Chapter 2

Factors Associated with Childhood Obesity in Asian Countries: A Review of Recent Literature

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Abstract

Childhood obesity is a substantial health issue in both developed and developing countries. As obesity is associated with the development of a number of co-morbidities in childhood or adulthood, including hypertension, insulin resistance, dyslipidaemia and psychological disorders, the identification of associated factors, termed obesogenic factors, is important for the effective prevention of obesity. Many previous review articles have focused on obesogenic factors in the Western countries, predominantly based on the data obtained from studies on Western paediatric populations. Although we were able to identify a single review article conducted in an Asian country, there is a lack of cross-sectional studies from Asian populations. Therefore, the present article reviewed previously published reports from the Asian countries, including East, Southeast and South Asia and Iran. Initially, articles evaluating the relationship between childhood obesity and obesogenic factors published in the last ten years were identified by searching the PubMed database. Obesogenic factors included in the present review were nutrition, physical activity, sleep, socioeconomic status, birth weight and genetics. Articles were selected based on the quality, i.e., the number of enrolled subjects and the analytical method (i.e. multivariate analysis). Then, the association of each obesogenic factor with the development of obesity was reviewed. Finally, interventional programs for the prevention of obesity currently utilized in the Asian countries were briefly described.

Introduction

Obesity in children and adolescents represents a major public health issue in both developed and developing countries [1-3], although the reported prevalence has plateaued in some developed countries [4,5]. As in adults, several factors have been shown to be associated with the development of childhood obesity, including nutrition, physical activity, sleep, socioeconomic status, parental obesity, birth weight and genetics as summarized in Table 1. In order to decrease the prevalence of obesity, there is a substantial clinical need for interventions based on an increased understanding of factors associated with the development of childhood obesity. Numerous previously published reviews evaluate the factors associated with childhood obesity in the Western countries [6-8]. On the other hand, there is a lack of review articles based on data from children in the Asian countries with only one article reported from a South Asian country [9]. Therefore, the purpose of the present review is to highlight the factors associated with childhood obesity in Asian populations with a particular focus on similarities and differences with those observed in Western populations. In the present review, the term 'children' includes 'children' and 'adolescents' unless specifically indicated otherwise.

Table 1: Factors associated with the development of childhood obesity.

Nutrition	
	Calorie intake*
	Nutrient balance*
	Fruit and vegetable intake*
	Sugar-sweetened beverage intake
	Breakfast skipping
	Breastfeeding (exclusiveness and duration)
	Complementary feeding (time of start and duration)*
Physical activity	
	Physical (sports) activity
	Screen time (duration)
Sleep	
	Sleep duration
	Quality
	Time of going to bed and waking up*
Socioeconomic status	
	Family income
	Parental education level*
	Parental anthropometrics
	Siblings (number and order)*
	Place of residence (urban or rural)*
	Parental smoking*
Birth weight	
	Birth weight (high or low)
	Body weight gain during early infancy
	Maternal weight gain during pregnancy*
Genetics	
	Gene polymorphism** (FTO, ADRB2, MCR4, etc.)
_	Epigenetics*
* Factors not discussed in this review.	
** FTO, fat mass and obesity-associated gene; ADRB2, β2-adrenergic	
receptor; MCR4, melanocoltin 4 receptor	

Materials and Methods

Selection of Articles

This article is a narrative review that focuses on factors associated with childhood obesity in Asia. For the present review, studies published in the last 10 years were identified primarily by searching the PubMed database using the terms 'child', 'obesity' and 'Asia' and one of the following terms: 'nutrition—sugar-sweetened beverage (SSB), breakfast skipping or breastfeeding'; 'physical activity or sedentary lifestyle'; 'sleep'; 'socioeconomic status (SES)'; 'parental obesity'; 'birth weight' or 'genetics'. Asian countries included those in East Asia (Japan, Korea, China and Taiwan), Southeast Asia (countries located in the Indochina peninsula and the Philippines) and South Asia (India, Sri Lanka, Pakistan and Bangladesh). Although inclusion of articles from West Asian countries was also planned, only studies from Iran were identified from the literature search. Turkey was considered to belong to Europe and was excluded from the present study. The inclusion criteria for the present review were as follows: (i) clear reporting of the prevalence of obesity regardless of the definition used for obesity (see below); (ii) inclusion of more than 100 study subjects and (iii) application of multivariate analysis. In addition, I attempted to use the most recently published articles in cases where multiple articles from different countries, evaluating the same topic, were identified.

