

# Sex and ethnic disparities in weight and height among children of transnational couples, aborigines, and Han Chinese in Taiwan

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## Abstract

In this study, we examined sex and ethnic disparities in growth and body mass index (BMI) status among schoolchildren of transnational families, the aborigines and Han Taiwanese in Nantou, Taiwan. We tested the hypothesis that cultural and social factors of the transnational couples could impact the growth status of their children. The study also determined the factors associated with the growth status of schoolchildren. A total of 1674 school age children in the county were cluster sampled, and their weight and height data were statistically analyzed by 1-way analysis of variance,  $\chi^2$  test, and linear regression analysis according to sex, ethnicity, and residential locations. The institutional review board of Asia University, Taiwan, ROC, approved the study protocol. Results showed that aboriginal boys were significantly shorter in stature than sons of the transnational couples and Han Taiwanese. However, weight and BMI were not different among the 3 groups. Daughters of the transnational couples were significantly shorter and lighter, whereas the aboriginal girls were shorter but not lighter and had significantly greater BMI compared with their Han Taiwanese counterparts. Regression analysis revealed significant associations of weight and BMI with sex and ethnicity. Results suggest that culture plays a role in sex disparity. Ethnic and sex disparities in growth status exist in Taiwan. Aboriginal boys and girls are shorter but not lighter compared with their Han Taiwanese counterparts, whereas daughters but not sons of transnational couples are shorter and lighter compared with Han Taiwanese counterparts. These findings are useful information for the educators and healthcare policy makers for improving diet and health.

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## 1. Introduction

There is a rapid increase in the number of transnational marriages between Taiwanese men and women from China and Southeast Asian countries in recent years. According to government statistics in 2006, 14.3% of all marriages in Taiwan were Taiwanese men married to immigrant wives.

Among them, 68% were from China and the rest mainly from Vietnam and Indonesia [1]. In the same year, approximately 11.6% of all births in Taiwan were born to transnational couples [2]. In the 2006 to 2007 school year, approximately 68 000 elementary students (3.4% of the total elementary school enrollment) were children of transnational couples. Among these schoolchildren, approximately 38% were children of mothers from mainland China and 49% from Southeast Asian countries [3,4].

Facing a new culture, a new language, and a new family role, many of these marital immigrants have encountered

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great difficulties in transition. The hardship is often further aggravated by the fact that many of the immigrants and their Taiwanese spouses are socially, economically, or environmentally disadvantaged [5]. Government statistics show that nearly 20% of those transnational couples either have low income or are physically or psychologically handicapped [6]. Studies have shown that the marital immigrants have encountered various kinds of daily life difficulties and healthcare problems [7–9]. There are concerns that children born to these marital immigrants might have developmental problems (such as improper nutrition and obesity) or healthcare disparities (such as inadequate personal hygiene and immunization). The children of these transnational marriages have become a new “ethnic minority,” and their growth and development has become a new public health issue in Taiwan.

Nantou Hsien, a county in central Taiwan, has a relatively high proportion of marital immigrants and a high density of aborigines. Approximately 2.1% of the total Taiwanese population is aborigines, and they reside mainly in mountainous areas. Unlike the Han Taiwanese whose ancestors came from mainland China throughout the generations, the aboriginal Taiwanese are ethnic minority groups of Malayo-Polynesian and Austronesian origins [10,11]. Approximately 7.2% of elementary school students in Nantou County are aborigines [12,13], concentrated mainly in Ren-Ai Hsiang and Hsin-Yi Hsiang, 2 mountainous districts. The aboriginal Taiwanese have a unique culture and lifestyle and have been shown to have high prevalence rates of adult overweight-obesity and other chronic diseases [14–18]. This good mix of urban, rural, and mountainous areas and the high proportions of the minority ethnic groups make Nantou County an ideal district for studying the ethnicity-related health issues.

Therefore, the objective of this study was to test the hypothesis that cultural and social factors can play a role in influencing the growth status of the children. The study also attempted to identify the factors that are associated with the growth status of these schoolchildren. The information should be helpful for the policy makers in planning nutrition and healthcare-related corrective measures.

## 2. Methods and materials

### 2.1. Subjects and study design

Data used in this analysis were students' annual growth (weight and height) based on records of schoolchildren in Nantou County, Taiwan. The institutional review board of Asia University, Taiwan, ROC, approved the study protocol, and the county health administrator and the administrators of the schools approved the use of these data for this study. Written consent was obtained from families. All data were treated according to approved ethical standards, and the confidentiality of all individuals was preserved throughout the entire analysis.

