しているが、14 歳以降の上位パーセンタイル値は横ばいに転じる。また、女児より男児のパーセンタイル値は高い傾向であり、男女の差はパーセンタイル値が上がるほど大きくなる（図 3)。

中国全国レベルの BMI 参考曲線と比較すると、男女とも北京の方が高いレベルにあり、パーセンタイル値が上がるほど差が大きくなる（図 4)。

男児の国際比較において、P50 では、北京が 6.5-14 歳で僅かに上回り、その後、CDC、WHO 及び日本を下回るが、インドより僅かに高い。P3 については、北京はインドより高いレベルだが、CDC、WHO 及び日本より低い。P95 については、北京が 13 歳まで最も高いが、その後、インドに上回り、18 歳になると CDC とほぼ同様である。女児の国際比較において、P50 では、12.5-15 歳で WHO 及び CDC とほぼ同じである以外に、北京の方が WHO、CDC、日本及びインドより僅かに低い。P3 では、男児と同様に、北京はインドより高く、WHO、CDC 及び日本より低い。P95 では、北京は 15.5 歳までに WHO 及び日本（12.5-15.5 歳）より高いが、その後、北京が最も低くなる（図 5)。

E. 結論

情報収集の結果から、中国は独自の小児成長曲線を作成したことが明らかになった。標準化された成長曲線に基づくデータは全国をカバーする大規模調査であったことと、作成方法は世界的によく利用されている LMS 法であったため、国際的な比較ができると考えられる。

中国北京市 6-18 歳児の身長、体重及び BMI のパーセンタイル曲線を作成したことより、中国小児の成長状況の特徴及び変化を把握することができた。BMI パーセンタイル曲線に関する比較では、北京男児の BMI レベルは女児より高く、北京男児女児の BMI はともに中国全国レベルより高いことが明らかとなった。また、WHO 及び先進国に比べ、北京男児のパーセンタイル曲線は上位パーセンタイル値で高く、下位パーセンタイル値で低いことから、中国小児、特に男児は、肥満と体重不足が共存していることが明らかになった。このような BMI 値の二極化傾向は同じ発展途上国であるインドにもみられた。中国を含む発展途上国が経済発展に伴いライフスタイル及び食事パタンーの変遷による過剰栄養と栄養不足という二重負担になっていることが示唆された。

G.研究発表

1. 論文発表

なし

2. 学会発表

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表 1. 2005 年北京市学生体質及び健康調査対象者の年齢分布

Age (years)	Boys		Girls	
	Number	%	Number	%
6-7	306	7.5	268	6.6
7-8	307	7.5	308	7.6
8-9	273	6.7	309	7.6
9-10	307	7.5	311	7.6
10-11	314	7.7	315	7.7
11-12	313	7.7	316	7.8
12-13	318	7.8	292	7.2
13-14	308	7.6	318	7.8
14-15	309	7.6	314	7.7
15-16	322	7.9	315	7.7
16-17	310	7.6	302	7.4
17-18	313	7.7	322	7.9
18-19	378	9.3	387	9.5
Total	4078	100.0	4077	100.0

