

CHILDHOOD OBESITY IN HONG KONG: A DEVELOPMENTAL PERSPECTIVE AND REVIEW, 1986–2005

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Overweight and obesity is related to many problematic health conditions including gallbladder disease, glucose intolerance, non-insulin-dependent diabetes, cardiovascular disease risk factors, and cancer. It is clear that the childhood obesity rate in Hong Kong has increased rapidly in the last two decades. A critical review of the development of childhood obesity in Hong Kong may allow health professionals to gain and provide practical guidance and scientific solutions for prevention and intervention. In this study, we elucidate and review the evidence for childhood obesity to provide insight and directions for future research. The specific objectives were to: (1) assess the current state of knowledge in the field of childhood obesity research by reviewing local studies published between 1986 and 2005; (2) integrate the findings in relation to childhood obesity risk factors observed in Hong Kong; and (3) recommend aspects of future study to benefit research on obesity in Hong Kong Chinese children. Three stages of research development on childhood obesity are identified and discussed, namely: the pilot stage; the consolidation stage; and the stage of medical and exercise sciences. Finally, visions and recommendations are discussed regarding the future development of Hong Kong childhood obesity.

Keywords: childhood obesity, obesity development, obesity history

Introduction: Childhood Obesity Worldwide

Although childhood obesity is a non-communicable disease, it has become a “global epidemic of the new millennium” (Nash 2003; Ebbeling et al. 2002). The prevalence of childhood obesity has doubled in the United States of America, Canada, the United Kingdom, Australia, and Sweden in the past two decades. Currently, obesity prevalence rates among children and adolescents in these developed Western countries range from 17% to over 25% (Table 1).

Developed countries in the West are not alone in showing an alarming increase in the prevalence rate of obesity. Recent data indicate that many Asian countries that previously had a very low prevalence of obesity, such as Japan, Thailand and Mainland China, are facing this problem too. Hong Kong, as one of the newly industrialized “four little dragons” in Asia, has a childhood obesity prevalence rate (15–17.9%) that is broadly similar to those of Singapore, Taiwan, and South Korea. In developing countries, it was estimated that 3.3% (or 17.5 million) of preschool children were obese in 1995 (de Onis & Blössner 2000) (Table 1).

Despite the recognition of the increased prevalence of obesity in children in developed countries, childhood obesity as a social issue remains low on the public agenda of Hong Kong. Given the Chinese cultural belief of “gaining weight and being fat means affluence” (Jing 2000), it is not surprising that most Hong Kong

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Table 1. Worldwide prevalence of childhood overweight before, during, and after the 1990s

Country	Before 1991 (% of overweight)	1991 and after (% of overweight)	Study
Developed countries			
Canada			Tremblay et al. 2002
7–13 yr old boys	11	33	
7–13 yr old girls	13	27	
(overweight: BMI \geq 25 kg/m ²)	(1981)	(1996)	
United States			Wang et al. 2002
6–9 yr old	11.8	22	
10–18 yr old	16.8	27.3	
	(1971–1974)	(1988–1994)	
United Kingdom	14.7 (1989)	23.6 (1998)	Bundred et al. 2001
Sweden			Peterson et al. 2003
6–11 yr old boys	13	17.6	
6–11 yr old girls	9.8 (1986)	27.4 (2001)	
Australia			Magary et al. 2001
Boys	10.7	19.5	
Girls	11.8 (1985)	21.1 (1995)	
Japan			Matsushita et al. 2004
Boys	6.1	11.1	
Girls	7.1	10.2	
	(late 1970s)	(late 1990s)	
Newly industrialized countries			
South Korea			Kang et al. 1997
6–17 yr old	5 (1979)	23 (1996)	
Singapore			cited in Leung et al. 1996
Primary 1, 6 & Form 1	5 (1980)	15 (1992)	
Taiwan			Huang et al. 2003
6.5–18.5 yr old			
Boys		18.5	
Girls		15 (2002)	
Strongly developing countries			
Brazil			de Onis & Blössner 2000
0–5 yr old	4.9 (1974)	4.9 (1996)	Wang et al. 2002
6–9 yr old	3.7 (1974)	17.4	
10–18 yr old		12.6 (1997)	
Thailand		12 (1991)	Wang 2001
		16 (1993)	
Mainland China (urban areas)			Luo & Hu 2002
2–6 yr old	4.2 (1989)	6.4 (1997)	Wang et al. 2002
6–9 yr old	10.5	11.3	
10–18 yr old	4.5	6.2	
	(1991)	(1997)	
Egypt			de Onis & Blössner 2000
0–5 yr old	2.2 (1978)	8.6 (1995)	
Developing countries			
Preschool children		3.3 (1995)	

people lack adequate awareness of the increasing problem of childhood obesity and do not consider it to be a highly significant health issue. Nevertheless, the observation that Hong Kong children are getting fatter is an

empirical fact as the secular change in weight and height data clearly show (Fu & Hao 2002; Leung 1997 & 1994). The sharply rising prevalence rate recorded in the last 10 years suggests that this should be a public health

Table 2. Detection rates of childhood obesity* in primary and secondary schools in the Student Health Service of the Department of Health, Hong Kong (2005)

School year	Obesity rate (%)		Overall obesity rate (%)
	Primary school students (P.1 – P.6)	Secondary school students (F.1 – F.3)	
1995/96	16.1	N/A	16.1
1996/97	15.9	13.2	15.0
1997/98	16.4	13.6	15.7
1998/99	17.6	14.8	16.9
1999/00	17.7	15.1	17.1
2000/01	17.9	15.4	17.3
2001/02	17.6	15.2	17.0
2002/03	18.6	15.6	17.8
2003/04	18.7	15.8	17.9
2004/05	18.7	15.8	17.8

*Obesity defined as body weight > 120% of the median weight for height. N/A = not available.

issue marked for priority action. The detection rates of obesity obtained from primary and secondary school students in Hong Kong attending the Student Health Service are shown in Table 2.

Comparisons of cross-national prevalence data are difficult as the definitions of overweight or obesity differ between epidemiologic studies. Nevertheless, the rapidly changing rate of prevalence amongst Hong Kong children remains a reason for concern. A longitudinal study on a cohort of Hong Kong babies born in 1984 showed that the prevalence of obesity of the 7-year-old children in 1991 was estimated as 5% (Leung et al. 1994a). A 1993 territory-wide growth survey (Leung 1994) indicated that 13.4% of boys and 10.5% of girls (6–18 years old), i.e. an average of 12.0%, were obese. By 2005, the overall prevalence of childhood obesity was 17.8%. This is an approximate increase of 1.5-fold over 10 years in Hong Kong, which compares to a 2.0-fold to 2.8-fold over 10 years in England (4–11 years old), and 3.3-fold over about 25 years in the USA (6–11 years old) (Ebbeling et al. 2002).

Obesity is an important and pressing health issue because it is a source of increased morbidity and mortality in adulthood. Identified obesity-related diseases include high blood pressure, high blood lipid, diabetes, obstructive sleep apnea, coronary heart disease and degenerative arthritis (Deckelbaum & Williams 2001; Dietz 1998a & b). Studies have also demonstrated that 30–70% of obese children and adolescents will become obese adults (Kotani et al. 1997; Whitaker et al. 1997).

In order to get a thorough understanding of the obesity epidemic in Hong Kong and help health professionals to take into account the contextually relevant factors, an overview of the problem should be undertaken. This paper documents the development of childhood obesity research over the last two decades in Hong Kong. The findings will be presented in three major sections, namely: *stages of childhood obesity research development; etiology and intervention of childhood obesity; and recommendations*, with the following specific objectives: (1) to assess the current state of knowledge in the field of childhood obesity research by reviewing local studies published between 1986 and 2005; (2) to integrate the findings in relation to childhood obesity risk factors observed in Hong Kong; and (3) to recommend aspects of future study for Hong Kong Chinese children.

Development of Research on Childhood Obesity in Hong Kong (1986–2005)

The following keyword combinations were used: “overweight”, “obesity”, “fat”, “body mass index”, “child”, “adolescents”, “obese child”, “childhood obesity”, “Hong Kong”, and “Chinese”. Over 50 articles were retrieved from computer databases and reviewed for relevance. In total, 45 empirical grounded studies/articles with participants less than 19 years of age were included (42 in English, 3 in Chinese). In addition, few review

Table 3. Timeline of Hong Kong childhood obesity research development†

	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	Subtotal				
Prevalence of obesity	*																				5				
Medical consequences																						10			
Nutrition and diet								*	**	*	*											5			
Measurement of fatness								*		*	*							**				8			
Physical fitness										*	*						***		*	*		7			
Psychosocial impacts																	*		*	*		3			
Interdisciplinary‡							*										*	**	*	*		7			
	Pilot stage (3 studies or 6.6% were published prior to 1993)																Consolidation stage Growth, nutrition and measurement of fatness as a focus (21 studies or 46.7% were published between 1993 and 2001)				Medical and exercise sciences stage (21 studies or 46.7% were published after 2001)				Total = 45

†Only empirical studies were counted, review papers or commentaries were not included; ‡interdisciplinary included studies on dietary intake, level of physical activity, familial factors, medical tests, etc.

papers were found to be relevant for the purpose of the following discussion.