The study used a cluster-sampling technique. Primary schools in Nantou County were first classified into 3 levels of urbanization (mountainous, rural and urban) according to the degree of urbanization and geographic location of the school. The 2 mountainous districts, Ren-Ai Hsiang and Hsin-Yi Hsiang, were first identified as the areas of aboriginal schoolchildren. Schools in areas with higher concentrations of transnational marriages were also identified. The remaining schools in both rural and urban areas were treated as a pool for random selection of schools for Han Taiwanese schoolchildren. In all, data of 1674 schoolchildren (377 aborigines, 339 children of marital immigrants and 958 Han Taiwanese) from 10 of 32 mountainous, 15 of 60 rural, and 16 of 57 urban schools were used for this study (Table 1). Once a school was selected and the schoolchildren agreed to have their data analyzed, all eligible students in grades 4, 5, and 6 in the school were included.

### 2.2. Statistical analyses

Each subject's demographic data and growth records taken at 6 years old (first grade) and 9 years old (fourth grade) were extracted from the personal files. Weight, height, body mass index (BMI) (kilograms per meter squared), parental ethnicity, residential location, and urbanization of each schoolchild were statistically analyzed. All data were taken from the first health examination (usually in September) of the school year. Distributions of body weight, height, and BMI were classified according to the specific percentile cut-point values of the standard growth curves for Taiwanese published by the Department of Health of Taiwan (as shown in Table 2) [19]. Body heights were classified into slow (<15th percentile), normal (15th to 85th percentile), and fast growth (>85th percentile); body weights into light (<15th percentile), normal (15th to 85th percentile), and heavy (>85th percentile); and BMI into underweight (<15th percentile), normal weight (15th to 85th percentile), overweight (85th to 95th percentile), and likely obese (>95th percentile).

Statistical software package SPSS 11 was used to perform the analysis (Statistical Package for the Social Sciences, SPSS Inc, Chicago, Ill). Analysis of variance and

Table 1  
Number of observations stratified by parental ethnicity, sex, and residential urbanization of subjects

Parental ethnicity	Urban		Rural		Mountainous		Total
	Boys	Girls	Boys	Girls	Boys	Girls	
Han Taiwanese	226	188	261	252	20	11	958
Transnational <sup>a</sup>	102	90	96	77	6	6	377
Aborigines	0	0	0	0	171	168	339
Total	328	278	357	329	197	185	1674

<sup>a</sup> Most transnational marriages were females from China and Southeast Asian countries married to Taiwanese men.

Table 2  
Standard height, weight, and BMI percentile values for 6- and 9-year-old schoolchildren in Taiwan<sup>a</sup>

	Boys		Girls	
	6 years old	9 years old	6 years old	9 years old
Height (cm)				
15th percentile	114.2	128.0	113.4	128.0
85th percentile	126.0	140.1	123.3	141.0
Weight (kg)				
15th percentile	20.2	25.8	18.4	24.4
85th percentile	29.4	37.0	26.8	36.9
BMI (kg/m <sup>2</sup> )				
15th percentile	14.5	15.2	14.1	14.9
85th percentile	17.9	19.7	17.2	19.3
95th percentile	19.7	22.5	19.1	21.6

<sup>a</sup> As published by the Department of Health of Taiwan [19].

$\chi^2$  test were used to determine the ethnicity effects, whereas Student *t* test was used to determine the sex effect. Multiple linear regression analysis was performed to determine the significance of the association of weight, height, and BMI with age, sex, ethnicity, and school location. A probability of  $P < .05$  was designated as the level of significance.

### 3. Results

#### 3.1. Distribution of subjects

Table 1 shows the distribution of schoolchildren according to urbanization, sex, and ethnicity. Data from 377 children of transnational marriages and 339 aboriginal and 958 Han schoolchildren, representing 54.5%, 25%, and 6.6% of the respective total available students in the county, were analyzed. Most (96.8%) schoolchildren of transnational marriages and Han Taiwanese were from urban and rural areas, whereas all aboriginal schoolchildren were from mountainous areas.

Table 3  
Height, weight, and BMI at 6 and 9 years old of subjects stratified by sex and parental ethnicity\*

