OVERWEIGHT AND OBESITY AMONG PRIMARY SCHOOLCHILDREN IN NAKHON PATHOM, THAILAND: COMPARISON OF THAI, INTERNATIONAL OBESITY TASK FORCE AND WHO GROWTH REFERENCES

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Abstract. Differences in estimation of over-nutrition due to use of different classification methods lead to difficulty in comparison. This study determined prevalence of overweight and/or obesity using different criteria and their relationship to socio-demographic determinants. A total of 605 schoolchildren (Grades 4-6) in Nakhon Pathom, Thailand were assessed for overweight and/or obesity based on Thai Growth Reference (TGR), WHO Growth Reference (2006) and International Obesity Task Force (IOTF) (2012). Prevalence of combined overweight and obesity ranged from 23.1% using TGR to 37.2% using WHO Growth Reference. Prevalence of obesity showed better concordance among the three methods, ranging from 11.5% using IOTF to 17% using WHO Growth Reference and TGR. All methods showed good agreement, with the highest being between TGR and IOTF (Kappa = 0.81; 95% CI: 0.76-0.87 in boys and 0.76; 95% CI: 0.68-0.83 in girls). Boys, children of mothers with high body mass index and having no sibling were more likely to be overweight or obese, regardless of the methods used. Our results show marked differences in prevalence of overweight and/or obesity estimated by these three classifications, and the impact of the choice of classification system should be considered with caution according to the purpose of the estimation.

Keywords: obesity, overweight, prevalence, primary schoolchildren, socio-demographic factor, Thailand

INTRODUCTION

As childhood obesity is associated with a number of health problems, such as type II diabetes, increased cardiovascular risk factors, sleep apnea, and psychosocial problems (WHO, 2000) and contributes to increases in mortality and morbidity in the long term, it has been one of the most serious public health challenges (WHO, 2000). Indeed, it has reported that with increasing prevalence of obesity in both children and adults in Thailand (Jitnarin *et al*, 2011; Yamborisut and Mo-Suwan, 2014), morbidity of type 2 diabetes has increased from

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5% during 1986-1995 to 17.9% during 1996-1999 among Thai children (Likitmaskul *et al*, 2003) and total socio-economic cost of overweight and obesity accounts for 0.13% of Thailand's GDP (Pitayatienanan *et al*, 2014).

As childhood obesity tends to persist into adulthood (Guo *et al*, 2002), diagnosis of overweight and obesity in childhood is of important relevance to public health (Daniels *et al*, 2005). Methods such as dual-energy X-ray absorptiometry are more accurate for measuring adiposity, but are of limited applicability for population screening (WHO, 2000). Therefore, for population screening or for epidemiologic research, using a weight/height index to define obesity has advantages that outweigh its limitations.

Many studies in Thailand have used the national Thai Growth Reference (TGR) developed from a cross-sectional study of children and adolescents from birth to 19 years of age in urban areas of 17 provinces in 1999 (Yamborisut and Mo-Suwan, 2014). For a global cut-off to define overweight or obesity, WHO Growth Reference (WHO, 2006; de Onis *et al*, 2007) and the International Obesity Task Force (IOTF) (Cole *et al*, 2000; *idem*, 2007) are generally accepted for making appropriate comparisons across studies and monitoring global obesity epidemic because the cut-off values are comprehensive, available and easy to be used. However, differences in estimation of overweight and obesity due to the use of different classification methods can make it difficult to monitor national and global trends, to perform comparisons among studies, and for employment in public health and clinical settings (Neovius *et al*, 2004).

To the best of our knowledge, a limited effort has been made to compare the application of these classification systems in Thai schoolchildren. Hence, the aims of this study were to determine the prevalence of overweight and obesity using the three different methods and to investigate whether socio-demographic factors of Thailand to the prevalence are the same for the different criteria used. This study may provide insights into whether and under what circumstances a national or international growth reference standard is most useful for schoolchildren.