Table 3 shows the Hong Kong childhood obesity studies from a developmental perspective. It is mainly divided into three periods: the pilot stage (1986–1992); the consolidation stage (1993–2001); the stage of medical and exercise sciences (2002–2005).

1986–1992: pilot stage of exploring prevalence of obesity among adolescents

The earliest findings of childhood obesity in Hong Kong children originated from three student projects in which students were under the supervision of medical doctors to examine the prevalence of obesity in Hong Kong children from 1985 to 1992. With samples of Form 4 and 5 students in secondary schools (aged 14–20 years), the prevalence of overweight (body mass index, BMI, > 25) was found to be 2.5% (Ho & Donnan 1986), 3.5% (Ho 1987), and 6.07% (Ho 1992), respectively. These findings indicated the first warnings of obesity in school adolescents. Whilst there were hints that the prevalence of overweight was increasing in adolescence, the sampling limitations made it difficult to ascertain the development of obesity in the young population. Despite these initial findings, health professionals did not realize that childhood obesity was a growing problem. It was partially due to the fact that, around that time, the prevalence rate of overweight/obesity in adolescents in Hong Kong was still much lower than that reported in the developed countries where the rate was estimated to range between 6% and 15% (Ho 1987).

Even though these surveys (Ho 1992; Ho 1987; Ho & Donnan 1986) have the shortcoming of being small in scale within a district and conformed to sub-age groups and very few used random sampling frames, Ho's work should be recognized as a milestone in the local investigation of adolescents' obesity. These few studies were ground-breaking in the sense that, prevalence rate aside, they related adolescents' overweight with different aspects of the issue such as body image and psychosocial problems (Ho & Donnan 1986), physical activity level (Ho 1987), knowledge of obesity as well as the consumption of fast food (Ho 1992). However, these studies had no follow-up and were relatively descriptive and superficial regarding the theoretical foundation. Nevertheless, Ho was the first health

Table 4. Empirical studies of Hong Kong childhood obesity (1986–1992)*

The Pilot Stage		
Major themes	Research design	Study
Prevalence of obesity	639 F.4 and F.5 students (14–20 yr old) in 2 secondary schools in Shatin, body measurement and questionnaire	Ho & Donnan 1986
Prevalence of obesity and physical activity levels, genetic factors	14–20 yr old, secondary school students, community-based small scale survey in Shatin	Ho 1987
Prevalence, knowledge of obesity and diet, activity levels	F.4 students of 3 schools in Kowloon Tong, questionnaire, 260 boys, 267 girls	Ho 1992

*No commentaries, editorials, letters or review articles were included.

professional to explore the issue of childhood obesity in Hong Kong and her study entitled *Risk Factors of Obesity Among Hong Kong Youths* (Ho 1990) was probably the first empirical study in Hong Kong and one of the few amongst the Asian cities that investigated the relationship between dietary intake, level of physical activity, parental factor and young people's overweight problem.

Studies in this stage mainly focused on the assessment of obesity among adolescents and were conducted in hospitals by medical professionals; the targeted population concentrated on individuals aged above 15 years (Table 4).

1993–2001: consolidation stage of epidemiologic study of childhood obesity, with special focus on body growth, dietary fat intake and measurement of overweight

Five major characteristics have been identified in the second stage of childhood obesity studies in Hong Kong. Firstly, investigators established the case that the problem of childhood obesity was not confined to certain districts of Hong Kong or restricted to adolescents (Leung 1994), but a territory-wide health issue of children and adolescents. In 1993, a Hong Kong Growth Survey (Leung 1994) was carried out. This landmark study covered 25,000 individuals from birth to the age of 18 years, with different family backgrounds in various districts of Hong Kong. The findings of the survey indicated that the prevalence of childhood obesity in Hong Kong was high. Prevalence of obesity in children and adolescents aged 3–18 years was 10.08% (with obesity defined as weight >120% weight-for-height),

which was much higher than the figures previously reported by Ho (1992, 1987). According to Leung (1994), the initial objective of this study was to produce updated local growth standards, as pediatricians realized that the only available growth standard reference provided by Chang et al's (1965) pioneer study was no longer appropriate for medical diagnostic purposes. These findings were alarming when Leung compared the figures with those of previous Hong Kong and Mainland China studies. The remarkable results demonstrated that amongst Hong Kong school children aged 6–18 years, 13.4% of boys and 10.5% of girls were obese (Leung 1995). Obviously, the dramatic increase in the prevalence of obesity among students represented a threat to public health for which the government has to intervene. The watershed occurred between the years 1995 and 1996. Since this period onwards, the Student Health Service, Department of Health, in Hong Kong has officially taken up the responsibilities of observing child obesity among school children and has documented the data annually.

Based on the 1993 growth survey data, Leung and colleagues have produced a series of papers, either in English or Chinese, on the topics of growth standards (such as weight for height, skinfold thickness, puberty) and secular change of Hong Kong children (Leung et al. 2000a; Liang et al. 1996; Leung et al. 1996c). This research area was subsequently expanded to cover the relationship of dietary fat intake with serum cholesterol (Leung et al. 2000b; Leung et al. 1998; Leung et al. 1996b; Leung et al. 1995a) and nutritional studies of vegetarian children in Hong Kong (Leung et al. 2001). The initial achievement of identifying the typical diseases,

such as impaired glucose intolerance or type 2 diabetes (Wong & Leung 1993), high serum cholesterol or blood lipid disorder (Leung et al. 2000b), which directly associated with childhood obesity is the second significant characteristic.

In addition to the increased number of local childhood obesity studies examining the health consequence and dietary pattern, pioneer comparative studies of Chinese obese children were also conducted with Guangdong and Beijing Chinese children in the mid-90s (Wu et al. 1998; Leung et al. 1994b).

Another noteworthy effort performed was the measurement of fatness in children. Definition of overweight or obesity for children and adolescents has not been consistent. A variety of criteria for obesity have been used in community health projects (e.g. Ho 1992, using BMI > 25), clinical settings (e.g. Leung 1994, using weight > 120% weight-for-height; Wong & Leung 1993, using > 97 percentile BMI), and amongst academic researchers (e.g. Yu et al. 2002, using BMI above age- and sex-specific international cut-off standards on the percentile curves). Ideally, the best definition would be sensitive to the ethnic growth standards of Hong Kong children, be indicative of their fat distribution, puberty status, nutritional status and be related to morbidity outcomes, as well as be generally accepted by researchers worldwide. Consequently, local studies began to work towards this goal by employing magnetic resonance imaging, leg to leg bioimpedance analysis, and dual-energy X-ray absorptiometry to search for a more accurate and ethnical standard for measuring the body fat of Chinese children (Lu et al. 2003; Sung et al. 2001; Chan et al. 1998).

Evidently, in this stage, medical professionals were the major investigators who spent time and energy to tackle the obesity etiology and induced health outcomes of overweight/obesity in terms of morbidity and mortality. This skewed attention on medical etiology and health outcomes has been found to be ineffective in reducing the problem. Finally, other treatment outcomes measured in behavioral terms (e.g. eating pattern, exercise pattern) were also scrutinized by the end of the 1990s, which is an important characteristic of the second stage of Hong Kong childhood obesity research development. For example, Leung (1997) and her colleagues (Leung et al. 2000a & b) provided extensive

evidence to suggest that children's eating patterns are changing. These studies suggest an upward trend of consuming more fat, sugar and meat. Less often recognized, but of equal importance at this research development stage, is the progress of studies exploring the physical activity level of Hong Kong children. Au & Leung (1995)'s evaluation report of a physical fitness program for obese children is a significant study on this aspect of treatment effectiveness. The "fun-for-fit" project conducted in 1999 was the second formally documented weight loss intervention (Hui et al. 2000) in the second stage of childhood obesity studies. However, up to the year 2001, no one significant study of treatment outcome measured in psychologic terms (such as self-esteem) had been published (Table 5).

2002–2005: stage of tackling childhood obesity issues by both medical and exercise sciences

In recent years, researchers have deepened and broadened their scope in tackling the health problem of childhood obesity. They have not only diagnosed various diseases caused by overweight/obesity, but also examined the issues of physical fitness, behavioral as well as psychologic problems (Table 6).