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Definition of Obesity and Age of Children

Two important issues were discussed for developing the present review. First, the methodology used for defining obesity in the selected articles. Several international criteria for childhood obesity have been presented by the International Obesity Task Force, Centers for Disease Control and World Health Organization [1,10,11]. However, these criteria predominantly rely on the use of growth curves established from populations of children from the Western countries; therefore, there is a need for childhood obesity criteria based on growth curves established from populations of children from the Asian countries [11]. Regional criteria have also been established and were used in a number of included studies, particularly in articles from China or Japan [10,12]. Second, the age of children, i.e. infancy, pre-school, school or adolescence, has important effects on associated factors in childhood obesity. For example, the effect of breastfeeding on obesity may differ between infancy and adolescence. However, taking these two factors into consideration is difficult because of the complexity and the limited space, and therefore, I have not referred to these two factors specifically throughout the present review.

Results

Nutritional Factors

Diet apparently a cardinal effect on the development of obesity. A so-called Western diet style, i.e. high in energy-dense, high fat and low-fibre foods together with high intakes of SSB and fast food, has been shown to be associated with obesity in children [13]. Asian countries at present are facing with a nutritional transition from a traditional Asian diet to a Western diet [14]. However, I failed to find the articles that dealt with the dietary intake, presumably due to the difficulty of measuring dietary intakes in a large cohort. Therefore, the present review focused on SSB and fast food, breakfast skipping and breastfeeding.

SSB and fast food

A direct association between SSB consumption and obesity has been well documented in the Western countries. However, Keller and Bucher Della Torre pointed out a number of methodological limitations of the previous studies and casted doubt on the provision of a definitive conclusion on this issue [15]. In China [16,17], Vietnam [18] and Iran [19], frequent consumption of SSB has been found to be associated with an increased risk of obesity. In contrast, no such correlation has been reported in studies from Hong Kong [20], Cambodia and Japan [21]. This disparity may partly be attributable to the method used to measure SSB consumption and the age of the studied

cohorts, i.e., school children [17,20,21] or adolescents [16,18,19]. High fast food consumption, the so-called junk food, has also been associated with an increased risk of obesity [19]. Interestingly, Chiang et al. reported that a high geographical density of fast food stores was associated with an increased risk of obesity in boys compared to convenience stores [22].

Breakfast skipping

A systematic review on the association between breakfast consumption and body weight in European children by Szajewska and Ruszczynski demonstrated that eating breakfast regularly is associated with a decreased risk of becoming overweight or obese [23]. Several Asian studies have also indicated that breakfast skipping is associated with obesity in adolescents [24-26]. In a two-year prospective study in Hong Kong, Tin et al. reported that breakfast skippers had a significantly higher body mass index (BMI) at both grades 4 and 6 of primary school [27]. Furthermore, they demonstrated that breakfast skippers experienced a greater increase of BMI during the two-year follow-up period than breakfast eaters. However, as the definition of breakfast skippers varies in these studies, caution should be taken when drawing conclusions on this issue as presented by Szajewska and Ruszczynski [23].

Breastfeeding

Recent reviews from the USA [28] and Italy [29] have reported that breastfeeding may exert protective effects on the development of childhood obesity, although this concept remains controversial. In large scale studies, enrolling more than 40,000 children aged 7–8 years in Japan [30] or 4–5 years in China [31], exclusive breastfeeding was found to be associated with a decreased risk of obesity. Furthermore, a prospective nation-wide study evaluating children aged between 1.5 and 8 years in Japan revealed a latent protective effect against obesity, especially for boys [32]. In contrast, reports from Singapore [33], Iran [34] or India [35] failed to show a significant beneficial effect of breastfeeding on obesity, although the number of enrolled children was generally small; i.e. 500-800 subjects. Further studies are required to elucidate the optimal breastfeeding status (exclusiveness and duration) for protection against childhood obesity.

