of meats, fish, and eggs. Energy intake derived from meats, fish, eggs, and food containing them accounts for 10% of the total daily energy intake.[44] Higher consumption of such food may reflect larger energy intake, which may increase the possibility of being overweight and obese. These findings call for parental attempts to modify their children's unhealthy eating habits.

This study explored the potential factors of intellectually disabled children's overweight and obesity from multiple blocks in relation to the background characteristics of children and parents, parenting practices, and children's lifestyles. The progressive influence of each block was also taken into account. However, several limitations should be considered. First, some of the children's dietary habits (e.g., fruit and vegetable consumption) were categorized into dichotomous responses due to the small sample size, which limited the analysis for a dose-response effect. Further studies are recommended to recruit more participants to measure the quantities of intake and explore the dose-response effect of intake on body weight status. Second, children's PA was assessed by self-reported questionnaire by parents in combination with discussions with children. Such measures may lead to reporting bias. Objective measures (e.g., accelerometers) are suggested for further studies to obtain the children's PA patterns. Third, the low response rate of the study may

threaten the generalization of the findings. Lastly, with a cross-sectional design, the study provided hints about the factors in child overweight and obesity but cannot demonstrate causal relationships.

Conclusions

Children with ID are vulnerable to overweight and obesity. Maternal overweight and obesity, parenting practices of lower pressure to eat more, children's co-morbidity with autism, longer sedentary behaviors, shorter sleep duration, higher intakes of energy-dense foods (i.e., fried food and sweetened food), and consumption of meats, fish, and eggs were identified as risk factors of overweight and obesity in intellectually disabled children. More risk profiles and collective evaluation of the potential factors are required to explore in this population further. Undoubtedly, planning promotion strategies for healthy weight among children with ID require a multi-faceted approach targeting both children and parents.

Acknowledgments

This research was supported by the Health Care and Promotion Fund (HCPF) of Hong Kong (Ref. No.: 01170068).

Author Disclosure Statement

No competing financial interests exist.

References:

1. Lakshman R, Elks CE, Ong KK. Childhood Obesity. *Circ* 2012;126:1770-1779.
2. Park MH, Falconer C, Viner RM, Kinra S. The impact of childhood obesity on morbidity and mortality in adulthood: a systematic review. *Obe Rev* 2012;13:985-1000.

3. Ji CY, Chen TJ. Empirical Changes in the Prevalence of Overweight and Obesity among Chinese Students from 1985 to 2010 and Corresponding Preventive Strategies. *Biomed Environ Sci* 2013;26:1-12.
4. Department of Health of Hong Kong. Overweight and Obesity Rate of Hong Kong Primary Students. 2016. Retrieved from: http://school.eatsmart.gov.hk/files/pdf/Childhood_obesity_bi.pdf (accessed 15 June 2017)
5. World Health Organization. Better health, better lives: children and young people with intellectual disabilities and their families. 2010. Retrieved from: http://www.euro.who.int/intellectual_disabilities (accessed 13 May 2014)
6. Maulik PK, Harbour CK. *Epidemiology of Intellectual Disability*. In: JH Stone, M Blouin, editors. International Encyclopedia of Rehabilitation. 2010.
7. Commission on Youth of Hong Kong. Youth in Hong Kong: A Statistical Profile 2012. 2014. Retrieved from: http://www.coy.gov.hk/en/research/index.html (accessed 13 May 2014)
8. Hinckson EA, Curtis A. Measuring physical activity in children and youth living with intellectual disabilities: a systematic review. *Res Dev Disabil* 2013;34:72-86.
9. Frey GC, Chow B. Relationship between BMI, physical fitness, and motor skills in youth with mild intellectual disabilities. *Int J Obe* 2006;30:861-867.
10. Ells LJ, Shield JP, Lidstone JS et al. Teesside Schools Health Study: body mass index surveillance in special needs and mainstream school children. *Public Health* 2008;122:251-254.
11. Maïano C. Prevalence and risk factors of overweight and obesity among children and adolescents with intellectual disabilities. *Obe Rev* 2011;12:189-197.