The health complications and morbid conditions identified in overweight/obese children in Hong Kong and in other countries are shown in Table 7. During the second stage of local childhood obesity study, only the blood glucose (such as impaired glucose tolerance) (Wong & Leung 1993) and blood cholesterol-related diseases (such as lipid disorder) (Leung et al. 1998; Leung et al. 1995a) have been examined. Yet in the new millennium, Hong Kong medical professionals have gradually expanded their knowledge in parallel with international development in pediatric obesity research. Physiologic diseases such as sleep apnea (Wing et al. 2003), lung function impairment (Li et al. 2003), insulin resistance and metabolic syndrome (cardiovascular risk factors such as dyslipidemia high blood pressure, hyperinsulinemia) (Sung et al. 2003), asthmatic airway inflammation (Leung et al. 2004), fatty liver (Chan et al. 2004), and atherosclerosis and endothelium (Woo et al. 2004a) have been detected in Hong Kong's overweight or obese children. Other disease conditions, such as orthopedic issues, certain cancers, psychiatric disorder, although documented in foreign literature of childhood

Table 5. Empirical studies of Hong Kong childhood obesity (1993–2001)*

The Consolidation Stage		
Major themes	Research design	Study
Prevalence of obesity		
Prevalence of obesity and growth standards	0–18 yr old, territory-wide cross-sectional survey, a representative sample of 25,000 HK children	Leung 1994
Prevalence of obesity territory-wide study	Analysis of the 3–18 yr old section of the 1993 survey data	Leung et al. 1995b
Comparison of obesity in schoolchildren between Beijing and Hong Kong	Comparison of HK 1993 survey data with the 1987–94 Beijing children	Wu et al. 1998
Medical consequences		
Glucose tolerance	21 patients, 8–17 yr old, laboratory tests	Wong & Leung 1993
Serum cholesterol and diet	Longitudinal study cohort, 125 children, 7 yr old, dietary history, body measurements, laboratory tests	Leung et al. 1994a
Blood cholesterol, dietary fat intake	Comparative study of HK and Mainland Chinese children	Leung et al. 1994b
Serum cholesterol and obesity	7 yr old	Leung et al. 1995a
Measurement of obesity		
Evaluate BIA measurements for estimating fat mass and fat-free mass	46 girls, 48 boys, 11–17 yr old, cross-validate with other Caucasian children	Eston et al. 1993
Separate weight-for-age and weight-for-height percentile charts for boys and girls	Analysis of 0–18 yr old children of the 1993 survey data	Leung et al. 1996b
Fat estimation by MRI, compared with assessment by BMI	19 children (8–12 yr old)	Chan et al. 1998
Fat distribution	Longitudinal study cohort, 88 11-yr-old children, laboratory tests with MRI, body measurements	Leung et al. 1998
Cross-validation of BIA	74 children, 8–12 yr old, cross-validate with other Asian children	Hui et al. 2001
Body fat and leg to leg, BIA	17 obese, 32 non-obese (7–18 yr old) for BIA validation; 2382 children (7–16 yr old) from 8 local schools were sampled for BIA	Sung et al. 2001
Nutrition and diet		
Eating habits and prevalence of obesity	Preschool children, 2–7 yr old, territory-wide questionnaire (3042 effective return)	HKDA 1995
Secular change in growth, fat intake and cholesterol	Analysis of the 0–18 yr old children of the 1993 survey data	Leung et al. 1996c
Early dietary practices and growth	Longitudinal study cohort, 173 newborn babies randomly recruited, 125 children remained at 7 years, of body measurements and dietary history	Leung et al. 2000a
Fat intake, HK vs. Mainland China children	Longitudinal study cohort, 124 children at 7 yr old, dietary assessment of 52 lactovovegetarian children aged 4–14 yr and comparative fatty acid analysis of 20 HK and 20 Mainland China children at 7 yr old	Leung et al. 2000b
Vegetarian diet	51 vegetarians (4–14 yr old), 7 d dietary intake records and laboratory tests	Leung et al. 2001
Physical activity level		
Effect of physical fitness program	27 obese children assessed with a matched control group	Au & Leung 1995
School-based intervention program: fat reduction and fitness development	8–12 yr old, 120 children, pre- and post-test	Hui et al. 2000
Interdisciplinary		
Lifestyle (dietary, physical activities, health practices such as TV viewing, skipping breakfast)	869 primary school students, 9–12 yr old, cross-sectional survey	Guldan et al. 1998

*No commentaries, editorials, letters or general essays were included. BIA = bioimpedance analysis; MRI = magnetic resonance imaging; BMI = body mass index.

Table 6. Empirical studies of Hong Kong childhood obesity (2002–2005)***The Medical and Exercise Sciences Stage**

Major themes	Research design	Study
Medical consequences		
Insulin resistance and metabolic syndrome	Comparison of 129 obese/overweight and non-obese children (9–12 yr old), laboratory tests	Sung et al. 2003
Pulmonary function	16 girls and 48 boys with primary obesity, laboratory tests	Li et al. 2003
Sleep-related disorders	46 obese children (7–15 yr old) and 44 matched children, physical examinations and sleep studies	Wing et al. 2003
Arterial endothelial function and carotid intima–media thickness	9–12 yr old, 36 overweight and 36 matched normal children, laboratory tests, case-control comparison	Woo et al. 2004a
Asthmatic airway inflammation	92 asthmatic patients, 7–18 yr old with 23 controls	Leung et al. 2004
Hepatic steatosis	84 obese children	Chan et al. 2004
Measurement of obesity		
Comparing definitions of obesity: BMI vs. > 120% of median weight-for-height	1066 boys and 1379 girls (6–12 yr old) from 3 schools	Tong & Fung 2003
Validate leg to leg BIA by comparing with DXA	64 overweight children were measured with BIA and DXA	Lu et al. 2003
Physical activity level and fitness		
Resistance training, diet and lipid level	151 children, 8–11 yr old, from 13 local schools allocated into 2 different training groups, control group study, laboratory tests	Sung et al. 2002
Physical activity level related to body fat	50 children (8–11 yr old) wore uniaxial accelerator for 7 d; skinfold test	Rowlands et al. 2002
Energy expenditure and physical activity of obese children	18 obese and 18 age-sex matched non-obese children	Yu et al. 2002
Resistance training and physiologic effect	36 obese children, 10–17 yr old, laboratory tests, control group experiments	Lau et al. 2004b
Strength training and bone mineral content	82 overweight children (9–11 yr old) randomly assigned for control group comparison	Yu et al. 2005
Psychosocial impact		
Sex differences in body satisfaction and pressure to diet	Random convenience sample of 356 secondary school students (12–18 yr old), questionnaires	Lam et al. 2002
Self-concept and ideal body size	386 primary school students, 7–13 yr old, cross-sectional study by questionnaires	Lau et al. 2004a
Self-perception of physical competence	643 children, 8–12 yr old, cross-sectional study, questionnaire and fitness tests	Sung et al. 2005
Interdisciplinary		
Physical activity and dietary habits	404 secondary school students (12–18 yr old), medical tests and self-report questionnaire	Fu & Hao 2002
CHD risk factors such as hypertension, hyperlipidemia, overweight, stress, smoking, physical inactivity and family history of CHD	404 students (12–18 yr old) randomly selected from 4 secondary schools, body measurements, laboratory tests, questionnaire survey	Fu & Hao 2003
Dietary habits, lifestyle habits, family structure	343 children, 6–7 yr old, control group study, dietary record, questionnaire, and parent interviews	Hui et al. 2003
Effect of diet and exercise on obesity-related vascular dysfunction	82 overweight children, 9–12 yr old	Woo et al. 2004b
Prevalence of obesity, weight-related concerns and behaviors	Self-reported questionnaire, 5402 boys and 5371 girls (8–15 yr old) from one district	Wong et al. 2005

*No commentaries, editorials, letters or general essays were included. BMI = body mass index; BIA = bioimpedance analysis; DXA = dual-energy X-ray absorptiometry; CHD = coronary heart disease.

Table 7. Health complications and morbid conditions of childhood obesity identified in Hong Kong and overseas literature

Health risks	Hong Kong studies	Classic or recent overseas studies
Blood lipid disorder/serum cholesterol	Leung 1993 Leung et al. 1994b Leung et al. 1995a Leung et al. 1998	McMurray et al. 1995 Srinivasan et al. 1996
Type 2 diabetes (impaired glucose tolerance, insulin resistance)	Wong & Leung 1993 Sung et al. 2003	Ludwig & Ebbeling 2001
Sleep apnea	Wing et al. 2003	Mallory et al. 1989
Pulmonary function	Li et al. 2003	Inselman et al. 1993
Metabolic syndrome (cardiovascular risk factors: dyslipidemia, hyperinsulinemia, hypertension)	Sung et al. 2003	Srinivasan et al. 1996 Freedman et al. 1999 He et al. 2000
Atherosclerosis and endothelial dysfunction	Woo et al. 2004a	Tounian et al. 2001
Asthma/asthmatic airway inflammation	Leung et al. 2004	Luder et al. 1998
Hepatic steatosis (fatty liver)	Chan et al. 2004	Kawasaki et al. 1997
Psychosocial problems	Lau et al. 2004a Lau et al. 2004b Sung et al. 2005	Braet et al. 1997
Orthopedic issues (e.g. Blount disease, tibia vara)	NIL	Dietz et al. 1982
Increased risk of obesity in adulthood/ follow-up mortality in adult age	NIL	Mosseberg 1989 Hoffmans et al. 1988 Niet et al. 1992
Psychiatric disorders (e.g. attention deficit hyperactivity disorder, depression)	NIL	Mustillo et al. 2003
Cancers	NIL	Gascon et al. 2004

obesity, have not yet been investigated in Hong Kong (Table 7).

