Infant Growth Rates Predict Childhood Obesity in Her Royal Highness Princess Maha Chakri Sirindhorn Medical Center, Thailand

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Background: *Obesity is increasingly becoming a problem among the Thai people; infant growth rates have been shown to be linked to childhood obesity.*

Objective: *The aim of the present study was to determine the period of infant growth and to identify a cut-off point, in order to be able to predict overweight and obesity in children age 3-4 years at the Well Baby Clinic, Her Royal Highness Princess Maha Chakri Sirindhorn Medical Center (HRH MSMC).*

Material and Method: *The design was retrospective cohort. All subjects born on 2005 at HRH MSMC, in Nakhon Nayok. The author used means of weight and length at 1-6 months, 7-12 months, 13-18 months, 19-24 months and 37-48 months and then constructed a weight-for-length Z score using the LMS method. The difference in Z score between each age group was compared, to predict overweight and obesity at 37-48 months of age. A defined cut-off point, with a receiver operating characteristic (ROC) curve, p-value < 0.05 was regarded as significant.*

Results: *The 227 from newborns were included in the present study. The prevalence of overweight and obesity at 3-4 years of age was 14%. The cut-off point for accelerated growth was $\geq$ 0.62SD or $\geq$ 23.2 percentiles (Z score changes from 7-12 months to 13-18 months), with a positive predictive value of 40%.*

Conclusion: *The accelerated change of weight-for-length at 7-12 to 13-18 months of age can be used to predict overweight and obesity at 3-4 years of age at HRH MSMC.*

Keywords: *Overweight, Obesity, Infant, Childhood*

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Obesity is of growing concern to health practitioners in Thailand, especially the increasing prevalence among children. The prevalence of obesity among Thai preschool-age children has increased from 5.8% to 7.9% in only four years[1]. Childhood obesity causes multisystem disease, such as hypertension, sleep apnea, dyslipidemia, diabetes and an increased risk of death from ischemic heart disease in adulthood[2]. Treatment alone cannot solve the problem. The author need to understand more about how early rates of growth affect childhood obesity and provide interventions to avoid adverse health consequences.

Several studies identified weight gain in the first two years as an important predictor for future overweight. Some studies, which based their measurements on weight alone[3-7], did not reflect adiposity[8]. However, weight should be measured in relation to actual length or height; this provides a more accurate picture of obesity rates in preschool-age children[7,8]. Most studies have not provided enough detail to be useful in predicting future obesity. However, the present study by Taveras et al[7] in the United States of America, showed that weight status in the first six months of life can be linked to obesity at three years of age.

In Thailand, no previous study has determined which periods of infant growth correspond to future overweight or obesity in preschool age, or which cut-off point is the most valid for prediction. The aim of the present study was to determine this period of infant growth and to identify a cut-off point, in order to be able to predict overweight and obesity in children age 3-4 years at the Well Baby Clinic, Her Royal Highness Princess Maha Chakri Sirindhorn Medical Center (HRH MSMC).

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Material and Method

Study population

All subjects were born in 2005 at HRH MSMC. All of them were term newborns and appropriate for gestational age. These subjects and their mothers had no chronic disease affecting growth rate. Data of newborns were collected from medical records; incomplete records of newborns were excluded.

Study definition

Gestational age was calculated from the last menstrual period, and term newborns had a gestational age between 37 and 42 weeks. Appropriate for gestational age was a birth-weight between the 10^{th} and 90^{th} percentile of the standard growth curve. Nutritional status was according to WHO guidelines: severe thinness means a Z score < 3SD; thinness a Z score < 2SD; overweight a Z score > 1SD and obesity a Z score > 2SD.