12. Allerton LA, Welch V, Emerson E. Health inequalities experienced by children and young people with intellectual disabilities: a review of literature from the United Kingdom. *J Intellect Disabil* 2011;15:269-278.
13. Lloyd M, Temple VA, Foley JT. International BMI comparison of children and youth with intellectual disabilities participating in Special Olympics. *Res Dev Disabil* 2012;33:1708-1714.
14. Rimmer JH, Yamaki K. Obesity and intellectual disability. *Ment Retard Dev Disabil Res Rev* 2006;12:22-27.
15. Mcgillivray J, Mcvilly K, Skouteris H, Boganin C. Parental factors associated with obesity in children with disability: a systematic review. *Obe Rev* 2013;14:541–554.
16. World Health Orgnization. Meeting report: autism spectrum disorders & other developmental disorders: from raising awareness to building capacity. 2013. Retrieved from: http://www.who.int/mental_health/maternal-child/autism_report/en/ (accessed 13 October 2016)
17. Sutherland G, Couch MA, Iacono T. Health issues for adults with developmental disability. *Res Dev Disabil* 2002;23:422-445.
18. World Health Orgnization. Early Childhood Development and Disability. 2010. Retrieved from: http://apps.who.int/iris/bitstream/10665/75355/1/9789241504065_eng.pdf (accessed 15 July 2017)
19. Sorof JM, Lai D, Turner J, Poffenbarger T, Portman RJ. Overweight, ethnicity, and the prevalence of hypertension in school-aged children. *Pediatr* 2004;113(3):475-482.

20. Education Bureau of Hong Kong. Special Education. 2014. Retrieved from: http://www.edb.gov.hk/en/about-edb/policy/special/index.html (accessed 14 May 2014)

21. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240-1243.

22. Cole TJ, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. *BMJ* 2007;335:194-201.

23. Health NIo. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. *Obes Res* 1998;6:51S-209S.

24. Wen X, Hui SS-C. Parenting style as a moderator of the association between parenting behaviors and the weight status of adolescents. *J Early Adolesc* 2012;32:252-268.

25. Arredondo EM, Elder JP, Ayala GX et al. Is parenting style related to children's healthy eating and physical activity in Latino families? *Health Educ Res* 2006;21:862-871.

26. Frey GC, Stanish HI, Temple VA. Physical activity of youth with intellectual disability: review and research agenda. *Adapt Phys Activ Q* 2008;25:95-117.

27. Central Health Education Unit of Hong Kong. A qualitative study on dietary and exercise practice people in Hong Kong. 2015. Retrieved from: http://www.chp.gov.hk/files/pdf/grp-pmpdb-focus_group_e.pdf (accessed 23 July 2016)

28. World Health Organization. Global Physical Activity Surveillance. 2014. Retrieved from: http://www.who.int/chp/steps/GPAQ_CH.pdf?ua=1 (accessed 15 May 2014)

29. Polder J, Meerding WJ, Bonneux L, Van Der Maas P. Healthcare costs of intellectual disability in the Netherlands: a cost-of-illness perspective. *J Intellect Disabil Res* 2002;46:168-178.

30. Maiano C, Hue O, Morin AJ, Moullec G. Prevalence of overweight and obesity among children and adolescents with intellectual disabilities: a systematic review and meta-analysis. *Obe Rev* 2016;17:599-611.

31. Frey G, Chow B. Relationship between BMI, physical fitness, and motor skills in youth with mild intellectual disabilities. *Int J Obe* 2006;30:861-867.

32. Wang JJ, Gao Y, Lau PW. Prevalence of overweight in Hong Kong Chinese children: Its associations with family, early-life development and behaviors-related factors. *J Exerc Sci Fit* 2017;15:89-95.

33. Einfeld SL, Ellis LA, Emerson E. Comorbidity of intellectual disability and mental disorder in children and adolescents: A systematic review. *J Intellect Dev Disabil* 2011;36:137-143.

34. Safer D, Agras W, Bryson S, Hammer L. Early body mass index and other anthropometric relationships between parents and children. *Int J Obe* 2001;25:1532-1536.

35. Murphy NA, Christian B, Caplin DA, Young PC. The health of caregivers for children with disabilities: caregiver perspectives. *Child: care, health and development* 2007;33:180-187.

36. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. *Obe Rev* 2001;2:159-171.

37. Fisher JO, Mitchell DC, Smiciklas-Wright H, Birch LL. Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *J Am Diet Assoc* 2002;102:58-64.

38. Lee A, St Leger L, Cheng FF. The status of health-promoting schools in Hong Kong and implications for further development. *Health Promot Int* 2007;22:316-326.

39. Vanhelst J, Bui-Xuan G, Fardy P, Mikulovic J. Relationship between sleep habits, anthropometric characteristics and lifestyle habits in adolescents with intellectual disabilities. *Res Dev Disabil* 2013;34:2614-2620.

40. Jordan AB, Robinson TN. Children, television viewing, and weight status: summary and recommendations from an expert panel meeting. *Ann Am Acad Pol Soc Sci* 2008;615:119-132.