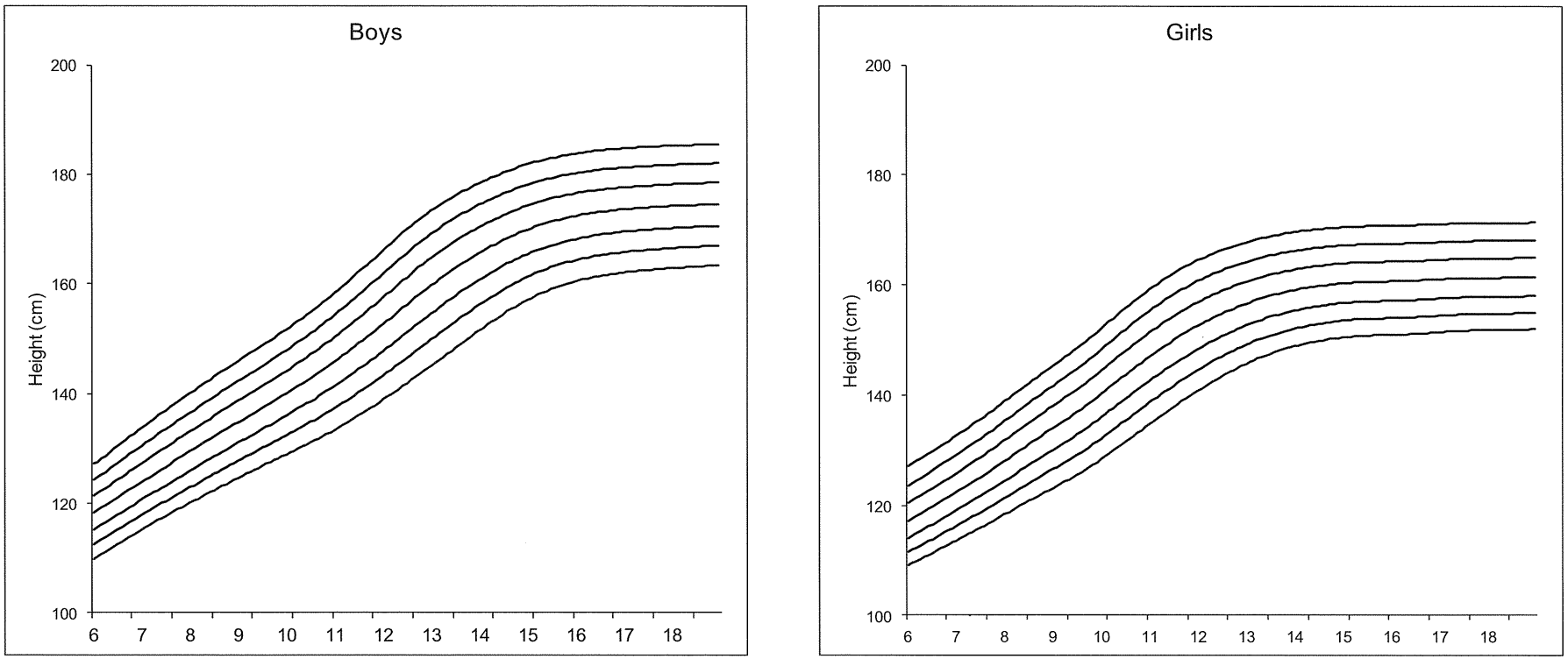

図 1. 北京市 6-18 歳児身長のパーセンタイル曲線（凡例：上から 97th、90th、75th、50th、25th、10th 及び 3rd の順である）

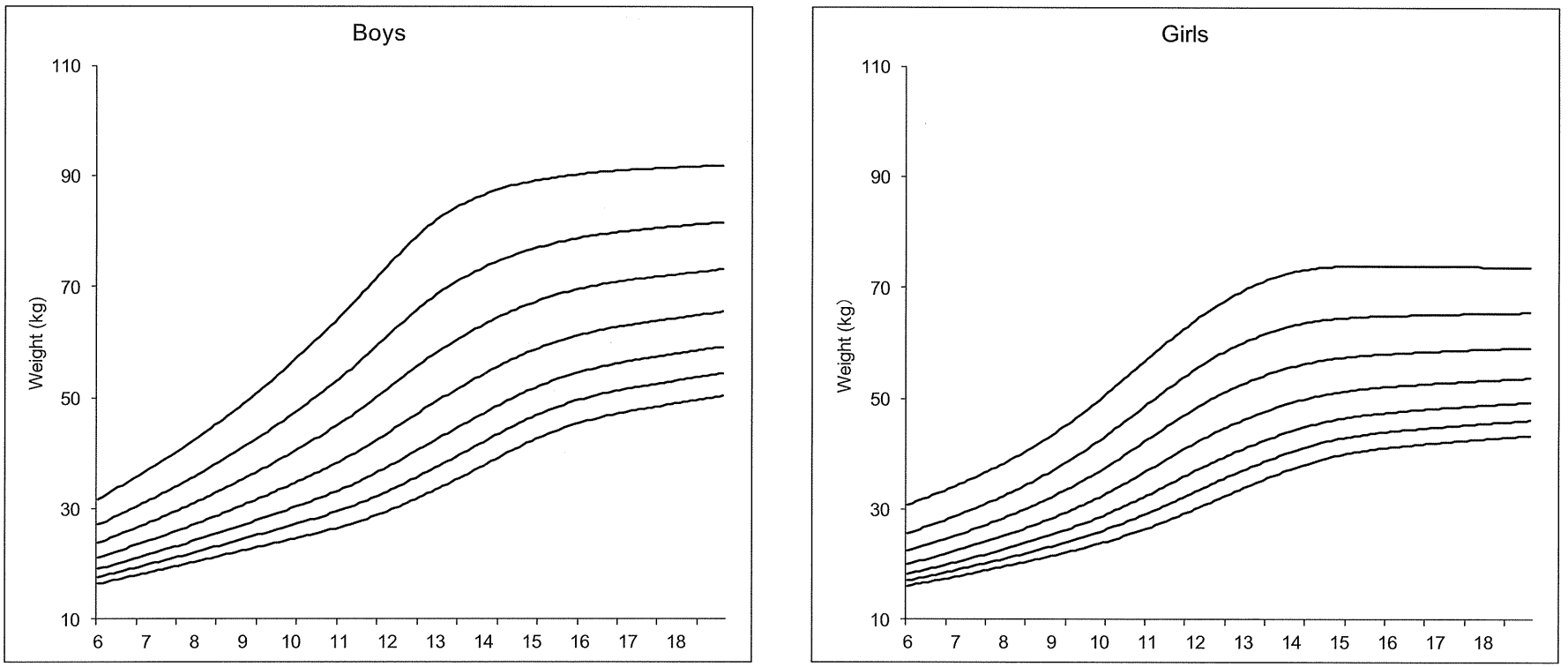

図 2. 北京市 6-18 歳児体重のパーセンタイル曲線（凡例：上から 97th、90th、75th、50th、25th、10th 及び 3rd の順である）

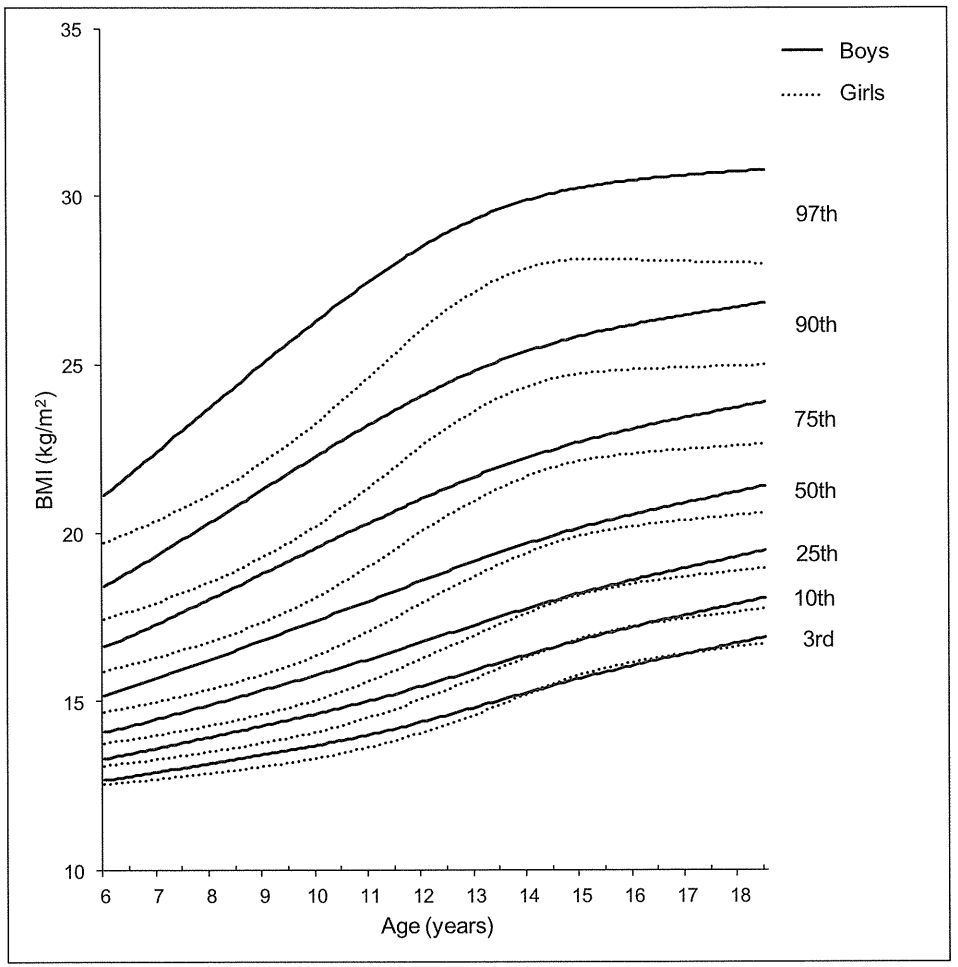

図 3. 北京市 6-18 歳児 BMI パーセンタイル曲線の男女比較

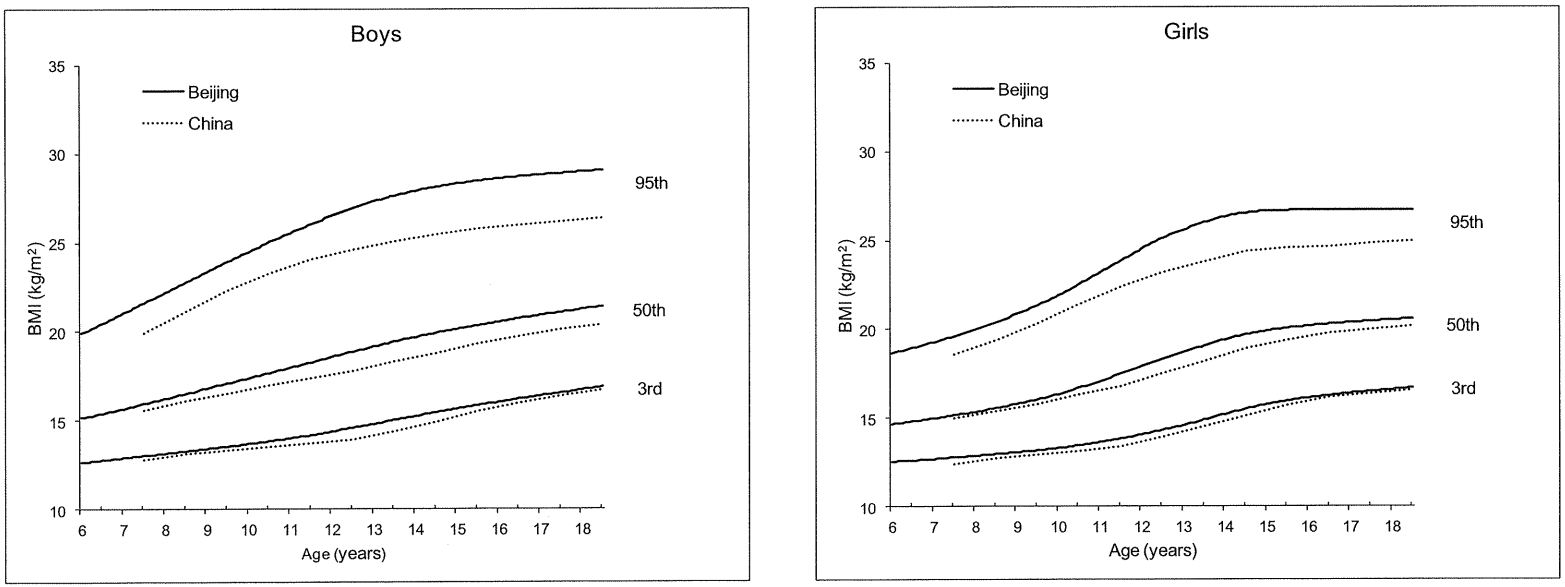