Data collection

The Faculty of medicine, Srinakharinwirot University ethics committee approved the research and then collected data from November, 2011 to February, 2012. The present study design was retrospective cohort study. Data collection included maternal age, gestational age, birth-weight, gravidity, mode of delivery, sex of newborn and weight and length measurements on appointment at the Well Baby Clinic during the complete 1-48 month period. Weight and length were measured at the Well Baby Clinic by nurse aides. The author calculated means of weight and length at age 1-6 months, 7-12 months, 13-18 months, 19-24 months and 37-48 months and then calculated a weight-for-length Z score base on the LMS method[9].

Statistical analysis

Weight-for-length Z score calculated from weight at each length according to sex as this formula[9]. Weight-for-length Z score = $[(weight/M)^{L} - 1]/LS$; L, M, S came from WHO weight-for-length Z score table[9]. Z score was presented as a box-and-whisker plot. Delta represented the change in Z score between the different age groups: delta1 was Z score at 7-12 months of age minus Z score at 1-6 months of age; delta2 was Z score at 13-18 months of age minus Z score at 7-12 months of age and delta3 was Z score at 19-24 months of age minus Z score at 13-18 months of age. A comparison was then made between delta1, delta2 and delta3, to predict overweight and obesity (Z score > 1SD) at 37-48 months of age. A defined cut-off point with receiver operating characteristic (ROC) curve with p-value < 0.05 was considered significant. Predictive values were calculated based on prevalence of overweight and obesity at 37-48 months of age.

Results

The number of medical records collected at HRH MSMC was 227 newborns from total of 868 newborns. The characteristics of the present study subjects are described in Table 1.

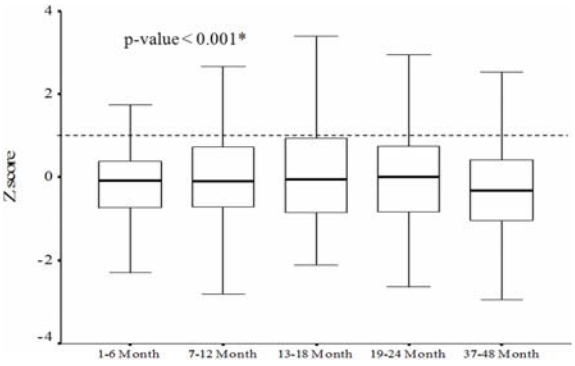
From Table 1, the prevalence of obesity,

Table 1. Characteristics of study subjects

Variables		Total number
Maternal age (mean ± SD, years)	27.8 ± 5.6	201
Gestational age (mean ± SD, weeks)	38.1 ± 1.1	227
Birth weight (mean ± SD, kilograms)	3.1 ± 0.3	227
Gravid		202
1^{st} (%)	97 (48.0)	
2^{nd} (%)	70 (34.7)	
3^{rd} (%)	20 (9.9)	
More than 3^{rd} (%)	15 (7.4)	
Mode of delivery		227
Normal labour (%)	124 (54.4)	
Caesarean section (%)	75 (33.2)	
Vacuum (%)	17 (7.5)	
Forceps (%)	11 (4.9)	
Sex of newborn		227
Male (%)	113 (49.8)	
Female (%)	114 (50.2)	

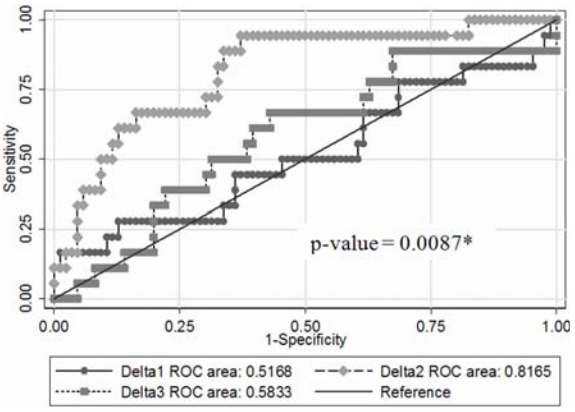
overweight, thinness and severe thinness, at 37-48 months of age, according to WHO criteria, was 7.3, 6.7, 4.9 and 0.6%, respectively. The Z scores of boys and girls in each age group were not statistically significantly different by paired t-test (p-value > 0.05). From Fig. 1, the highest Z scores were in the 13-18 month range and were more significant than Z score at 1-6 months of age.