MATERIALS AND METHODS

Study group

This cross sectional study was conducted in a group of 605 schoolchildren (Grades 4 to 6; 9-12 years old) attending two primary schools in Nakhon Pathom, Thailand in 2015. Prior to undertaking the study, the study design and purpose were discussed with the Director of each school and their approvals were obtained. Prior informed consents were granted from the parents/legal guardians after explanation of the study objectives, and assurance of confidentiality and that choosing not to participate would not disadvantage their children in any way. All procedures were approved by the Human Research Ethics Committee of Mahidol University (approval no. 2015/033.2701).

Measurements and statistical analysis

Children were asked to wear light indoor clothing without shoes for measurements. Weight was measured to the nearest 100 g using a digital weight scale and standing height was measured to the nearest 0.5 cm using a wall-mounted wooden ruler. Assessment of overweight or obesity was based on the indicators shown in Table 1.

Concordance among the three diagnostic criteria for normal weight, overweight and obesity was assessed by

Table 1
Classifications of overweight and obesity in Thai children.

Variable	Thai Growth Reference	IOTF Growth Reference	WHO Growth Reference
Source	Institute of Nutrition, Mahidol University and Ministry of Public Health, Thailand.	Cole and Lobstein (2012)	WHO and NCHS
Data and reference population	A cross sectional study of breast- and predominantly formula-fed children and adolescents from birth to 19 years of age in urban areas of 17 provinces in 1999 (Ministry of Public Health Thailand, 1999).	Large survey data sets from Brazil, Britain, Hong Kong, Singapore, The Netherlands and USA (Cole *et al*, 2000; Cole and Lobstein, 2012).	Non-obese US subjects with expected height from 1977 NCHS/WHO references (WHO, 1995), supplemented with data from WHO Child Growth Standards (WHO, 2006) (to facilitate a smooth transition at 5 years of age) (de Onis *et al*, 2007).
Age group	0-19 years	2-18 years	5-19 years
Classification method for children 9-12 years of age.	Age- and gender-specific weight-for-height Z (WHZ) score (INMU, 2002).	New age- and gender-specific BMI cut-offs defined in terms of the percentiles at 18 years of age corresponding to each BMI value in 2012 (Cole and Lobstein, 2012).	Age- and gender-specific BMI Z scores estimated using AnthroPlus (WHO, 2009).
Overweight	Age- and gender-specific WHZ score >1.5 SD to 2 SD of median.	Age- and gender-specific BMI cut-offs derived from BMI-age curves >BMI of 25 at 18 years of age.	Age -and gender-specific BMI >85th percentile or +1 SD score.
Obese	Age- and gender-specific WHZ > 2 SD of median.	Age- and gender-specific BMI cut-offs derived from BMI-age curves >BMI of 30 at 18 years of age.	Age- and gender-specific BMI >95th percentile or +2 SD score.

weighted Cohen's Kappa (k) coefficient, together with its 95% confidence interval (CI). In addition, in order to identify factors associated with obesity alone and combined overweight and obesity, logistic regression analysis was conducted to estimate Odds ratios (OR) and 95% CI for each of the three classification criteria (TGR, WHO Growth Reference and IOTF cut-offs) (all variables being modeled simultaneously). Statistical analysis was conducted using SAS for Windows, version 9.3 (SAS Institute, Cary, NC).

RESULTS

Prevalence of overweight and/or obesity among Thai children aged 9-12 years were determined according to the three classification methods. Obesity prevalence was lower when using IOTF (16% in boys and 8% in girls) compared to the other two methods (TGR: 24% in boys and 11% in girls; WHO Growth Reference: 26% in boys and 10% in girls) (Table 2). Prevalence of combined overweight and obesity was much lower when using TGR (33% in boys and 15% in girls) due to the lower estimation of overweight prevalence by TGR compared to the two other international criteria (WHO Growth Reference: 50% in boys and 27% in girls; IOTF: 40% in boys and 23% in girls). Weighted k-values for the three methods showed that the two international growth references estimating normal weight, overweight and obesity are in 'good agreement', but the highest k-value is between TGR and IOTF (0.81; 95% CI: 0.76-0.87 in boys and 0.76; 95% CI: 0.68-0.83 in girls) (Table 3). However, as regards obesity, WHO Growth Reference showed better agreement with TGR (data not shown).