図 4.　北京市 6-18 歳児 BMI パーセンタイル曲線と中国全国レベルとの比較

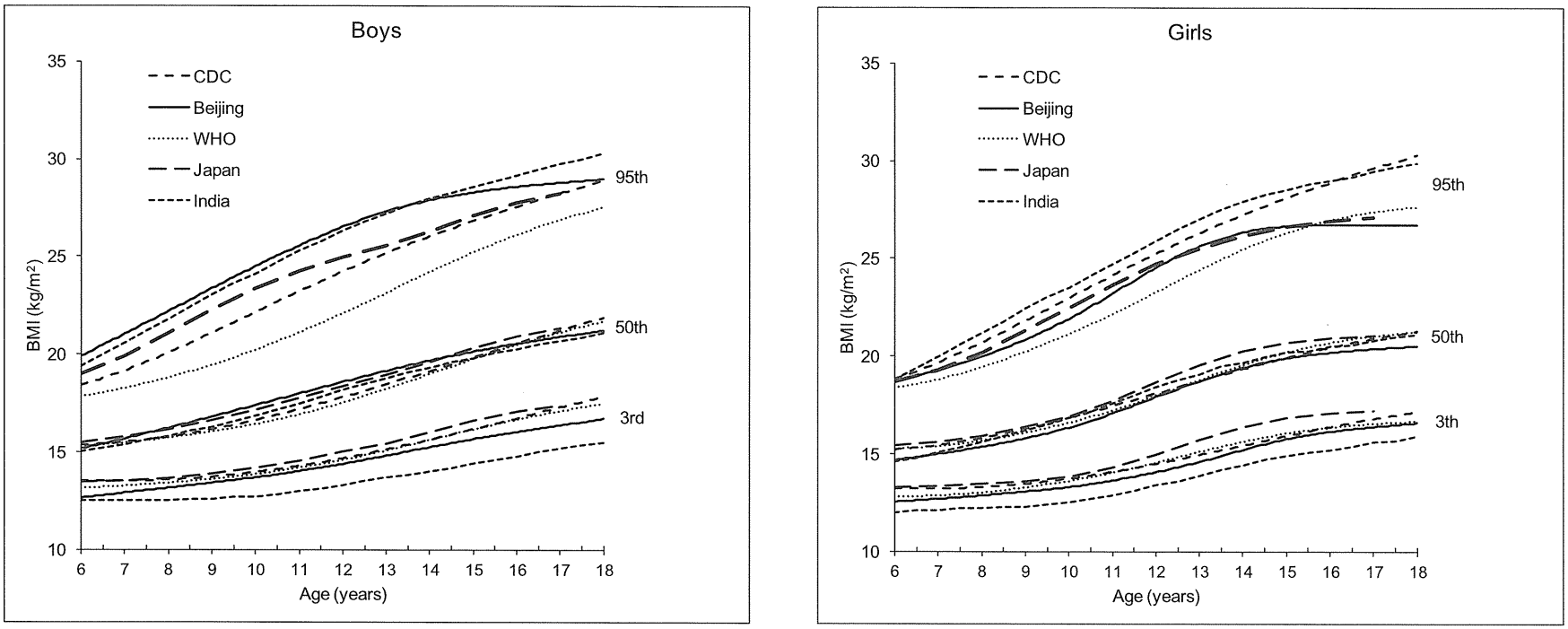

図 5.　BMI パーセンタイル曲線における北京市 6-18 歳児と WHO、CDC、日本及びインドとの国際比較

厚生労働科学研究費補助金（地球規模保健課題推進研究事業）
「アジア地域の小児成長曲線の作成と成長指標の開発」

（総合）研究報告書

ラオス人民民主共和国首都部における小児の発育

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研究要旨
本研究はラオス人民民主共和国の小児を対象とした初の身体計測学的縦断調査である。2005年12月から2006年9月に首都ビエンチャンの国立母子保健病院で出生した男児・女児各150人を対象とした5年間のコホート調査を行い，男児120人（80%），女児120人（80%）が5年間の追跡を完了した。WHO標準曲線を用いて評価をしたところ，コホートの体重と頭囲はWHO標準成長曲線に沿ったが，身長は生後6ヶ月から24ヶ月にかけてWHO標準曲線を約-0.5SDから-2SDまで離れ、その後5歳までに-1SD近くにキャッチアップする傾向を示した。その理由として、栄養学的要因，内分泌的要因，遺伝的要因，社会文化的環境要因が示唆された。

A. 研究目的

ラオス人民民主共和国（以下，ラオス）の国際保健指標はこの30年で大きく改善をしているが，いまだに栄養障害が大きな問題となっている。しかるにラオス小児を対象とした身体的成長データは非常に限られている。そこで我々はラオス小児の成長データを得るために5年間のコホート調査を実施した。