From Fig. 2, the ROC curve presents Z scores at 7-12 months minus 1-6 months (delta1), at 13-18 months minus 6-12 months (delta 2) and at 19-24 months minus 13-18 months (delta 3) to predict overweight and obesity at 37-48 months of age. The cut-off point of delta 2 was ≥ 0.62SD with sensitivity 66.7%, specificity 83.7%, positive predictive value (PPV) 40%, negative predictive value (NPV) 94%, positive likelihood ratio 4, and negative likelihood ratio 0.4. Delta 2 had the largest area under the ROC curve and the cut-off point to predict overweight and obesity at age 37-48 months was ≥ 0.62SD. The change of 0.62SD closed to change of 23.2 percentile from Z table.



* p-value from ANOVA (repeated). Bonferroni test found Z score at 1 to 6 months different from Z score at 13 to 18 months (p-value = 0.015). Plots above this dash line (Z score > 1 SD) were overweight and obesity

Fig. 1 Box-and-whisker plot of Z score at 1-6 months, 7-12 months, 13-18 months, 19-24 months, and 37-48 months



* Chi-square test compared area under ROC curve: delta 1, delta 2, and delta 3

Fig. 2 ROC Curve Z Scores

Discussion

The levels of obesity among the preschool-age children (3-4 years) at HRH MSMC were the same as found by Aekplakorn and Mo-Suwan[1], who surveyed the prevalence of obesity in Thailand, in 2009. Sinawat[10] reported that this prevalence was continuously increasing, where the growth rates of children aged ≤ 5-years had been monitored by measuring weight and height. Growth rate, especially for infants, was measured by changing of weight-for-length Z score because of distinctions in muscle, bone, and fat mass, compared with older children[11]. Z score at 13-18 months of age had more overweight and obesity than the other age groups, implying that infants experienced rapid growth during this period. Heinzer reported the association between rapid growth in infancy and overweight, obesity, or adiposity in subsequent years in her review in 2005[11]; thus, Z score at age 13-18 months may predict overweight or obesity at preschool age. Another cohort study by Taveras et al[7] reported that a rapid increase in weight-for-length in the first 6 months is linked to obesity at 3 years of age.

The link between excess weight gain in infancy and risk of overweight or obesity in later life has been made in several studies[3-7,11,12] and the effect was not only in terms of being overweight or obese-there were also metabolic changes[12]. If body-weight is controlled in the early years of life, the risk of health problems later in life is reduced. According to the study by Gardner et al[12] in the United Kingdom, weight gain during the under-5 years is somewhat unpredictable, but, after achieving control of weight gain at preschool age, normal weight could be sustained afterwards.

The present study demonstrated, using the ROC curve, that increases in weight-for-length Z score from 7-12 to 13-18 months of age were significant in predicting overweight and obesity at 3-4 years of age. As Toschke et al[3] similarly demonstrated with the ROC curve, weight gain in the first two years of life was the

best predictor for future overweight. Ong et al[13] defined a change in Z score of ≥ 0.67SD as accelerated infant growth. The present data revealed that a change in Z score of ≥ 0.62SD, or ≥ 23.2 percentiles, could predict overweight and obesity at 3-4 years of age. A positive likelihood ratio of 4 indicated that weight-for-length from 7-12 to 13-18 months of age increased more than 0.62SD (23.2 percentiles) and the risk of overweight and obesity at age 3-4 years changed to 4 times. PPV was 40%, implying that infants with accelerated growth (0.62SD) will have a 40% chance of being overweight and obese at 3-4 years of age. Because predictive potential depends on prevalence of overweight and obesity at 3-4 years of age, potential may be greater among high-risk populations. By contrast, the present study of Toschke et al[3] in Germany recorded the prevalence of overweight as 9%, while PPV was poor at 19%, so they required the use of additional childhood makers to predict future overweight-satisfactorily.