The second advancement in the Hong Kong research community is the effort being put into examining the psychosocial consequences of child obesity. Psychosocial issues related to childhood obesity include self-esteem, self-confidence, peer interaction, and emotional disturbances. In Hong Kong, as sedentary lifestyle has also been found to be a key factor in the energy balance equation (Rowlands et al. 2002 & 1999), the growing concern of the decline in physical activity during and after school hours has become an entry point of intervention that is pursued in addition to programs promoting better nutrition and dietary practices (Sung et al. 2002; Yu et al. 2002). Furthermore, Sung et al. (2005) showed that overweight children performed less well than normal weight children in measures of endurance, coordination and flexibility, but they are in fact neither less healthy nor less physically active. However, it was reported that these overweight children tended to perceive themselves as having poorer

appearance, less competence in sports, and lower self-esteem. Their poor self-perception of physical competence appeared to be partly related to the deficiencies in their actual physical competence.

Being fat has an impact on self-image and identity. Western studies have demonstrated that obese children and adolescents suffer from social discrimination, social isolation and altered self-esteem resulting from their appearance (Braet et al. 1997; Wardle et al. 1995). The low level of self-esteem was found to be associated with increased rates of sadness, loneliness and nervousness. Some investigators even suspect that labeling, stigmatization and social handicap can cause long-term damage to self-esteem and body concept (Klaczynski et al. 2004; Strauss 2000; Philips & Hill 1998; Hill & Silver 1995).

In recent years, there has been considerable progress in local obesity research on this psychologic aspect. Whilst Lam et al. (2002) examined the sex differences in body satisfaction, feeling fat and pressure of diet among Chinese adolescents, Lau et al. (2004a) conducted a

study on the associations among self-esteem, physical concept and body size rating in primary school children in Hong Kong. Their study revealed that the actual versus ideal discrepancy body rating of Chinese children was not predictive of global physical self-concept and global self-esteem. These findings are contrary to those reported in Western children, which may imply that culture plays a role in the formation of body attitude.

To summarize, investigators who contributed to the literature in the first two stages were mainly physicians and pediatricians, and particularly those teaching in medical schools. They laid a solid foundation of childhood obesity studies. In the third stage, the emergence of exercise scientists, nutritionists, and social scientists comprised the second group of contributors. Although most of their studies were published in the last decade, they have provided essential knowledge on children's food consumption, physical activity pattern, social consequence, and emotional disorders.

Risk Factors of Childhood Obesity in Hong Kong

As most studies have indicated, the possible risk factors of childhood obesity are multifactorial. Three components have been identified as major factors that play significant and interactive roles in the development of childhood obesity: (1) genetic factors such as family history; (2) social (or personal-related demographic) factors such as age, gender and class; and (3) environmental (or behavioral-related) factors such as food intake, diet composition and sedentary lifestyle (Pařížhová & Hills 2005).

Genetic factors

Research supports the view that body fatness is inherited and genes influence energy intake (Rosenbaum & Leibel 1998). A recent Hong Kong study conducted by Hui and his colleagues (2003) showed that childhood obesity was significantly associated with parental obesity. There was also a significant positive association between a child's birth weight and their weight status at age 6–7 years. However, the genetic composition of a population changes very slowly (Hill & Trowbridge

1998). Therefore, the rapid increase in the prevalence of childhood obesity in Hong Kong Chinese children can be attributed to non-genetic factors or genotype-environment interactions, rather than being purely influenced by genetic factors.

Demographic and social factors

Hong Kong studies have demonstrated that there is a gradual increase in the prevalence of obesity after the age of 5 years, reaching a peak at the age of 11 years for boys (21% overweight) and at the age of 8 years for girls (Leung et al. 1995b). Compared to children surveyed 30 years ago, the median weight at 18 years has increased by 16% in boys (8.5 kg) and 11% in girls (5.1 kg), while median height has increased by only 2% in boys (4 cm) and 1% in girls (2.1 cm) (Leung et al. 1996a, b & c; Leung et al. 1995a & b; Leung 1994). These results imply that a secular change has occurred. Furthermore, in 1993, 7.6% of boys and 7.8% of girls were overweight at the age of 7 years. Three years later, in 1996, 10.4% of boys and 8.9% of girls were overweight (Leung et al. 2000a). Examined from the viewpoint of East–West comparison, the peak age of obesity of Hong Kong boys is similar to that of boys in England. Braddon et al. (1986) reported a 36-year follow-up of all babies born in Great Britain during 1 week in 1946. It was found that the prevalence of obesity rose during childhood, reaching a peak at the age of 11 years.

UK studies found little difference in mean BMI between boys and girls, although it has been reported that the percentage classified as obese is larger for girls (Adamson et al. 1992). US studies showed that at 10 years of age, Americans had an equal prevalence of obesity among boys and girls (21%), but African-Americans had a much higher prevalence of obesity among girls (38% in girls vs. 26% in boys) (Goran et al. 1995 quoted in Leung et al. 1998). When compared with studies of Caucasian subjects, higher prevalence of obesity in boys than girls is a unique feature in Hong Kong Chinese adolescents (Leung et al. 1998 & 1995b).

Little is known about the social class factor. Based on the 1993 growth standards survey data, we found that there was a tendency for boys in the higher social class to be more obese (Leung 1994). Yet, in Hui et al.'s (2003) case control study of primary 1 students, no significant

relationship was found between socioeconomic status and overweight and normal weight children.

Environmental factors

While personal-related or social factors influence the onset of obesity, other studies have suggested that behavioral and environmental factors contribute significantly to the onset of childhood obesity (Fu & Hao 2002; Hill & Melanson 1999). Changes in body weight and fat storage are the results of an imbalance in energy input and output. Our dietary eating patterns influence our input, and the amount of physical activity has an impact on our energy output. Local studies have indicated that Hong Kong is following the global trend of creating an *obesogenic* environment (Egger & Swinburn 1997), i.e. an environment that is conducive to an individual gaining weight more easily. For example, people are more likely to consume lots of high-fat food, spend hours watching television, use remote controls instead of manual tuning, and use cars and elevators instead of walking in their daily lives.

Fat intake

Fat intake amongst Hong Kong children has risen markedly in the last decade. Leung et al. (1994a) reported that Hong Kong children's food consumption has changed from a traditional low-fat Chinese diet (~18% of total energy from fat) to a Western diet (~30% of total energy from fat). Rather than having carbohydrates, such as rice, and vegetables as the main sources of energy, Hong Kong children now consume excess protein and fat from animal foods. As Leung (1995) has reported, in her hospital pediatric clinic, 8% of child referrals were obese cases. These obese children shared a similar preference for meat products, such as chicken wings and sausages, as well as sugary foods such as soft drinks and ice-cream. By the age of 7 years, the prevalence of obesity among the subject cohort was 5%. As pointed out by Leung (1995, 1993), this figure was the second highest in the world for the same age group during the early 1990s. Furthermore, the Hong Kong Dietitians Association revealed that preschool children (2–6 years old) who had potato chips as their major snack were identified to be positively associated with obesity (HKDA, 1995).

Poor diet (high-fat foods, junk food) aside, Guldan et al. (1998) further pointed out that skipping breakfast might also be associated with childhood obesity.

Although Leung (1995) raised the red flag that increasing childhood obesity rates represent an obvious warning of over-nutrition and that there is a need for education on growth and nutrition in schools, the situation has not changed much. Leung et al. (2000a) reported that about 30% of the total daily energy intake of Hong Kong Chinese children (1–7 years old) was derived from fat. This figure is similar to Lee et al.'s 1994 study of the dietary practice of Hong Kong adolescents, which reported that 28.8% of their energy intake was from dietary fat.