B. 研究方法

対象は2005年12月から2006年9月に首都ビエンチャンの国立母子保健病院で出生した在胎36週以降，出生体重1800-3400g，出生時明らかな先天異常を伴わない，保護者から研究参加についての同意が得られた男児・女児各150人である。調査法は前方視的コホート調査で，トレーニングをうけた看護師，医学生が家庭訪問を行いに統一した方法で身体計測を行うとともに，インスタントカメラを用いて児の全身写真を2枚撮影し，1枚を計測データとともに保存し，もう1枚を成長の記録として家族に手渡した。データは現地の責任医師が管理し，定期訪問時にデータクリーニングと解析を行った。また訪問時に測定員のトレーニングを継続的に実施した。

（倫理面への配慮）
本研究は両国各施設の倫理委員会によって承認を得た。研究については文書を用いて説明を行い，文書による同意を得た。

C. 研究結果

最終的に男児120人、女児120人が5年間の追跡を完了した（追跡率80%）。脱落の主な理由は転居（92%）で，死亡は4例であった。生後から5歳までのコホートの身体計測値をWHO Child Growth Standards（2006）（以下，WHO標

準曲線）に外挿すると，男女ともコホートの体重，頭囲の平均値はそれぞれ WHO 標準曲線の平均値に平行して成長した（6 ヶ月，12 ヶ月，24 ヶ月，36 ヶ月，48 ヶ月，60 ヶ月時の体重 z-score はそれぞれ男児-0.47，-0.56，-0.30，-0.41，-0.33，-0.25，女児 -0.45，-0.48，-0.50，-0.25，-0.38，-0.33，-0.22，頭囲 z-score はそれぞれ男児-0.47，-0.53，-0.20，0.01，0.35，0.71，女児 -0.47，-0.53，0.03，0.18，0.51，1.02)。一方、身長は生後 6 ヶ月頃から 2 歳にかけて WHO 標準曲線を約-0.5SD から-2SD まで離れ、その後-2SD 近くを標準曲線に沿って成長し，5 歳までに再度標準曲線に近づく傾向が見られた（6 ヶ月，12 ヶ月，24 ヶ月，36 ヶ月，48 ヶ月，60 ヶ月時の身長 z-score はそれぞれ男児-0.21，-1.08，-1.66，-1.86，-1.89，-1.43，-0.75，女児 -0.66，-1.40，-2.19，-2.24，-1.87，-1.14)。

D. 考察

本研究はラオス小児を対象とした初の縦断調査である。開発途上国におけるコホート調査では追跡からの脱落が問題となるが，本研究では家庭訪問による追跡を行うことにより，高い追跡率を維持することが可能となった。

本研究では対象が首都部の経済的に恵まれた環境で成育する小児を主な対象としたにもかかわらず，WHO 標準曲線を用いて評価すると，体重が WHO 標準曲線に沿う一方で身長は WHO 標準曲線を大きく下回った。高度の栄養障害においては年齢比体重（Weigh-for-Age）ならびに身長比体重（Weight-for-Height）の減少を認めることが多いこと，対象が比較的裕福な都市部の環境であり低栄養リスクが低いと考えられることから，この身長の成長率のみが低下する傾向を低栄養のみで説明することは難しい。ラオスの社会文化的環境要因を背景とする特殊な栄養障害の可能性や何らかの内分泌学的要因，遺伝的要因の可能性も考えらえた。

ラオスの子どもを取り巻く生活環境や生活スタイルは年々変化してきており，経年的な成長トレンドを追跡することが必要である。また他のアジア諸国でも同様の傾向があるか，他国の計測データとの比較検討を行いたい。

E. 結論

本研究によりラオス小児の 0-5 歳時の計測学的データを得ることができた。

F. 研究発表

1. 論文発表　なし

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G. 知的所有権の取得状況

なし

II. 研究成果の刊行物・別刷

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Central body fat distribution indices in Thai preschool children*

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ABSTRACT

Background: Central obesity is associated with adverse health outcomes. This study aimed to determine the characteristics of central body fat distribution in Thai preschool children and to examine factors that could influence on body fat distribution of children. Methods: The total 811, 5 - 6 years old children were randomly sampled from 9 primary schools in Saraburi province. Body weight and height were measured in each child. Waist circumference (WC) was measured at the umbilicus level and hip circumference (HC) at the level yielding maximum circumference over buttock. Subcutaneous skinfold was measured on biceps, triceps, subscapular, supra-iliac and abdominal regions. Total body fat (TBF) was measured with bioelectrical impedance analyzer. Results: Mean values of WC, waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) of boys were not different from those of girls. Even though trunk skinfolds of both genders were similar, girls tended to have slightly greater biceps, triceps and subscapular skinfolds than boys. Strongly positive correlation was found between WC, WHtR, trunk skinfold and child's BMI ($p = 0.01$) as well as between WC, WHtR, trunk skinfold and child's TBF ($p = 0.01$). Multiple regression analysis demonstrated, in both genders, that BMI, age and TBF were strongly associated with WC (Adjusted R^2 0.92 - 0.93) and WHtR (Adjusted R^2 0.90 - 0.92) and that BMI and TBF were strongly associated with trunk skinfold (Adjusted R^2 0.88 - 0.89). The association between WHR and TBF for boys and between WHR and BMI for girls were found to be weak in this study. Conclusion: No gender difference in body fat distribution indices was found in Thai preschool children. Change in central body fat distribution of children could be strongly influenced by their changes in age, BMI and TBF.

*The authors declare no conflict of interest.