41. Rimmer JH, Braddock D, Pitetti KH. Research on physical activity and disability: an emerging national priority. *Med Sci Sports Exerc* 1996;28:1366-1372.

42. Prentice AM, Jebb SA. Fast foods, energy density and obesity: a possible mechanistic link. *Obe Rev* 2003;4:187-194.

43. Phillips SM, Bandini LG, Naumova EN et al. Energy-dense snack food intake in adolescence: Longitudinal relationship to weight and fatness. *Obe* 2004;12:461-472.

44. Koivisto U-K, Fellenius J, Sjöden P-O. Relations between parental mealtime practices and children's food intake. *Appetite* 1994;22:245-258.

Table 1 Distribution of the index children's body weight statuses [a]

	n	Underweight %	Normal %	Overweight %	Obesity %	Statistics χ^2	*p*
All	524	13.4	55.3	22.1	9.2		
Gender						1.31	0.73
Male	361	14.4	54.6	21.6	9.4		
Female	163	11.0	57.1	23.3	8.6		
Age group [b]						3.38	0.34
6-12 years	283	15.2	56.2	20.8	7.8		
≥13 years	241	11.2	54.4	23.7	10.8		

[a] Classification criteria for body weight status: age- and gender-specific BMI cut-offs by Cole (2000, 2007).

[b] The range of age was 6 - 21 years old.

Table 2 Associations between background characteristics and overweight and obesity in children with intellectual disability

	n	Overweight and obesity		
		%	OR (95% CI)	AOR (95% CI)
Characteristics of the study schools				
School participation rate				
High (36.5% - 54.1%)	227	32.6	1.00 (Ref)	1.00 (Ref)
Middle (25.5% - 28.2%)	182	30.8	0.92 (0.60, 1.40)	0.88 (0.57, 1.35)
Low (15.0% - 17.6%)	118	29.7	0.87 (0.54,1.42)	0.85 (0.53, 1.39)
School type				
Mild ID (IQ of 50-69)	262	32.8	1.00 (Ref)	1.00 (Ref)
Moderate ID (IQ of 35-49)	86	27.9	0.79 (0.46, 1.36)	0.80 (0.47, 1.36)
Mixed (IQ of 35-69)	176	30.7	0.91 (0.60, 1.37)	0.87 (0.57, 1.32)
Characteristics of the index child				
Individual ID level				
Mild (IQ: 55-69)	354	31.6	1.00 (Ref)	1.00 (Ref)
Moderate (IQ: 35-54)	154	29.9	0.92 (0.61, 1.39)	0.91(0.60, 1.37)
Birth place				
Hong Kong	450	29.8	1.00 (Ref)	1.00 (Ref)
Others	74	40.5	1.61 (0.97, 2.67)†	1.58 (0.95, 2.63)†
Boarding				
Yes	469	31.3	1.00 (Ref)	1.00 (Ref)
No	50	34.0	1.13 (0.61, 2.09)	1.09 (0.59, 2.03)
Co-morbidity and Medication				
Neither co-morbidity nor medication	66	24.2	1.00 (Ref)	1.00 (Ref)
Co-morbidity without medication	332	32.5	1.51 (0.82, 2.77)	1.62 (0.87, 3.01)
Co-morbidity with medication	123	31.7	1.45 (0.74, 2.86)	1.52 (0.76, 3.03)
Co-morbidity in specific				
Autism				
No	216	26.9	1.00 (Ref)	1.00 (Ref)
Yes	305	34.4	1.43 (0.98, 2.10)†	**1.57 (1.04, 2.38)***
Attention deficit hyperactivity disorder (ADHD)				
No	344	29.4	1.00 (Ref)	1.00 (Ref)
Yes	177	35.0	1.30 (0.88, 1.91)	1.34 (0.91, 1.98)
Down Syndrome				
No	475	30.9	1.00 (Ref)	1.00 (Ref)
Yes	46	34.8	1.19 (0.63, 2.25)	1.19 (0.62, 2.27)
Epilepsy				
No	477	31.2	1.00 (Ref)	1.00 (Ref)
Yes	44	31.8	1.03 (0.53, 1.99)	1.00 (0.51, 1.94)
Characteristics of the parents				
Paternal education				
Junior secondary and below	160	35.0	1.00 (Ref)	1.00 (Ref)
Senior secondary	177	29.9	0.79 (0.50, 1.25)	0.81 (0.51, 1.28)
College or above	157	28.7	0.75 (0.46, 1.20)	0.75 (0.47, 1.21)
Missing	30	33.3	0.93 (0.41, 2.12)	0.92 (0.40, 2.11)
Maternal education				
Junior secondary and below	158	32.3	1.00 (Ref)	1.00 (Ref)
Senior secondary	216	31.0	0.94 (0.61, 1.47)	0.94 (0.60, 1.46)
College or above	127	32.3	1.00 (0.61, 1.65)	1.03 (0.62, 1.70)
Paternal occupation				
Administrators and professionals	195	28.2	1.00 (Ref)	1.00 (Ref)
Others (clerks, sales and workers)	286	33.9	1.31 (0.88, 1.94)	1.29 (0.87, 1.92)