Physical Activity

In the Western countries, increased physical activity is thought to have a beneficial effect on preventing childhood obesity [36,37]. However, van Stralen et al. demonstrated in a review of studies on pre-schoolers (4–7 years) from six European countries that sedentary behaviours were more closely associated with the development of obesity than physical activity or dietary behaviours [38]. Several reports from Asia have indicated an inverse relationship between physical activity and obesity [24,26,39,40]. These studies evaluated physical activity in a given subject, predominantly through the use of physical activity questionnaires. For more objective measurement of physical activity, international physical activity questionnaires based on usual activities performed in a week may be recommended [41,42]. Moreover, Minematsu et al. proposed that moderate-to-vigorous exercise defined by 40 min of 4 metabolic equivalents and 11,000 steps per day are essential for the prevention of childhood obesity [43]. In contrast, a separate study of Iranian students aged 11–20 years reported that long durations of TV viewing (screen time) was an obesogenic factor and was independent of physical activity [44]. A possible effect of long screen time has been proposed by other investigators, however, there is currently no standardized cut-off time for screen time per day [24,26,39,40,43]. However, it is clear that length of screen time should be measured simultaneously in order to accurately determine the effect of physical activity on obesity.

Sleep

As the relationship between sleep and obesity has only recently been appreciated, the number of studies in this field remains limited, particularly in children. A recent review by Miller et al. classified sleep status according to sleep duration, sleep timing and chronotype [45]. This review indicated that sleeping patterns, beyond sleep

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duration, may contribute to obesity risk. Several reports from the Asian countries, including Japan [24,46], China [47], Korea [48] and Malaysia [49] have indicated that decreased sleep duration was associated with obesity, although different cut-offs for short sleep duration were used in these studies. A report from Malaysia also demonstrated poor sleep quality, which was evaluated using a sleep habit questionnaire, as a risk factor for childhood obesity [49]. In a longitudinal study of more than 8000 Japanese children, changes in BMI between the ages of 3 years and 6 years were found to be associated with sleep duration (cut-off, 9 h) in boys [50]. Finally, although causality remains uncertain, a relationship between obesity and obstructive sleep apnoea has been documented in children [51].

SES

SES is a subtle term, encompassing a variety of issues, including economic status (household income), parental education level, parental occupational status, parental anthropometry and family structure [52]. Among these factors, we focused on the effect of economic status and parental obesity on childhood obesity.

Economic status

A study of US-born children (2–11 years) and adolescents (12–19 years) revealed that children from lower-income families exhibited greater BMI and obesity than those from higher-income families [53]. In addition,

Wang and Lim concluded in their review that low-SES groups in developed countries and high-SES groups in developing countries tended to have a higher risk of obesity than their counterparts [1]. In Asian countries, a tendency similar to that reported in the review by Wang and Lim was found. Namely, childhood obesity was more common in families with low household economic status in developed countries, such as Korea [52] or Japan [54] but was more common in children from families with high household economic status in developing countries, such as Indonesia [55], China [56], Vietnam [18, 57], Malaysia [58] and Sri Lanka [26]. On the other hand, Schooling et al. did not find any association between SES and BMI in a Chinese population aged 6–11 years in Hong Kong [59]. Although these reports predominantly used multivariate analyses, other selected confounding SES variables were relatively heterogeneous. Accordingly, there is a need to standardise the included other SES factors when assessing the association between economic status and childhood obesity.

Parental anthropometrics

It is generally accepted that parental obesity has an effect on the development of childhood obesity in both the Western [60,61] and Asian [18,24,25,62,63] populations. Although not fully elucidated, this finding may be explained by either genetic effects or similar lifestyles, particularly in early infancy. Recently, increased attention has been paid to the contributions of paternal or maternal

obesity in determining childhood obesity of both genders. As summarized in the Fels longitudinal study by Linabery et al., many studies from the Western countries have reported a stronger influence of maternal obesity on infant or early childhood obesity than paternal obesity [61]. Studies from the Asian countries on this issue are still insufficient, and conflicting results demonstrating the following relative contributions of maternal or paternal BMI have been reported: (i) equal [62], (ii) only maternal BMI on daughters [64], (iii) paternal BMI on sons and daughters and maternal BMI on daughters [65] and (iv) maternal BMI on sons and paternal BMI on daughters [66]. Future large scale studies in conjunction with evaluation of the genetic backgrounds described below are required to fully elucidate the contributions of maternal and paternal BMI on childhood obesity.