Keywords: Central Body Fat Distribution; Thai; Preschool Children; Waist Circumference; Subcutaneous Skinfold

1. INTRODUCTION

The prevalence of childhood obesity has strikingly increased in many countries during the past decades [1,2]. Tracking of obesity in children is generally performed using body mass index (BMI). However, the limitation of BMI is that it does not distinguish obesity due to excess fat mass from the obesity due to excess lean body mass [3]. The change in body fat distribution in addition to the increased total body fat, has an importance as predictor of cardiovascular risk factor in children [4,5]. Evidence shows that gender difference in fat distribution has been observed in adolescents [6-8] and one study reported the sexual dimorphism of body fat distribution in prepubertal children [9]. Studies also demonstrated ethnic difference in fat distribution in prepubertal children [10-12] and in pubertal children [13]. In children, body fat distribution could be assessed using various anthropometric indices such as waist circumference (WC) alone [14], waist-to-height ratio (WHtR) [15] and skinfold ratio [16]. The use of WC and WHtR provides the advantage in that the indexes are good predictors of intra-abdominal fat deposition and are related to the development of cardiovascular risk factor [17-19] Previous reports have also indicated the trunk skinfold as the sensitive tool to detect metabolic abnormalities in children and adolescents [4,20]. Nevertheless, less information was known on the determinant factors that could influence on change in body fat distribution in terms of anthropometric and body composition measures.

In Thailand, the rapid change in national economic during past 20 years has had the impact on nutrition transition and that problem of over-nutrition in children persistently exist in different areas. In 2009, data from the National Health Examination Survey in 3015, 1 - 5

year-old children from 21 provinces in Thailand indicated that the prevalence of the overweight and obesity in children were 3.5% and 8.5%, respectively [21] and the obesity rate among young children in urban area such as; Bangkok city, was as high as 14.9%. Since data on the characteristics of central body fat distribution in young Thai children is not available. The aims of this study was 1) to determine gender difference in central body fat distribution of young Thai children and 2) to examine the determinant factors that influence on body fat distribution indices of children.

2. METHODS

2.1. Study Subjects

This cross-sectional study was conducted in Saraburi, a province located in the central part of Thailand, during July-September 2008.The province was 113 km. away from Bangkok. The city comprises of 13 districts. Two-stage stratified sampling technique was applied to recruit target children. Approximately 30% of total 13 districts was sampled and that Mueang, Phra Phuttabat, Kaeng Khoi and Nong Khae were sampled as the representative districts. School selection was based on school zone located in these 4 districts. The large school size (≥600 pupils) was subsequently sampled and that target children from 9 primary schools were recruited in the study. Subjects were 5 - 6 year old children, whose families were residing in the municipal areas of Saraburi province. They were studying in the kindergartens grade 1 and 2. Children who were under- or over-nutrition resulting from pathological disease or receiving any medication were excluded from the study. Prior to the beginning of the study, formal letter were sent to school directors and children's parents for asking permission. Written consent forms were also obtained from all parents. The study design was approved by the Mahidol University Institutional Review Board (MU-IRB) (COA. No. MU-IRB-2008/050.1507).

2.2. Anthropometric Measurement

Anthropometric measurements were performed in all children. Body weight of each child was measured using digital weighing scale (CAMRY^{R}; Model EB-6571, Nanjing; capacity 0 - 150 kg) to the nearest 100 g. To check for the reliable data, weighing balance was calibrated with standard weight before measurement. Standing height of the child was measured with stadiometer (Stanley-Mabo^{R}, Poissy, France). The subjects stood without shoes, feet together and buttock in contact with the wall. The head-bar was lowered to attach the crown of subject's head and height was measured to the nearest 0.1 cm. Body mass index was calculated as the value of child's body weight divided by squared height (kg/m^2). Waist circumference (WC) was measured at the umbilicus level using non-elastic tape. Hip circumference (HC) was measured at the level yielding maximum circumference over the buttock. Waist-to-hip ratio (WHR) was calculated by WC divided by HC value. Waist-to-height ratio was calculated by WC divided by height value. Measurement of subcutaneous skinfolds at various sites were also performed using skinfold calipers (Holtain Ltd, Crymych, UK). Triceps skinfold was measured on the upper right arm, mid-way between acromiom process of scapular and tip of ulna. Biceps skinfold was measured at the anterior aspect of right arm at the same level as triceps. Subcsapular skinfold was measured 1 cm inferior to the inferior angle of the scapular. Suprailiac skinfold was measured immediately superior to the iliac crest as the oblique skinfold. The abdominal skinfold was at 3 cm lateral to the umbilicus and 1 cm inferior to it. Measurement of skinfold at each anatomical site was performed twice and the average value was estimated. Percentage of trunk/total skinfold was calculated as sum of subscapular, abdominal and supra-iliac skinfolds divided by total skinfolds ×100. Measurement of total body fat (TBF) of children was done using tetra-polar bioelectrical impedance analyzer (Tanita^{R}; InnerScan, Model BC-545, Tokyo, Japan). After stepping on the platform, subject was instructed to hold the electrodes with both hand grips and arms straight down for 1 - 2 minutes until body fat was determined.

2.3. Statistical Analysis

All anthropometric data were analyzed by Statistical Package for Social Science (SPSS, version 18, Chicago, IL, USA). Anthropometric variables were presented as mean ± standard deviation (SD). Significant mean difference in anthropometric variables between genders was analyzed using unpaired student's *t*-test. Pearson correlation coefficient was applied to examine the relationship between central body fat distribution indices and anthropometric measures of children. Multiple linear regression using stepwise method was used to determine factors that influenced on body fat distribution indices of children.