Missing	43	27.9	0.99 (0.47, 2.06)	0.94 (0.45, 1.98)
Maternal occupation				
Housewives	255	29.4	1.00 (Ref)	1.00 (Ref)
Administrators and professionals	94	31.9	1.13 (0.68, 1.87)	1.13 (0.68, 1.89)
Others (clerks, sales and workers)	149	34.2	1.25 (0.81, 1.93)	1.24 (0.81, 1.92)
Missing	26	30.8	1.07 (0.45, 2.56)	1.07 (0.44, 2.56)
Parental marital status				
Married and cohabiting	417	32.4	1.00 (Ref)	1.00 (Ref)
Divorced, separated, and widowed	89	25.8	0.73 (0.43, 1.22)	0.72 (0.43, 1.20)
Questionnaire respondent				
Mother	384	30.5	1.00 (Ref)	1.00 (Ref)
Father	102	36.3	1.30 (0.82, 2.05)	1.30 (0.82, 2.06)
Others	30	20.0	0.57 (0.23, 1.43)	0.57 (0.23, 1.44)
Paternal body weight				
Non-overweight (BMI<25 kg/m^2)	213	28.6	1.00 (Ref)	1.00 (Ref)
Overweight and obesity (BMI ≥25 kg/m^2)	220	35.0	1.34 (0.89, 2.01)	1.37 (0.91, 2.06)
Missing	91	28.6	1.00 (0.58, 1.72)	0.98 (0.57, 1.70)
Maternal body weight				
Non-overweight (BMI<25kg/m^2)	332	26.5	1.00 (Ref)	1.00 (Ref)
Overweight and obesity (BMI≥25 kg/m^2)	141	44.7	**2.24 (1.48, 3.38)*****	**2.24 (1.48, 3.39)** ***
Missing	51	25.5	0.95 (0.48, 1.86)	0.93 (0.47, 1.83)

Missing data < 5% were not presented in this table, which were not counted in when calculating percentage.
OR, univariate odds ratios; AOR, adjusted odds ratio, odds ratios adjusted by children's gender and age.
OR_s and 95%CI of variables with p<0.05 were bold.
† p<0.10, * p<0.05, ***, p<0.001

Table 3 Associations between parenting practices and overweight and obesity in children with intellectual disability

	Mean (SD)		Logistic regression	
	Non-overweight	Overweight and obesity	OR (95% CI)	AOR (95% CI)
Diet and PA monitoring (MO)	3.69 (0.67)	3.71 (0.70)	1.04(0.79, 1.37)	1.13 (0.85, 1.52)
Restricting access to unhealthy food and sedentary behaviors (RA)	3.66 (0.83)	3.64 (0.79)	0.97 (0.77, 1.22)	1.07 (0.84, 1.36)
Pressure to eat more (PE) [#]	3.17 (0.65)	2.75 (0.62)	**0.36 (0.26, 0.49)**[***]	**0.35 (0.25, 0.50)**[***]
Reinforcement (RF)	4.20 (0.65)	4.28 (0.61)	1.21 (0.89, 1.63)	1.18 (0.86, 1.61)
Use food or sedentary behaviors as rewards (UR)	3.10 (0.86)	3.16 (0.76)	1.08 (0.86, 1.35)	1.06 (0.83, 1.34)

OR, univariate odds ratios; AOR, adjusted odds ratio, odds ratios adjusted by children's gender, age, birth place, co-morbidity with autism, and maternal body weight status.
OR_s and 95%CI of variables with $p<0.05$ were bold.
[#] The significant difference was found between the overweight and obesity group and non-overweight group with $p<0.001$ by *t* test.
***, $p<0.001$

Table 4 Associations between lifestyles and overweight and obesity in children with intellectual disability