Birth Weight and Body Weight Gain During Early Infancy

Birth weight

A meta-analysis by Yu et al. demonstrated that high birth weight (>4000 g) was associated with an increased risk of obesity [67]. Similar trends have been observed in cohort studies from Asia [68,69]. On the other hand, reports regarding anthropometric outcomes in babies with low birth weight (<2500 g) are limited. Recently, Kato et al. reported that there was no significant increase in levels of obesity among children with low birth weights compared to children with normal birth weights [70].

Body weight gain during early infancy

Weight gain during infancy is regarded as a potential predictor of future development of obesity during infancy and at pre-school ages [60]. Druet et al. performed a meta-analysis of more than 47,000 subjects from 10 studies reported in the Western countries and concluded that infant weight gain was consistently and positively associated with subsequent obesity at the age of 1 year [71]. It has been reported that (rapid) weight gain during the first 3 months in China [72] and 2 years of life in Sri Lanka [73)] predicted the risk of subsequent obesity. Notablly, in a longitudinal study, tracking BMI from the ages of 4 months to 12 years, children who developed adiposity rebound earlier tended to have a higher BMI at the age of 12 years [74].

Genetics

With recent developments in molecular biology, genetics has emerged as a new factor that is involved in the pathogenesis of childhood obesity, particularly regarding the association between single nucleotide polymorphisms (SNPs) of candidate genes and specific diseases. An earlier review on this issue postulated that approximately 5% of childhood obesity cases are caused by defects that impair the function of obesity susceptibility genes, although their effect sizes may be relatively small [75]. Manco and Dallapiccola recently summarised 20 genes associated with

an increased BMI in paediatric populations [76]. Among them, fat-mass and obesity-associated (FTO) gene has been most vigorously investigated, and a meta-analysis of the association between SNPs of FTO and risk of obesity in childhood has confirmed the role of FTO in the development of childhood obesity [77]. Several FTO SNPs have been found to be associated with childhood obesity, including rs3751812 in Japanese children [78], rs7206790, rs11644943 and rs9939609 in Chinese school-age children [79] and rs9939609 in Indian adolescents (waist-to-hip ratio) [80]. Furthermore, Arg16Gly polymorphism of the β-adrenergic receptor in Taiwanese adolescents [81] and rs17782313 (MCR4), rs543874 (SEC16B), rs2241423 (MAP2K5) and rs11084753 (KCTD15) in Chinese school-age children [82] were found to be significantly associated with the development of obesity. However, in a genome-wide association study of eight candidate genes, only variants of rs9939609 (FTO) and rs6548238 (TMEM18) were found to be associated with obesity-related indices during puberty [83]. At present, there is a lack of reports from the Asian countries except Japan and China, presumably due to technical difficulties and costs associated with genetic studies. Further studies in the Asian countries are eagerly anticipated, since the effects of genetics on the development of obesity are thought to be ethnicity-specific.

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Intervention

Many intervention programs for preventing childhood obesity have been established and implemented in the Western countries during the past two decades. An increased understanding of obesogenic factors and the mechanisms underlying the development of childhood obesity is likely to facilitate the development of such strategies. Thus, the most recent review by Brown et al. raised two important issues, namely (i) public policies and environmental interventions and (ii) family habits and parenting strategies [84]. Probably, the first intervention program in Asia was introduced in the field of nutrition approximately 100 years ago in Japan [85]. This program has been integrated into a recent school-based nutritional education, Shokuiku, based on an appreciation of inappropriate dietary habits [86]. As Shokuiku has been shown to achieve positive results, this method is now utilized in other Asian countries. In addition, programs targeting other obesogenic factors have been initiated in India [87] and China [88]. Specifically, the Chinese program consists of the following four components:, (i) creation of supportive school and family environment, (ii) health styles education, (iii) instruction and promotion of school physical education and (iv) self-monitoring of obesity related behaviours. As the development of interventional programs is a time- and cost-consuming task [89], collaboration between the Asian countries on this issue is highly recommended.

Conclusions

The current review provides a discussion on the similarities and differences in obesogenic factors between the Asian and Western countries and between developed and developing countries. A proportion of these differences may diminish or disappear with the passage of time. However, other differences may be maintained because of associations with ethnicity or the different cultural backgrounds of individual countries. Further high-quality epidemiological studies are required to examine these points. Finally, as stated by Hollingworth et al. [89], we have to put it in mind that interventions to treat childhood obesity are potentially cost effective, although health benefits may not appear until the sixth or seventh decades of life.

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