3. RESULTS

All data analysis was performed on total 811 children; 406 boys and 405 girls. The characteristics of children are shown in **Table 1**. Mean age of boys was similar to that of girls. Boys had slightly greater BMI than girls. Regarding anthropometric parameters, it was found that mean values of WC, HC, WHR and WHtR of boys were not significantly different from those of girls. Although there was no mean difference in trunk skinfold between

Table 1. Anthropometric characteristics of children.

Anthropometric variables	Boys (n = 406)	Girls (n = 405)
Age (y)	5.5 (0.36)	5.6 (0.36)
Weight (kg)	20.4 (4.9)	19.8 (5.3)
Height (cm)	111.9 (5.3)	111.4 (5.6)
BMI (kg/m^2)	16.2 (2.9)	15.7 (2.8)*
Waist circumference (WC, cm)	54.2 (7.6)	53.8 (7.4)
Hip circumference (HC, cm)	57.3 (6.5)	57.3 (6.6)
Waist-to-hip ratio (WHR)	0.94 (0.04)	0.94 (0.04)
Waist-to-height ratio (WHtR)	0.48 (0.06)	0.48 (0.05)
Subcutaneous skinfolds Biceps (mm)	5.6 (2.6)	6.1 (2.6)*
Triceps (mm)	9.2 (3.9)	9.8 (3.7)*
Subscapular (mm)	6.4 (3.7)	6.9 (3.6)*
Supra-iliac (mm)	5.8 (4.3)	6.3 (4.1)
Abdominal (mm)	7.2 (4.9)	7.6 (4.5)
Trunk skinfold† (mm)	19.4 (12.5)	20.8 (11.4)
% trunk/total skinfold‡	55.1 (4.6)	55.5 (4.4)
% Total body fat	14.0 (8.2)	14.4 (6.4)

Values were mean (SD); †Subscapular + supra-iliac +abdominal skinfolds; ‡Subscapular + suprailiac + abdominal skinfolds/biceps + triceps + subscapular + supra-iliac + abdominal skinfolds × 100; *Significantly different from boys at $p < 0.05$, by unpaired student *t*-test.

boys and girls, however, girls had significantly greater values of biceps, triceps and subscapular skinfolds ($p < 0.05$) than those of boys, Mean TBF of boys was similar to that of girls. **Table 2** demonstrates the relationship of fat distribution indices to anthropometric variables of both genders. It was shown that child's body weight strongly correlated with WC, WHtR and trunk skinfold whereas the correlation between child's height and WC, WHtR and trunk skinfold were found to be weaker. The child's BMI strongly correlated with WC ($r = 0.96$, $p = 0.01$), WHtR ($r = 0.94$ - 0.95, $p = 0.01$) and trunk skinfold ($r = 0.92$ - 0.93, $p = 0.01$). Similarly, percentage TBF of both genders strongly correlated with WC, WHtR and trunk skinfold. By multiple regression analysis, **Table 3** demonstrated that factors that were associated with change in WC and WHtR of both genders were BMI, TBF and the age of the child (Adjusted R^2 0.92 - 0.93 for WC and adjusted R^2 0.90 - 0.92 for WHtR). In addition, trunk skinfold could also be predicted by TBF and BMI but not the age of the child. (Adjusted R^2 0.88 - 0.89). Although WHR of boys could be predicted by TBF and age and WHR of girls predicted by BMI, however, the predictive value was smaller (Adjusted R^2 0.22 - 0.31) compared to those of WC, WHtR and trunk skinfold.

4. DISCUSSION

The main findings of this study was the characteristic of central body fat distribution in young Thai children. Our results showed no significant mean difference in WC, WHR and WHtR between boys and girls. This could be explained by the fact that central fat patterning does not occur in prepubertal period. Former studies [22,23] demonstrated that WC increased with age in both genders and the difference in WC was significant after pu berty. Regarding WHR parameter, previous studies in European children indicated that sexual dimorphism in fat distribution as indicated by WHR was present in 5 - 7 year old children [9,24] but our results showed no difference in WHR between genders. This might be due to the influence of ethnic difference that conveys to the difference in body size of the growing child. The effect of ethnic difference on body fat distribution has been investigated in young children. He *et al.* [11] demonstrated that among girls, Asian had generally lower extremities and gynoid fat than Caucasians and African-American whereas among boys, Asian had lower extremity fat by dual-energy X-ray absorptiometry (DXA) than Caucasian but greater gynoid fat by skinfolds than African-American. The fact that mean percentage of TBF of boys was similar to that of girls found in our study was consistent with previous study which demonstrated that gender difference in fat mass is negligible before 5 - 6 years of age [25]. Then the increase in fat mass was found more in girls than in boys through adolescence period and boys have an increase in muscle mass and central adiposity due to the secretion of testosterone hormone whereas girls have increased body fat, primarily at gluteal site due to estradiol [26]. Several studies indicated that sexual dimorphism of body fat distribution had been reported during puberty [7,8,27] and one study in young children [9].