Physical activities and sedentary lifestyle

Au & Leung (1995) reported that obese Hong Kong children were reluctant to participate in physical activity, and their fitness was poorer than non-obese children. Wong & Macfarlane's study (1997) also indicated that primary school children had a lower level of habitual physical activity, which might be a contributing factor to the increasing prevalence of childhood obesity in Hong Kong. Review articles such as Macfarlane's (1997) and Adab & Macfarlane's (1998) further pointed out that Hong Kong's primary school children might be one of the most inactive cohorts in the world. In a follow-up study, Macfarlane (1999) revealed that there was a consistent decrease in the already low levels of habitual physical activity when primary 6 (age, 12 years) children move into secondary 1 (age, 13 years). Rowlands et al.'s (2002) study supports the claim of a negative relationship between physical activity and body fatness in Hong Kong Chinese boys (age, 8–11 years old). In Fu & Hao's (2002) investigation, the association between overweight and obesity with physical inactivity and inappropriate food selection (such as foods rich in fat) was also noted in secondary school students aged 12–18 years old.

In order to better understand the patterns of activity and energy expenditure, Yu and colleagues (2002) conducted a study on energy expenditure and physical activity of obese children in Hong Kong. In this cross-sectional study, 36 children aged 6–17 years old were recruited and divided into two groups (obese and non-obese)

according to their age and sex. The basal metabolic rate between the two groups was no different after normalizing for body weight. However, the total daily energy expenditure of the obese children was found to be significantly lower (by 22%) than their non-obese counterparts, which implies that an intrinsic difference in metabolic rate is not a major contributory cause of obesity. In addition, the researchers noticed that obese children spent 12% less time sleeping, but 51% more time on sedentary activities and 30% less time on physical activities than non-obese children. Hence, the potential benefit of increasing physical activity time relative to sedentary activities to reduce the prevalence of childhood obesity was highlighted (Yu et al. 2002).

Watching television, playing videogames and spending time on computers are widely recognized in Western countries as probable contributing behavioral factors to body fatness among children (Ebbeling et al. 2002; Hernandez et al. 1999; Gortmaker et al. 1996), based on a hypothesis of physical activity displacement and with a confounded factor of consuming too much energy-dense snacks (Marshall et al. 2004). While Hong Kong school children were found to have television watching as a major activity, in our local empirical findings, television watching and inactivity were not shown to be important risk factors, at least for the 6–7-year-old Hong Kong children in Hui et al.'s (2003) study. Although Hui and his colleagues (2003) also confirmed the general inactive behavior in the sample population (average time spent on exercise was 0.4 ± 0.5 hr d^{-1} and watching television and studying were 2.8 ± 1.5 hr d^{-1} and 2.4 ± 1.1 hr d^{-1} , respectively), the association between television watching and body fatness was not established (Hui et al. 2003). This result, when viewed in light of Marshall et al.'s (2004) meta-analysis of the literature on the association between television watching and body fatness, allow us to speculate that watching television or playing videogames are not independent risk factors but part of a sedentary lifestyle. It may exert a synergistic effect when children also have high-fat food intake.

In addition, parental influence is another important variable that is associated with the physical activity level of children. A number of studies have demonstrated that children with energetic parents are more likely to be active than those with sedentary parents (Moore et al. 1991; Freedson & Evenson 1991). Kalakanis et al. (2001)

further pointed out that parental activity might be a determinant of the patterns of activity in obese children. According to Lau & Leung's (2003) study, Hong Kong parents seem to be quite inactive, although over 80% of them valued the importance of physical activity for the health of their children. Yet, in fact, only half of them actually encouraged their children to participate in physical activity. The study indicated that about 36% of the children surveyed had spent less than 2 hours in physical activity per week, excluding the time they spent in school PE lessons. Amongst the young participants, more than two-thirds assessed their family as inactive and more than two-fifths of the children perceived that their parents seldom or never encouraged them to participate in any type of physical activity. This finding helps to point out that the perceptions of children on parental encouragement or their family's physical activity environment may be a factor influencing Hong Kong children's physical activity participation.

Visions and Recommendations

Childhood obesity is on the rise in Hong Kong as elsewhere in the world. The scale and urgency of this health problem pose a challenge to everyone who is concerned with the wellbeing of our future generations. Beginning with an overview of the developmental stages of Hong Kong's childhood obesity research, this paper has highlighted the indigenous contributions as well as the limitations and inadequacy of the scientific data and information available at different time periods. With a closer look at the etiology of childhood obesity, the multiple risk factors and impacts have also been discussed. Lastly, recommendations are suggested to combat the rapid upward trend of obesity in Hong Kong's children.

Toward a consistent and international consensus definition of obesity

In the last two decades of childhood obesity study, one of the methodological challenges in advancing research in Hong Kong is the lack of a common and consistent definition of child obesity that can be used for international comparison amongst epidemiologic studies. The three stages are confined by the crucial problem of

miscellaneous working definitions and cut-off points used by different investigators.

As has been noted, the Student Health Service database is adopting the percentage median weight-for-height for measuring fatness, which has been used by Leung (1994) since performing her 1993 territory-wide survey. Leung (1994) adopted the definition of obesity as those with body weight >120% of the median weight for height. This definition of quantifying fatness in children is different from the generally accepted definition of using certain BMI cut-off points for obesity in children (Cole et al. 2000). However, according to the empirical result of Tong & Fung's (2003) study, the two estimation methods should not be used interchangeably as the difference between these two methods for 6–12-year-old children ranged from –4.7% to 21.7% in boys and from 4.1% to 13.1% in girls. In other words, we must choose one estimation method purposefully as a standardized way of defining childhood obesity.

Since BMI (kg/m^2) is an anthropometric measurement recommended by the World Health Organization and has been adopted by the International Obesity Task Force and the Group of China Obesity Task Force (2004), we suggest that the Department of Health, Hong Kong, also employ BMI as the overweight/obesity measure. The prime reason is that this index has been generally accepted by most academics worldwide (despite its considerable limitations in distinguishing fat mass and muscle mass or imprecision by taking into account ethnic differences in height). Hence, if we want to advance our local child obesity research and help to provide internationally comparable prevalence rates of overweight and obesity in children, it is imperative to develop our database along the line of using Cole et al.'s (2000) proposed cut-off points as the common definition. As Cole et al.'s (2000) working definition of childhood obesity was constructed from a pool of six national children growth databases, including Hong Kong's, we believe, on the one hand, that their classification of childhood overweight/obesity is less arbitrary and more internationally-based than all other current alternatives. On the other hand, the limitations of this international definition due to averaging data from several selected countries need to be acknowledged (Chinn & Rona 2001).

Holistic approach to tackle childhood obesity

Obese children are facing an increased risk for many chronic diseases, including both physiologic and psychosocial problems. Therefore, to improve the quality of treatment and prevention as well as to adapt to social and cultural changes in Chinese society, a holistic approach that emphasizes medical treatment, psychosocial perspectives and preventive measures should be implemented. The developmental trend of the third stage of obesity research in Hong Kong reveals that medical scholars are beginning to work hand in hand with exercise scientists and nutrition professionals. Through better understanding of the etiologies of childhood obesity, an interdisciplinary approach can help us to develop interventions that are theoretically sound and socioculturally practical. The coordinated efforts of pediatricians, dietitians, exercise scientists, teaching professionals, parents, and the children themselves can alleviate the prevalence of childhood obesity. Furthermore, to successfully counteract the advent of an obesogenic living environment, a government-led policy is essential. Policymakers and government administrators need to determine guidelines for insurance reimbursement of medical treatment of childhood obesity (Tershakovec et al. 1999), regulations for food advertising targeted at children, nutritional standards for food sold in schools (Nestle 2002), and funded projects for improving the dietary and physical education curriculum in primary and secondary schools.

Multiple levels of treatment and prevention: behavioral modification as a central component and health promotion during early childhood as the focus

Childhood obesity has multiple causes; therefore, multiple levels of prevention are needed. From local experiences, such as the *Fun And Fit* project (Hui et al. 2000), prevention efforts should be focused not only on educating the public on the hazards of obesity, but they also need to facilitate children to modify their lifestyles effectively to avoid disproportionate adiposity development. Hui et al. (2000) suggest that the most feasible approach is a child-oriented behavior modification program that has an emphasis on fun that is provided in the Hong Kong school setting.

Studies indicate that efforts at preventing childhood obesity are probably more effective if regular exercise and a balanced diet are promoted as part of a healthy lifestyle in the very early stage of childhood (Canning et al. 2004; Lau 2004; Deckelbaum & Williams 2001). There are several reasons that support a call for early preventive measures. First, there is evidence to show that treatment of obesity in adulthood can be more difficult than in childhood (Bray & Bouchard 2004). Second, puberty has been recognized as a period of rapid growth and hormonal changes, during which adipose cells increase at an accelerating rate (Pařížhová & Hills 2005; Wabitsch 2002). Third, as a longitudinal study has indicated, the lasting attitudes towards physical activity appear to be established before children reach adulthood (Pease & Anderson 1986). Hence, as Hui et al. (2003) have already pointed out, children studying in primary schools are potential important target groups for obesity prevention programs for establishing healthy lifestyle habits.