The prevalence pattern of obesity and combined overweight and obesity with age were different between genders (Table 2). In boys, prevalence of combined overweight and obesity decreased with age until year 11 and then slightly increased at years 12 regardless of the methods used. In girls, this did not change much with age until year 11 regardless of the methods, but dramatically rose at year 12 when using TGR only (24%). As regards obesity alone, while a decrease in prevalence with age was apparent in boys, particularly when using international growth references, in girls, the prevalence tended to decrease until year 11, regardless of the methods used, but the prevalence at year 12 depended on the growth reference used: 10% using IOTF, 15% using WHO Growth Reference and 21% using TGR.

Combined overweight and obesity and obesity alone were elevated in boys, children of mothers with high body mass index (BMI), and those with no sibling, regardless of the classification system used (Table 4). There are no statistically significant association with child's age, household income and maternal education levels with the combined overweight and obesity or obesity alone.

DISCUSSION

The problem of obesity is present throughout Thailand. A recent review of the prevalence of obesity from six national surveys from 1995 to 2009 showed that using TGR, despite fluctuations of prevalence of overweight and obesity throughout the period due to differences in age categorization and classification systems, the prevalence among children 6-14 years of age is continuously increasing (Chavasit *et al*, 2013; Yamborisut and Mo-Suwan, 2014). According to the 4th National Health Examination Survey of Thailand (2008-2009), the prevalence of

Table 2
Prevalence of normal weight, overweight and obesity among Thai schoolchildren (Grades 4-6) using TGR, IOTF and WHO Growth Reference.

Age (years)		Boy					Girl				
	Total	9	10	11	12	Total	9	10	11	12	Total
Number	605	30	95	82	67	274	30	127	116	58	331
TGR[a]											
Overweight (>+1.5 - +2.0)	6.4	20	10.5	4.9	9.0	9.4	3.3	4.7	3.5	3.5	3.9
Obesity (<+2)	16.6	26.7	24.2	23.2	20.9	23.6	10.0	8.7	8.6	20.7	10.9
Combined overweight and obesity	23.1	46.7	34.7	28.1	29.9	33.0	13.3	13.4	12.1	24.1	14.8
WHO[b]											
Overweight (>+1 - +2)	19.9	30	24.2	17.1	29.9	23.9	16.7	16.5	19.0	12.1	16.6
Obesity (>+2)	17.3	36.7	30.5	23.2	16.4	25.7	10.0	11.0	6.9	15.5	10.3
Combined overweight and obesity	37.2	66.7	54.7	40.2	46.3	49.6	26.7	27.6	25.9	27.6	26.9
IOTF[c]											
Overweight (25-29.9)	19.4	40	23.2	18.3	26.9	24.3	13.3	15.0	16.4	15.5	15.4
Obesity (30+)	11.5	20	21.1	13.4	9.0	15.9	10.0	7.9	6.0	10.3	7.9
Combined overweight and obesity	30.9	60	44.2	31.7	35.8	40.2	23.3	22.8	22.4	25.9	23.3

[a]Sex-specific weight-for-height Z-score >1.5 SD and >2.0 SD of median for overweight and obesity, respectively. [b]Age and sex-specific BMI-for-age Z-score >1.0 SD and >2.0 SD of median for overweight and obesity, respectively [sex-specific BMI-for-age Z-score estimated using WHO Growth Reference table (http://www.who.int/growthref/en)]. [c]Sex-specific BMI-for-age value >25 and 30 kg/m^2 for overweight and obesity at age 18 years based on new IOTF BMI cut-offs (2012).

Table 3
Kappa coefficient and 95% confidence interval (CI) among TGR, IOTF, WHO Growth Reference for classification of combined overweight and obesity in children.