	N	Overweight and obesity		
		%	OR (95%CI)	AOR (95% CI)
Physical activity				
MVPA ≥ 60 min/day	32	34.4	1.00 (Ref)	1.00 (Ref)
MVPA < 60min/day	480	31.2	0.87 (0.41, 1.85)	0.88 (0.39, 1.99)
Sedentary behaviours				
< 4 hours/day	249	26.5	1.00 (Ref)	1.00 (Ref)
≥ 4 hours/day	232	35.3	**1.52 (1.03, 2.24)***	**1.60 (1.04, 2.45)***
Sleep duration				
≥ 8 hours/day	422	29.1	1.00 (Ref)	1
< 8 hours/day	70	41.4	**1.72 (1.02, 2.89)***	**1.96 (1.09, 3.51)***
Fruit consumption				
≥ 2 portions/day	129	39.5	1.00 (Ref)	1
< 2 portions/day	389	28.3	**0.60 (0.40, 0.91)****	0.67 (0.42, 1.06)
Vegetable consumption				
≥ 2 portions/day	72	37.5	1.00 (Ref)	1
< 2 portions/day	446	30.0	0.72 (0.43, 1.20)	0.92 (0.51, 1.66)
Meats, fish, and eggs consumption				
< 3 liang/day *(1 liang = 38 grams)*	206	20.4	1.00 (Ref)	1
3-4 liang/day	253	34.4	**2.15 (1.34, 3.14)****	**1.84 (1.15, 2.96)***
≥ 5 liang/day	58	55.2	**4.81 (2.59, 8.92)*****	**3.86 (1.91, 7.83)*****
Fried food				
< 1 time/day	408	27.9	1.00 (Ref)	1
≥ 1 time/day	103	44.7	**2.08 (1.33, 3.25)****	**1.88 (1.15, 3.07)***
Sweetened food				
< 1 time/day	279	26.2	1.00 (Ref)	1
1 time/day	186	37.1	**1.66 (1.12, 2.48)***	**1.69 (1.09, 2.62)***
≥ 2 times/day	50	36.0	1.59 (0.84, 3.00)	1.22 (0.61, 2.44)
Snack consumption				
< 1 time/day	166	25.9	1.00 (Ref)	1
1 time/day	221	31.2	1.30 (0.83, 2.03)	1.32 (0.79, 2.18)
≥ 2 times/day	126	38.1	**1.76 (1.07,2.90)***	1.74 (0.99, 3.09)
Having breakfast everyday				
Yes	407	31.7	1.00 (Ref)	1
No	106	29.2	0.89 (0.56, 1.42)	0.89 (0.53, 1.48)
Regular 3 meals/day				
Yes	447	29.3	1.00 (Ref)	1
No	67	41.8	**1.73 (1.02, 2.93)***	1.51 (0.84, 2.72)

OR, univariate odds ratios; AOR, adjusted odds ratio, odds ratios adjusted by children's gender, age, birth place, co-morbidity with autism, maternal body weight status, and parental pressure to eat more.

OR_s and 95%CI of variables with $p<0.05$ were bold.

* $p<0.05$, **, $p<0.01$, ***, $p<0.001$

Table 5 Hierarchical logistic regression for factors associated with overweight and obesity in children with intellectual disability

	$OR_{m,}$ (95% CI)	*p*
Background variables		
Birth place		
Hong Kong	1.00 (Ref)	
Others	2.15 (1.16, 4.00)	0.016
Co-morbidity with autism		
No	1.00 (Ref)	
Yes	1.54 (0.95, 2.48)	0.079
Maternal body weight		
Non-overweight (BMI<25 kg/m^2)	1.00 (Ref)	
Overweight and obesity (BMI≥25 kg/m^2)	2.23 (1.40, 3.57)	0.001
Missing	0.96 (0.32, 2.83)	0.938
Parenting practice		
Pressure to eat more (PE)	0.35 (0.24, 0.51)	<0.001
Children's lifestyle variables		
Sleep		
≥ 8 hours/day	1.00 (Ref)	
< 8 hours/day	2.16 (1.13, 4.12)	0.019
Meat, fish, and eggs consumption		
< 3 liang/day *(1 liang = 38 grams)*		
3-4 liang/day	1.50 (0.89, 2.53)	0.132
≥ 5 liang/day	2.90 (1.35, 6.21)	0.006
Fried food		
< 1 time/day	1.00 (Ref)	
≥ 1 time/day	1.62 (0.94, 2.81)	0.082

Hierarchical logistic regression was performed to estimate adjusted OR for multiple variables (OR_m). Gender and age group were forcedly entered in the model. Background variables, including school, children and parental characteristics were forward selected in Block 2, parenting practices were forward selected in Block 3, and children's lifestyle 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.