The present data were obtained from medical records and were not typically recorded at a date precise enough for longitudinal study. This limitation was regulated by presenting infancy data at 6-monthly intervals and by using means of weight and length at each interval to estimate weight-for-length Z scores. Chomtho et al[6] reported that infant weight gain is linked to later free fat mass and is influenced by feeding, but was independent of birth weight, current height, sex, age, physical activity, socioeconomic class, ethnicity, and parental body mass index (BMI). In spite of some variables did were not included in the present study. However, the present study validity was not significantly affected because the confounders were controlled by matching design which compared data in the same group of infants.

In conclusion, the accelerated change (0.62SD or 23.2 percentiles) of weight for length at 7-12 months of age to 13-18 months of age can be used to predict overweight and obesity at 3-4 years of age at the Well Baby Clinic HRH MSMC, and has a PPV of 40%.

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Potential conflicts of interest

None.

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อัตราการเจริญเติบโตในทารกทำนายโรคอ้วน ณ ศูนย์การแพทย์สมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี ประเทศไทย

กิตติพงษ์ คงสมบูรณ์

***ภูมิหลัง**: โรคอ้วนเป็นปัญหาที่สำคัญของคนไทยและอัตราการเจริญเติบโตของทารกสัมพันธ์กับโรคอ้วน ในวัยเด็ก จุดมุ่งหมายของการศึกษา*

***วัตถุประสงค์**: เพื่อประเมินช่วงเวลาการเจริญเติบโตของทารกและอัตราการเจริญเติบโตที่เหมาะสม ในการทำนายภาวะน้ำหนักเกินปกติและโรคอ้วนในเด็กอายุ 3-4 ปี ที่มารับบริการ ณ คลินิกเด็กดี ศูนย์การแพทย์สมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี*

***วัสดุและวิธีการ**: การศึกษาแบบ retrospective cohort กลุ่มตัวอย่างเกิดในปี พ.ศ. 2548 ณ ศูนย์การแพทย์สมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี คำนวณค่าเฉลี่ยน้ำหนักและความยาวตามช่วงอายุ 1-6 เดือน, 7-12 เดือน, 13-18 เดือน, 19-24 เดือน และ 37-48 เดือน แล้วเทียบค่า Z score ของน้ำหนักต่อความยาวด้วยวิธี LMS นำค่า Z score ที่เปลี่ยนแปลงระหว่างช่วงอายุมาเปรียบเทียบเพื่อทำนายภาวะน้ำหนักตัวเกินปกติและโรคอ้วนที่อายุ 37-48 เดือน และกำหนดจุดตัดที่เหมาะสมด้วยกราฟ ROC ที่ระดับนัยสำคัญ p-value < 0.05*

***ผลการศึกษา**: จำนวนทารกแรกเกิดในการศึกษานี้มีทั้งสิ้น 227 คน (จำนวนทั้งหมด 868 คน) ความชุกของภาวะน้ำหนักตัวเกินปกติและโรคอ้วนที่อายุ 3-4 ปี ร้อยละ 14 จุดตัดที่เหมาะสมของอัตราการเจริญเติบโตคือ ≥ 0.62SD หรือ ≥ 23.2 เปอร์เซ็นไทล์ (ใช้ค่า Z score ที่เปลี่ยนแปลงระหว่างช่วงอายุ 7-12 เดือนและ 13-18 เดือน) ด้วยค่าการทำนายผลบวกร้อยละ 40*

***สรุป**: อัตราการเพิ่มขึ้นของน้ำหนักต่อความยาวระหว่างช่วงอายุ 7-12 เดือนและ 13-18 เดือน สามารถทำนายภาวะน้ำหนักตัวเกินปกติและโรคอ้วนที่อายุ 3-4 ปี ณ ศูนย์การแพทย์สมเด็จพระเทพรัตนราชสุดาฯ สยามบรมราชกุมารี*