	Boy Kw (95% CI)	Girl Kw (95% CI)
TGR *vs* IOTF	0.81 (0.76-0.87)	0.76 (0.68-0.83)
TGR *vs* WHO	0.76 (0.70-0.83)	0.72 (0.64-0.80)
WHO *vs* IOTF	0.77 (0.71-0.83)	0.88 (0.83-0.93)

Kw, weighted Kappa statistics.

overweight and obesity is 4% and 11%, respectively in children of 10-14 years (Yamborisut and Mo-Suwan, 2014). Our study, however, showed a higher prevalence in both categories. This could be due to the difference in age and study area. Studies have shown regional differences in overweight and obesity prevalence in Thailand (Jitnarin *et al*, 2011; Aekplakorn *et al*, 2014). A study similar to ours involving 5,126 primary schoolchildren 6-12 years of age in four public schools in Bangkok revealed 19% prevalence of obesity (Sirikulchayanonta *et al*, 2011).

Controversy exists whether and under what circumstances a national or international growth reference classification is most appropriate for Thai children. A recent Thai study suggested that cut-off between 112% and 125% of weight-to-height Z value (WHZ) based on TGR should be validated to determine overweight and obesity as defined by WHO BMI-for-age reference in Thai schoolchildren (Rerksuppaphol and Rerksuppaphol, 2013). This latter study, however, did not measure the adequacy of the WHZ cut-offs based on TGR in reflecting the percent body fat and the risk of negative health outcomes among the tested Thai primary schoolchildren. Thus, further studies are needed to produce a recommendation of an appropriate use of the national and international classification methods that reflects adequately percent body fat and risk of negative health outcomes among Thai primary schoolchildren.

To the best of our knowledge, the present study is the first to examine the impact of using the national and two recently reformulated international classification methods on estimating overweight and/or obesity among a primary schoolchildren in a sub-urban area of Thailand. Obesity prevalence was lowest using IOTF, while combined overweight and obesity prevalence was lowest using TGR.

These findings support a recent review revealing that the IOTF definition of obesity is highly conservative (Reilly *et al*, 2010). Thus, use of IOTF may be more problematic when such classification of obesity is used in clinical settings due to its negative health outcomes than overweight (Dietz, 1998). Further studies are needed to determine which IOTF cut-offs for Thai schoolchildren instead of the IOTF cut-offs of 25 or 30 kg/m^2 at age of 18 years.

As regards combined overweight and obesity, use of the TGR classification system is conservative, owing to lower estimations of overweight compared to that employed by using the other two

Table 4
Odds ratio (OR) and 95% confidence interval (CI) of association between obesity and combined overweight and obesity of Thai school children with socio-demographic factors.

	TGR[a]	WHO[b]	IOTF[c]
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Overweight or obesity			
Age (year)	0.94 (0.72-1.22)	0.92 (0.73-1.16)	0.84 (0.66-1.07)
Sex			
Girl	1.00	1.00	1.00
Boy	**3.44 (2.08-5.69)**	**3.26 (2.10-5.08)**	**2.49 (1.58-3.93)**
Maternal overweight			
No	1.00	1.00	1.00
Yes	**3.04 (1.79-5.16)**	**3.07 (1.95-4.83)**	**3.33 (2.07-5.36)**
Maternal education level			
Primary school	1.00	1.00	1.00
Secondary school	0.74 (0.38-1.42)	0.88 (0.49-1.58)	0.77 (0.42-1.41)
College	0.64 (0.33-1.27)	0.79 (0.43-1.46)	0.77 (0.41-1.44)
Number of siblings <18 years of age			
≥2	1.00	1.00	1.00
1	**2.28 (1.38-3.77)**	**1.93 (1.23-3.04)**	**2.03 (1.28-3.24)**
Monthly household income (Baht)			
≤10,000	1.00	1.00	1.00
10,000-20,000	2.10 (0.99-4.46)	1.65 (0.87-3.12)	1.58 (0.81-3.07)
>20,000	1.72 (0.79-3.76)	1.17 (0.60-2.27)	1.18 (0.59-2.36)
Obesity			
Age (year)	1.06 (0.80-1.42)	0.81 (0.60-1.08)	0.85 (0.61-1.17)
Sex			
Girl	1.00	1.00	1.00
Boy	**2.94 (1.69-5.09)**	**4.15 (2.36-7.31)**	**3.30 (1.73-6.26)**
Maternal overweight			
No	1.00	1.00	1.00
Yes	**2.31 (1.30-4.09)**	**1.92 (1.09-3.37)**	**1.89 (0.99-3.60)**
Maternal education level			
Primary school	1.00	1.00	1.00
Secondary school	0.70 (0.35-1.43)	0.73 (0.36-1.47)	1.08 (0.47-2.46)
College	0.73 (0.35-1.52)	0.61 (0.29-1.29)	1.10 (0.46-2.63)
Number of siblings <18 years of age			
≥2	1.00	1.00	1.00
1	**2.03 (1.18-3.51)**	**2.20 (1.27-3.81)**	**2.10 (1.12-3.92)**
Monthly household income (Baht)			
≤10,000	1.00	1.00	1.00
10,001-20,000	1.20 (0.55-2.61)	1.72 (0.79-3.75)	1.24 (0.52-3.00)
>20,000	1.04 (0.46-2.34)	1.02 (0.44-2.33)	0.85 (0.33-2.16)