Although no association has been found between Hong Kong children's weight status and those having a working mother or those in the care of their grandparents (Hui et al. 2003), there is some evidence that parents and caregivers (such as the Filipino maid) play an important role in the development of young children's eating habits (Guldan et al. 2002) and physical activity participation (Lau & Leung 2003). Therefore, to yield greater benefits, both school-based and family-based approaches to tackle obesity are recommended. In the primary school curriculum, health-promoting behaviors may include learning how to make healthy food choices and integrating exercises into the children's schedule during and after school hours. In addition, parental supervision or family participation in food choice and physical activities is valuable.

Conclusion

Elucidation of the development and issues reviewed in the form of *stages*, *etiology*, and *recommendations* in this article serve several purposes. First, it reminds us that the prevalence rate of childhood obesity in Hong Kong is increasing as fast as those in Western developed countries, partly because the dietary and physically

inactive lifestyle habits of Hong Kong children are similar to those of children in the West. Second, as a general recommendation for future research, more studies on the areas of intervention and prevention are needed as these areas have been under-explored in the past. Finally, an interdisciplinary and holistic approach would be the most effective way in which obesity in Hong Kong children can be tackled.

References

- Adab P, Macfarlane DJ (1998). Exercise and health — new imperatives for public health policy in Hong Kong. *Hong Kong Med J* 4:389–93.
- Adamson A, Rugg-Gunn A, Butler T, Appleton D, Hackett A (1992). Nutritional intake, height and weight of 11–12-year-old Northumbrian children in 1990 compared with information obtained in 1980. *Br J Nutr* 68:543–63.
- Au AWY, Leung SSF (1995). Effect of physical fitness programme on obese children. *HK J Paediatrics* 12:40–4.
- Bouchard C (ed) (2000). *Physical Activity and Obesity*. Champaign, IL: Human Kinetics.
- Braddon FE, Rodgers B, Wadsworth ME, Davies JM (1986). Onset of obesity in a 36 year birth cohort study. *Br Med J (Clin Res Ed)* 293:299–303.
- Braet C, Mervielde I, Vandereycken W (1997). Psychological aspects of childhood obesity: a controlled study in a clinical and nonclinical sample. *J Pediatr Psychol* 22:59–71.
- Bray GA, Bouchard C (2004). *Handbook of Obesity: Clinical Applications*, 2nd edition. New York: Marcel Dekker, Inc.
- Bundred P, Kitchiner D, Buchan I (2001). Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *BMJ* 322:326–8.
- Canning PM, Courage ML, Frizzell LM (2004). Prevalence of overweight and obesity in a provincial population of Canadian preschool children. *CMAJ* 171:240–2.
- Chan DFY, Li AM, Chu WCW, Chan MHM, Wong EMC, Liu EKH, Chan HIS, Yin J, Lam CWK, Fok TF, Nelson EAS (2004). Hepatic steatosis in obese Chinese children. *Int J Obesity* 28:1257–63.
- Chan YL, Leung SSF, Lam WWM, Peng XH, Metreweli C (1998). Body fat estimation in children by magnetic resonance imaging, bioelectrical impedance, skinfold and body mass index: a pilot study. *J Paediatr Child Health* 34:22–8.
- Chang KSF, Lee MMC, Low WD (1965). Standards of the height and weight of Southern Chinese children. *Far East Med J* 1:101–9.
- Chinn S, Rona RJ (2001). Prevalence and trends in overweight and obesity in three cross sectional studies of British children, 1974–94. *BMJ* 322:24–6.

- Cole TJ, Bellizzi MC, Flegal KM, Dietz WH (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 320:1-6.
- Crichlow RW, Seltzer MH, Jannetta PJ (1972). Cholecystitis in adolescents. *Dig Dis* 17:68-72.
- de Onis M, Blössner M (2000). Prevalence and trends of overweight among preschool children in developing countries. *Am J Clin Nutr* 72:1032-9.
- Deckelbaum RJ, Williams CL (2001). Childhood obesity: the health issues. *Obes Res* 9:239-43.
- Department of Health, Hong Kong (2005). Available from <http://www.info.gov.hk/dh> [Accessed: November 16, 2005].
- Dietz WH (1998a). Childhood weight affects adult morbidity and mortality. *J Nutr* 128:411-4.
- Dietz WH (1998b). Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 101:518-25.
- Dietz WH Jr, Gross WL, Kirkparick JA Jr (1982). Blount disease (tibia vara): another skeletal disorder associated with childhood obesity. *J Pediatr* 101:735-7.
- Ebbeling CB, Pawlak DB, Ludwig DS (2002). Childhood obesity: public-health crisis, commonsense cure. *Lancet* 360:473-82.
- Egger G, Swinburn B (1997). An 'ecological' approach to the obesity pandemic. *BMJ* 315:477-80.
- Eston RG, Cruz A, Fu F, Fung LM (1993). Fat-free mass estimation by bioelectrical impedance and anthropometric techniques in Chinese children. *J Sports Sci* 11:241-7.
- Figueroa-Colon R, Franklin FA, Lee JY, Aldridge R, Alexander L (1997). Prevalence of obesity with increased blood pressure in elementary school-aged children. *South Med J* 90:806-13.
- Freedman DS, Dietz WH, Srinivasna SR, Berenson GS (1999). The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Study. *Pediatrics* 103:1175-82.
- Freedson P, Evenson S (1991). Familial aggregation in physical activity. *Res Q Exerc Sport* 62:384-9.
- Fu FH, Hao X (2002). Physical development and lifestyle of Hong Kong secondary school children. *Prev Med* 35:499-505.
- Fu FH, Hao X (2003). The prevalence of coronary heart disease risk factors of Hong Kong secondary school students. *J Exerc Sci Fit* 1:23-32.
- Gascon F, Valle M, Martos R, Zafra M, Morales R, Castano MA (2004). Childhood obesity and hormonal abnormalities associated with cancer risk. *Eur J Cancer Prev* 13:193-7.
- Group of China Obesity Task Force (2004). Body mass index reference norm for screening overweight and obesity in Chinese children and adolescents. *Zhonghua Liu Xing Bing Xue Za Zhi* 25:97-102. [In Chinese]
- Goran MI, Figueroa R, McGloin A, Nguelyn V, Treuth MS, Ngay TR (1995). Obesity in children: recent advances in energy metabolism and body composition. *Obes Res* 3:277-89.
- Gortmaker SL, Must A, Sobel AM, Peterson K, Colditz GA, Dietz WH (1996). Television viewing as a cause of increasing obesity among children in the United States. *Arch Pediatr Adolesc Med* 150:356-62.
- Guldán GS, Au Yeung KM, Wan CW, Choi KY, Chui KH, Chiu HY, Chee YO, Chow CB, Lau WC, Ma K, Yiu N, Ho WSK (2002). Combating Obesity Among Hong Kong Primary and Secondary Students: The FUN-IN-SEVEN Program. Presented at the symposium and workshop *Forging Effective Strategies for Prevention and Management of Overweight and Obesity in Asia: Research Education Partnerships*, organized by ILSI, Singapore.
- Guldán GS, Cheung ILT, Chui KKH (1998). Childhood obesity in Hong Kong: embracing an unhealthy lifestyle before puberty. *Int J Obes Relat Metab Disord* 22:16.
- He Q, Ding ZY, Fong DY, Karlberg J (2000). Blood pressure is associated with body mass index in both normal and obese children. *Hypertension* 36:165-70.
- Hernandez B, Gortmaker SL, Colditz GA, Peterson KE, Laird NM, Parra-Cabrera S (1999). Association of obesity with physical activity, television programs and other forms of video viewing among children in Mexico City. *Int J Obes Relat Metab Disord* 23:845-54.
- Hill AJ, Silver EK (1995). Fat, friendless and unhealthy: 9-year-old children's perceptions of body shape stereotypes. *Int J Obes Relat Metab Disord* 19:423-30.
- Hill JO, Melanson EL (1999). Overview of the determinants of overweight and obesity: current evidence and research issues. *Med Sci Sports Exerc* 31:S515-21.
- Hill JO, Trowbridge FL (1998). Childhood obesity: future directions and research priorities. *Pediatrics* 101:570-4.
- HKDA (1995). *Eating Habits of Preschool Children in Hong Kong*. Hong Kong: The Hong Kong Dietitians Association.
- Ho SC (1990). Risk factors of obesity among Hong Kong youths. *Public Health* 104:249-55.
- Ho SC (1992). *The Knowledge of Obesity Among Kowloon Tong Secondary School Adolescents*. Project Report by Module 4, Department of Community Medicine, The Epidemiology and Community Health Project, with Supervisor Dr Suzanne C. Ho, Department of Community & Family Medicine, The Chinese University of Hong Kong.
- Ho SC, Donnan SPB (1986). Prevalence of overweight and self perception of overweight among the school adolescents in Shatin. *J HK Soc Community Med* 16:7-19.
- Ho SC (1987). Assessment of overweight and physical activity among adolescents and youths in Hong Kong. *Public Health* 101:457-64.
- Hoffmans MD, Kromhout D, de Lezenne Coulander C (1988). The impact of body mass index from 78,612 18-year-old Dutch men on 32-year mortality from all causes. *J Clin Epidemiol* 41:749-56.
- Huang YC, Wu JY, Yang MJ (2003). Weight-for-height reference and the prevalence of obesity for school children and adolescents in Taiwan and Fuchien areas. *J Chin Med Assoc* 66:599-606.
- Hui LL, Nelson EAS, Yu LM, Li AM, Fok TF (2003). Risk factors for childhood overweight in 6- to 7-year-old Hong Kong children. *Int J Obes* 27:1411-8.