The strongly positive correlation between WC, WHtR, trunk skinfold and BMI and between WC, WHtR, trunk skinfold and TBF in both genders found in our study suggested that these body fat distribution indices could be alternatively used as screening tools to detect obesity in children. Glaber *et al.* [28] reported that BMI and WC performed well in detecting excess body fat in 7 - 14 year old children. Similarly, Hubert *et al.* [29] showed that WC and WHtR were sensitive indicators used for obesity screening in prepubertal children. Our results also showed that change in WC of children could be strongly predicted by child factors; *i.e.*, age, BMI, and TBF. Daniels *et al.* [14] demonstrated that child's age was one important determinant of fat distribution as indicated by change in WC. A few studies reported the significantly

Table 2. Pearson correlation coefficient between central body fat distribution and anthropometric indices of children.

Variables	Boys (n = 406)				Girls (n = 405)			
	WC	WHR	WHtR	Trunk SKF	WC	WHR	WHtR	Trunk SKF
Body weight	0.96*	0.44*	0.84*	0.89*	0.96*	0.39*	0.84*	0.89*
Height	0.57*	0.03	0.28*	0.44*	0.66*	0.08	0.36*	0.52*
BMI	0.96*	0.54*	0.95*	0.92*	0.96*	0.47*	0.94*	0.93*
Total body fat	0.96*	0.56*	0.95*	0.94*	0.94*	0.46*	0.93*	0.95*

WC, waist circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio; Trunk SKF, subscapular + suprailiac + abdominal skinfold; BMI, body mass index; *p = 0.01.

Table 3. Multiple linear regression analysis to predict central body fat distribution of Thai preschool children.

Outcome variables	Boys (n = 406)				Outcome variables	Girls (n = 405)			
	B	SE	P	Adjusted R^2		B	SE	P	Adjusted R^2
Waist circumference				**0.931**	**Waist circumference**				**0.921**
Constant	16.101	2.524	0.0001		Constant	11.782	2.257	0.0001	
BMI	1.703	0.172	0.0001		BMI	1.985	0.146	0.0001	
Total body fat	0.304	0.060	0.0001		Age	1.309	0.294	0.0001	
Age	1.127	0.276	0.0001		Total body fat	0.238	0.065	0.0001	
Waist-to-hip ratio				**0.314**	**Waist-to-hip ratio**				**0.217**
Constant	0.965	0.026	0.0001		Constant	0.835	0.010	0.0001	
Total body fat	0.003	0.000	0.0001		BMI	0.006	0.001	0.0001	
Age	–0.011	0.005	0.023						
Waist-to-height ratio				**0.916**	**Waist-to-height ratio**				**0.903**
Constant	0.327	0.021	0.0001		Constant	0.330	0.017	0.0001	
BMI	0.011	0.001	0.0001		BMI	0.012	0.001	0.0001	
Total body fat	0.003	0.000	0.0001		Age	–0.013	0.002	0.0001	
Age	–0.010	0.002	0.0001		Total body fat	0.002	0.000	0.0001	
Trunk skinfolds				**0.877**	**Trunk skinfolds**				**0.898**
Constant	–12.757	4.298	0.003		Constant	–13.202	2.521	0.0001	
Total body fat	1.079	0.131	0.0001		Total body fat	1.343	0.114	0.0001	
BMI	1.059	0.376	0.005		BMI	0.942	0.258	0.0001	

BMI, body mass index; Trunk skinfolds, subscapular + suprailiac + abdominal skinfolds.

positive correlation between WC and BMI (r = 0.90 - 0.94) among Japanese school children [30,31] although study by Wang *et al.* [32], in Chinese children aged 6-11 years, found that WC was slightly correlated with TBF (r = 0.27 - 0.36) as measured by DXA. Regarding WHtR, our results indicated that child's age was one determinant factor of WHtR value in both genders. Generally, WHtR value was found to be relatively constant with age. [23,33]. The use of WHtR for nutritional assessment provides the advantage in that the index allows the same

boundary value for various age group of children as well as for different ethnic group [34] and evidence showed that WHtR index was associated with high metabolic risk [35,36]. The finding of association between WHtR and TBF in our study deserved be further investigated in young children. Our results also revealed that TBF and BMI were associated with trunk skinfolds of children. This was according to the former study which showed that total fat mass is an important determinant factor of intra-abdominal adipose tissue (IAAT) and abdominal skinfold was strongly correlated with IAAT [37]. In addition, skinfold thickness at a varying anatomical sites was used to address gender and ethnic variation related to subcutaneous fat distribution [6]. However, our results showed the weak association between WHR and TBF in boys and between WHR and BMI in girls which implied that WHR was less sensitive index than WC, WHtR and trunk skinfold for this age group. Goran *et al.* [38] demonstrated that, in young children, WHR was not significantly correlated with intra-abdominal adipose tissue (IAAT) while trunk skinfold thickness could explain 62% of variation in IAAT and that WC could explain 92% of the variation in subcutaneous abdominal adipose tissue (SAAT) [37]. Hence, the combination of skinfolds and waist circumference measurement could help to predict central adiposity in the absence of direct measurement by computed tomography or magnetic resonance imaging technique. The limitation of our study was that we did not directly measure the IAAT of children, thereby, this might affect the extensive interpretation of the results of study.

In summary, the assessment of central body fat distribution in children can be done using various anthropometric indices. Our study showed that there was no difference in central body fat indices between young Thai boys and girls. Change in body fat distribution could be affected by the age, BMI and TBF of children. Further study needs to investigate the relationship of various body fat distribution indices to adverse biochemical parameters among young children.

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