[a]Sex-specific weight-for-height Z-score >1.5 SD and >2.0 SD of median for overweight and obesity, respectively. [b]Age and sex-specific BMI-for-age Z-score >1.0 SD and >2.0 SD of median for overweight and obesity, respectively [sex-specific BMI-for-age Z-score estimated using WHO Growth Reference table (http://www.who.int/growthref/en)]. [c]Sex-specific BMI-for-age value >25 and 30 kg/m^2 for overweight and obesity at age 18 years based on new IOTF BMI cut-offs (2012).

international methods. Thus, if the main goal of assessing childhood overweight or obesity at the population level and thereby identify populations at risk of developing health consequences of obesity in adulthood, and to design appropriate public health interventions to prevent childhood obesity, data from using TGR might underestimate the prevalence of the population at risk of overweight or obesity. As these differences between the classification methods have important implications on public health policy concerning nutritional assessment aiming at identification of risk populations or at planning interventions, there should be an awareness of this problem.

In addition, there appears to a weak or no association with such socio-economic factors, as maternal education and family income with overweight and/or obesity among the test schoolchildren. This is different from many studies reporting that childhood obesity is more problematic in rich (Dinsa *et al*, 2012) than low- or middle-income countries, such as Thailand (Sakamoto *et al*, 2001), Russia and China (Wang, 2001). The discrepancy may be explained by nutrition and health transitions as supported by a study in China suggesting obesity becomes a condition that affects people of lower socio-economic status (SES) more than those of higher SES compared to a few decades earlier (Wang and Beydoun, 2007). We also found a positive relationship between maternal overweight status and existence of child's overweight and/or obesity. Further research should be conducted to identify the influence of SES and other family factors impacting on weight status among Thai children.

There was a clear gender difference in terms of the magnitude of prevalence of overweight and/or obesity as well as age. Although national surveys conducted in China (Wang and Wang, 2002; Tuan and Nicklas, 2009), Vietnam (Tuan and Nicklas, 2009), USA and Russia (Wang and Wang, 2002) showed no or little difference between genders, girls have 2 times lower prevalence of overweight and/or obesity than boys, consistent with other Thai studies conducted in urban areas (Langendijk *et al*, 2003; Sirikulchayanonta *et al*, 2011). Furthermore, while prevalence of obesity in boys decreased with age, that of girls decreased until 11 years of age and then rose at 12 years of age. It could be explained that girls reach a maturation age around 11 years old, resulting in an increase in age-and sex-specific BMI. These results should be interpreted with caution as there is no information on body composition, which can allow identification of the best screening tool to screen population at risk of overweight or obesity. In addition, we used measurement scales of weight and height available at each school, which may be subject to error. Further studies on the effects of gender and obesity pattern in the Thai context are needed.

In summary, this study shows differences in the estimation of combined overweight and obesity and obesity alone depending on the classification methods used, namely, TGR, IOTF and WHO Growth Reference. All three classification methods indicated boys, children of mothers with high BMI, and those having no sibling were more likely to be overweight or obese. These findings suggest use of international classifications along with national classification method should be considered in clinical and public health settings according to the purpose of the estimation.

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CONFLICT OF INTERESTS

The authors declare no conflict of interests.

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