- Hui SC, Lau WC, Yuen PY (2000). Fat-Fun-Fit Project: effects of a school-based weight loss intervention program in Hong Kong children. *Res Q Exerc Sport* 71 (Suppl):A39-40.
- Hui SC, Wong HS, Lau WC, Wong WK (2001). Cross-validation of bioelectrical impedance analysis for estimation of body fat in Chinese children aged 8 to 12. In: Chin MK, Hensley LD, Liu YK (eds). *Innovation and Application of Physical Education and Sports Science in the New Millennium: An Asia-Pacific Perspective*. Hong Kong: The Hong Kong Institute of Education, pp 487-92.
- Inselman LS, Milanese A, Deurloo A (1993). Effect of obesity on pulmonary function in children. *Pediatr Pulmonol* 16: 130-7.
- Jing J (2000). *Feeding China's Little Emperors: Food, Children, and Social Change*. California: Stanford University Press.
- Kalakanis LE, Goldfield GS, Paluch RA, Epstein LH (2001). Parental activity as a determinant of activity level and patterns of activity in obese children. *Res Q Exerc Sport* 72: 202-9.
- Kang YJ, Hong CH, Hong YJ (1997). The prevalence of childhood and adolescent obesity over the past 18 years in the Seoul area. *Korean J Nutr* 30:832-9.
- Kawasaki T, Hashimoto N, Kikuchi T, Takahashi H, Uchiyama M (1997). The relationship between fatty liver and hyperinsulinaemia in obese Japanese children. *J Pediatr Gastroenterol Nutr* 24:317.
- Klaczynski PA, Goold KW, Mudry JJ (2004). Culture, obesity stereotypes, self-esteem, and the "thin ideal": a social identity perspective. *J Youth Adolesc* 33:307-17.
- Kotani K, Nishida M, Yamashita S, Funahashi T, Fujioka S, Tokunaga K, Ishikawa K, Tarui S, Matsuzawa Y (1997). Two decades of annual medical examinations in Japanese obese children: do obese children grow into obese adults? *Int J Obes Relat Metab Disord* 21:912-21.
- Lam TH, Stewart SM, Leung G, Ho SY, Fan AH, Ma ALT (2002). Sex differences in body satisfaction — feeling fat and pressure to diet among Chinese adolescents in Hong Kong. *Eur Eat Disorders Rev* 10:347-58.
- Lau PWC (2004). *Weight Management for Children*. Hong Kong: The Commercial Press. [In Chinese]
- Lau PWC, Lee A, Ransdell L, Yu CW, Sung RYT (2004a). The association between global self-esteem, physical self-concept and actual vs ideal body size rating in Chinese primary school children. *Int J Obesity* 28:314-9.
- Lau PWC, Leung BWC (2003). Parental influences towards Chinese children's physical activity participation. *Educ Res J* 18:17-40.
- Lau PWC, Sung RYT, Yu CW (2003). The physiological and fitness of resistance training on Chinese obese adolescents. In: Macao Sport Development Board (eds). *International Seminar on Physical Fitness and Health Development of Infant and Young Child*. Macao: Macao Sport Development Board, pp 110-5.
- Lau PWC, Yu CW, Lee A, Sung RYT (2004b). The physiological and psychological effects of resistance training on Chinese obese adolescents. *J Exerc Sci Fit* 2:115-20.
- Lee WTK, Leung SSF, Leung DMY (1994). The current dietary practices of Hong Kong adolescents. *Asia Pac J Clin Nutr* 3:83-7.
- Leung SSF (1993). Nutrition of Hong Kong Chinese children. *HK J Paediatrics* 10:160-6.
- Leung SSF (1994). *Growth Standards for Hong Kong: A Territory Wide Survey in 1993*. Hong Kong: Department of Paediatrics, The Chinese University of Hong Kong, 1994.
- Leung SSF (1995). Childhood obesity in Hong Kong. *HK J Paediatrics* 1(Suppl):63-8.
- Leung SSF (1997). *Growth and Nutrition: A Transition Over Three Decades*. In *The First 35 Years*. Hong Kong: The Hong Kong Paediatric Society.
- Leung SSF, Chan SM, Lui S, Lee WTK, Davies DP (2000a). Growth and nutrition of Hong Kong Children aged 0-7 years. *J Paediatr Child Health* 36:56-65.
- Leung SSF, Chan YL, Lam CW, Peng XH, Woo KS, Metreweli C (1998). Body fatness and serum lipids of 11-year-old Chinese children. *Acta Paediatr* 87:363-7.
- Leung SSF, Lau JT, Xu YY, Tse LY, Huen KF, Wong GW, Law WY, Yeung VT, Yeung WK, Leung NK (1996a). Secular changes in standing height, sitting height and sexual maturation of Chinese — the Hong Kong Growth Study, 1993. *Ann Hum Biol* 23:297-306.
- Leung SSF, Lau JTF, Tse LY, Oppenheimer SJ (1996b). Weight-for-age and Weight-for-height references for Hong Kong children from birth to 18 years. *J Paediatr Child Health* 32: 103-9.
- Leung SS, Lee RH, Sung RY, Luo HY, Kam CW, Yuen MP, Hjelm M, Lee SH (2001). Growth and nutrition of Chinese vegetarian children in Hong Kong. *J Paediatr Child Health* 37:247-53.
- Leung SSF, Lee WT, Lui SS, Ng MY, Peng XH, Luo HY, Lam CW, Davies DD (2000b). Fat intake in Hong Kong Chinese children. *Am J Clin Nutr* 72(5 Suppl):1373S-8S.
- Leung SSF, Ng MY, Lam CWK, Lee TK (1994a). Dietary intake and serum cholesterol level of Hong Kong children. *Chin J Paediatr* 32:269-71.
- Leung SSF, Ng MY, Lam CWK, Lee WTK (1995a). Serum cholesterol and obesity of Hong Kong Chinese at 7 years. *HK J Paediatrics* 12:23-30.
- Leung SSF, Ng MY, Lau TF (1995b). Prevalence of obesity in Hong Kong children and adolescents aged 3-18 years *Zhonghua Yu Fang Yi Xue Za Zhi* 29:270-2. [In Chinese]
- Leung SSF, Ng MY, Tam BY (1994b). A comparative study on blood cholesterol and dietary fat intake between Hong Kong and Cantonese children. *Zhonghua Yu Fang Yi Xue Za Zhi* 28:199-201. [In Chinese]
- Leung SSF, Ng MY, Tan BY, Lam CWK, Wang SF, Xu YC, Tsang WP (1994c). Serum cholesterol and dietary fat of two populations of southern Chinese. *Asia Pac J Clin Nutr* 3:127-30.

- Leung SSF, Tse LY, Leung NK (1996c). Growth and nutrition in Hong Kong children. *Singapore Paediatr J* 38:61–6.
- Leung TF, Li CY, Lam CWK, Au CSS, Yung E, Chan IHS, Wong GWK, Fok TF (2004). The relation between obesity and asthmatic airway inflammation. *Paediatr Allergy Immunol* 15:344–50.
- Li AM, Chan D, Wong E, Yin J, Nelson EA, Fok TF (2003). The effects of obesity on pulmonary function. *Arch Dis Child* 88:361–3.
- Liang SSF, Xie LX, Liu DH, et al (1996). Growth standards for Hong Kong children. *Chin J Pediatr* 34:309–14.
- Lu K, Quach B, Tong TK, Lau PWC (2003). Validation of leg-to-leg bioimpedance analysis for assessing body composition in obese Chinese children. *J Exerc Sci Fit* 1:97–103.
- Luder E, Melnik TA, Dimaio M (1998). Association of being overweight with greater asthma symptoms in inner city black and Hispanic children. *J Pediatr* 132:699–703.
- Ludwig DS, Ebbeling CB (2001). Type 2 diabetes mellitus in children. *JAMA* 286:1427–31.
- Luo J, Hu FB (2002). Time trends of obesity in preschool children in China from 1989 to 1997. *Int J Obes Relat Metab Disord* 26:553–8.
- Macfarlane DJ (1997). Some disturbing trends in the level of habitual physical activity in Hong Kong primary school children: preliminary findings. *HK J Sports Med* 5:42–6.
- Macfarlane DJ (1999). Pilot investigation on the tracking of physical activity in Hong Kong young school children. *Health Services Research Committee Report No. 11*, February 1999.
- Magarey AM, Daniels LA, Boulton TJ (2001). Prevalence of overweight and obesity in Australian children and adolescents: reassessment of 1985 and 1995 data against new standard international definitions. *Med J Aust* 174:561–4.
- Mallory GB Jr, Fiser D, Jackson R (1989). Sleep-associated breathing disorders in morbidity obese children and adolescents. *J Pediatr* 115:892–97.
- Marshall SJ, Biddle SJH, Gorely T, Cameron N, Murdey I (2004). Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obesity* 28:1238–46.
- Matsushita Y, Yuoshiike N, Kaneda F, Yoshita K, Takimoto H (2004). Trends in childhood obesity in Japan over the last 25 years from the National Nutrition Survey. *Obes Res* 12:205–14.
- McMurray R, Harrell J, Levine A, Gansky S (1995). Childhood obesity elevates blood pressure and total cholesterol independent of physical activity. *Int J Obesity* 19:881–6.
- Moore L, Lombardi D, White M, Campbell J, Oliveria S, Ellison R (1991). Influence of parents' physical activity levels on young children. *J Pediatr* 118:215–9.
- Mosseberg HO (1989). A 40-year follow-up of overweight children. *Lancet* 2:491–3.
- Mustillo S, Worthman C, Erkanli A, Keeler G, Angold A, Costello EJ (2003). Obesity and psychiatric disorder: developmental trajectories. *Pediatrics* 111:851–9.
- Nash JM (2003). Obesity goes global. *Time* 162:53–4.
- Nestle M (2002). *Food Politics: How the Food Industry Influences Nutrition and Health*. Berkeley: University of California Press.
- Neumark-Sztainer D, Story M, Resnick MD, Blum RW (1997). Psychosocial concerns and weight control behaviors among overweight and non-overweight Native American adolescents. *J Am Dietetic Assoc* 97:598–604.
- Niet FJ, Szklo M, Cernstock GW (1992). Childhood weight and growth rate as predictors of adult mortality. *Am J Epidemiol* 136:201–13.
- Pařížhová J, Hills AP (2005). *Childhood Obesity: Prevention and Treatment*. Boca Raton, FL: CRC Press.
- Pease DG, Anderson DF (1986). Longitudinal analysis of children's attitudes toward sport team involvement. *J Sport Behav* 9:3–10.
- Peterson S, Brulin C, Bergström E (2003). Increasing prevalence of overweight in young schoolchildren in Umeå, Sweden, from 1986 to 2001. *Acta Paediatr* 92:848–53.
- Philips RG, Hill AJ (1998). Fat, plain but not friendless: self-esteem and peer-acceptance of obese preadolescent girls. *Int J Obes Relat Metab Disord* 22:287–95.
- Poskitt EME (2000). Body mass index and child obesity: are we nearing a definition? *Acta Paediatr* 89:507–9.
- Rosenbaum M, Leibel RL (1998). The physiology of body weight regulation: relevance to the etiology in children. *Pediatrics* 101:525–39.
- Rowlands AV, Eston RG, Ingledew DK (1999). Relationship between physical activity levels, aerobic fitness and body fat in 8- to 10-year-old children. *J Appl Physiol* 86:1428–35.
- Rowlands AV, Eston RG, Louie L, Ingledew DK, Tong KK, Fu FH (2002). Physical activity level of Hong Kong Chinese children: relationship with body fat. *Pediatric Exerc Sci* 14:286–96.
- Srinivasan SR, Bao W, Wattigney WA, Berenson GS (1996). Adolescent overweight is associated with adult overweight and related multiple cardiovascular risk factors. The Bogalusa Heart Study. *Metabolism* 45:235–40.
- Strauss RS (2000). Childhood obesity and self-esteem. *Pediatrics* 105:e15.
- Sung RY, Lau P, Yu CW, Lam PK, Nelson EA (2001). Measurement of body fat using leg to leg bioimpedance. *Arch Dis Child* 85:263–7.
- Sung RY, Tong PC, Yu CW, Lau PW, Mok GT, Yam MC, Lam PK, Chan JC (2003). High prevalence of insulin resistance and metabolic syndrome in overweight/obese preadolescent Hong Kong Chinese children aged 9–12 years. *Diabetes Care* 26:250–1.
- Sung RYT, Yu CW, So RCH, Lam PKW, Hau KT (2005). Self-perception of physical competences in preadolescent overweight Chinese children. *Eur J Clin Nutr* 59:101–6.

- Sung RYT, Yu CW, Chang SKY, Mo SW, Woo KS, Lam CWK (2002). Effects of dietary intervention and strength training on blood lipid level in obese children. *Arch Dis Child* 86:407-10.
- Tershakovec AM, Watson MH, Wenner WJ, Marx AL (1999). Insurance reimbursement for the treatment of obesity in children. *J Pediatr* 134:573-8.
- Tong S, Fung L (2003). The congruence of two different height-weight ratios in estimating obesity prevalence: a study with Hong Kong children aged 6 to 12. *J Exerc Sci Fit* 1:133-5.
- Tounian P, Aggoun Y, Dubern B, Varille V, Guy-Grand B, Sidi D, Girardet JP, Bonnet D (2001). Presence of increased stiffness of the common carotid artery and endothelial dysfunction in severely obese children: a prospective study. *Lancet* 358:1400-4.
- Tremblay MS, Katzmarzyk PT, Willms JD (2002). Temporal trends in overweight and obesity in Canada, 1981-1996. *Int J Obes Relat Metab Disord* 26:538-43.
- Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson CL. Overweight prevalence and trends for children and adolescents: the National Health and Nutrition Examination Surveys, 1963 to 1991. *Arch Pediatr Adolesc Med* 149:1085-91.
- Wabitsch M (2002). Molecular and biological factors with emphasis on adipose tissue development. In: Burniat W, Cole T, Lissau I, Poskitt EME (eds). *Child and Adolescent Obesity: Causes and Consequences, Prevention and Management*. New York: Cambridge University Press, pp 50-68.
- Wang Y (2001). Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. *Int J Epidemiol* 30:1129-36.
- Wang YF, Monteiro C, Popkin BM (2002). Trends of obesity and underweight in older children and adolescents in the United states, Brazil, China and Russia. *Am J Clin Nutr* 75:971-7.
- Wardle J, Volz C, Golding C (1995). Social variation in attitudes to obesity in children. *Int J Obes Relat Metab Disord* 19:562-9.
- Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH (1997). Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med* 337:869-73.
- Wing YK, Hui SH, Pak WM, Ho CK, Cheung A, Li AM, Fok TF (2003). Sleep-related disordered breathing in obese children. *Arch Dis Child* 88:1043-7.
- Wong GWK, Leung SSF (1993). Impaired glucose tolerance in obese Chinese children in Hong Kong. *HK J Paediatr* 10:109-12.
- Wong J, Ho S, Lai M, Leung G, Stewart S, Lam T (2005). Overweight, obesity, weight-related concerns and behaviours in Hong Kong Chinese children and adolescents. *Acta Paediatr* 94:595-601.
- Wong TK, Macfarlane DJ (1997). Levels of habitual physical activity and exercise intensity during physical education class among 8-13-year-old Hong Kong primary school children. *Res Q Exerc Sport* 68:A24.
- Woo KS, Chook P, Yu CW, Sung RYT, Qiao M, Leung SSF, Lam CWK (2004a). Overweight in children is associated with arterial endothelial dysfunction and intima-media thickening. *Int J Obesity* 28:852-7.
- Woo KS, Chook P, Yu CW, Sung RYT, Qiao M, Leung SSF, Lam CWK, Metreweli C, Celermajer DS (2004b). Effects of diet and exercise on obesity-related vascular dysfunction in children. *Circulation* 109:1981-6.
- Wu GC, Guo SY, Liang SF, et al (1998). Comparison on obesity in schoolchildren between Beijing and Hong Kong. *Chin J Child Health Care* 6:80-2. [In Chinese]
- Yu CCW, Sung RYT, So RCH, Lui KC, Lau W, Lam PKW, Lam EMC (2005). Effects of strength training on body composition and bone mineral content in children who are obese. *J Strength Cond Res* 19:667-72.
- Yu CW, Sung RY, So R, Lam K, Nelson EA, Li AM, Yuan Y, Lam PK (2002). Energy expenditure and physical activity of obese children: cross-sectional study. *HK Med J* 8:313-7.