Parameters	Parental ethnicity of boys			Parental ethnicity of girls		
	Han	Transnational**	Aboriginal	Han	Transnational**	Aboriginal
n	507	204	171	451	173	168
School age (y)	6.52 ± 0.31	6.50 ± 0.31	6.54 ± 0.29	6.51 ± 0.29	6.48 ± 0.32	6.49 ± 0.31
Height (cm)						
6 years old	118.7 ± 5.11 <sup>a,***</sup>	118.5 ± 5.22 <sup>a</sup>	115.8 ± 4.92 <sup>b</sup>	118.5 ± 5.03 <sup>a</sup>	116.7 ± 4.93 <sup>b,†</sup>	115.3 ± 5.08 <sup>c</sup>
9 years old	134.4 ± 5.91 <sup>a</sup>	134.7 ± 6.32 <sup>a</sup>	131.6 ± 6.51 <sup>b</sup>	135.6 ± 6.61 <sup>a</sup>	133.6 ± 6.42 <sup>b,†</sup>	132.2 ± 6.11 <sup>b</sup>
Weight (kg)						
6 years old	22.9 ± 4.72	23.1 ± 4.66	22.1 ± 4.13	22.5 ± 4.57 <sup>a</sup>	21.5 ± 4.20 <sup>b,†</sup>	22.8 ± 4.65 <sup>a</sup>
9 years old	33.5 ± 8.64	33.6 ± 8.92	32.2 ± 7.95	33.2 ± 8.30 <sup>a</sup>	31.4 ± 7.55 <sup>b,†</sup>	33.1 ± 7.37 <sup>a</sup>
BMI (kg/m <sup>2</sup> )						
6 years old	16.1 ± 2.38	16.5 ± 2.63	16.4 ± 2.09	15.9 ± 2.36 <sup>a</sup>	15.7 ± 2.32 <sup>a</sup>	16.6 ± 2.50 <sup>b</sup>
9 years old	18.4 ± 3.56	18.4 ± 4.01	18.4 ± 3.20	17.9 ± 3.32 <sup>a</sup>	17.4 ± 3.11 <sup>a</sup>	18.7 ± 3.01 <sup>b</sup>

\* All values, except n, are means ± SD.

\*\* Most transnational marriages were females from China or Southeast Asian countries married to Taiwanese men.

\*\*\* Values with different superscripts (a, b, and c) are significantly different ( $P < .05$ ) from each other within the same sex on the basis of Scheffé post hoc test.

† Significantly different from the respective values of the boys on basis of Student *t* test.

#### 3.2. Growth and BMI status

Weight, height, and BMI status of schoolchildren stratified by sex are shown in Table 3. The average school entry ages (as of September 1) for all 3 ethnic groups were the same, around 6.5 years old. Aboriginal boys and girls were significantly shorter in stature (approximately 3 cm) than their Han counterparts at 6 and 9 years old (first grade and fourth grade, respectively). Sons of transnational couples were as tall as Han counterparts at 6 and 9 years old, but daughters of transnational couples were 2 cm shorter at 6 years old ( $P < .05$ ) and 3 cm shorter at 9 years old ( $P < .05$ ) compared with their Han Taiwanese counterparts. There were no significant weight differences among boys of the 3 ethnic groups at either 6 or 9 years old, but daughters of the marital immigrants were significantly lighter, by 1 kg at 6 and 2 kg at 9 years old (both  $P < .05$ ) compared with their counterparts of the other 2 ethnic groups. Aboriginal girls had the same weight as Han girls. There were no differences in BMI among boys of the 3 ethnic groups at either 6 or 9 years old, whereas aboriginal girls had significantly (both  $P < .05$ ) higher BMI compared with girls of the other 2 ethnic groups at both ages.

#### 3.3. Factors associated with growth status

Associations of sex, age, ethnicity, and school location with height, weight, and BMI status of schoolchildren are shown in Table 4. At the age of 6 years, boys were associated with significantly greater height, weight, and BMI compared with girls. At the age of 9 years, girls were associated with significantly greater height but lower BMI compared with boys. The association with weight was not significant at the age of 9 years. The age of schoolchildren was significantly associated with height and weight but not BMI at 6 or 9 years old. Ethnicity was significantly associated with height and

Table 4

Linear regression analysis of the association of schoolchildren's height, weight, and BMI values with sex, age, ethnicity, and school locations at the age of 6 or 9 years<sup>a</sup>

	Height		Weight		BMI	
	$\beta^b$	<i>t</i>	$\beta$	<i>t</i>	$\beta$	<i>t</i>
At 6 years old						
Sex	-0.046	-2.041 *	-0.054	-2.238 *	-0.050	-2.068 *
Age	0.287	12.632 ***	0.148	6.143 ***	0.029	1.173
Ethnicity	-0.140	-4.708 ***	0.007	0.219	0.111	3.456 ***
Location	-0.077	-2.440 **	-0.060	-1.770	-0.045	-1.321
At 9 years old						
Sex	0.052	2.231 *	-0.028	-1.150	-0.063	-2.568 **
Age	0.218	9.312 ***	0.114	4.687 ***	0.039	1.587
Ethnicity	-0.110	-3.589 ***	-0.007	-0.221 *	0.050	1.558 **
Location	-0.085	-2.593 **	-0.038	-1.116	-0.002	-0.060

<sup>a</sup> All independent variables, except age, were treated as categorical. Age was expressed as a continuous number in month.

<sup>b</sup> Standardized coefficient  $\beta$ .

\*  $P < .05$ .

\*\*  $P < .01$ .

\*\*\*  $P < .001$ .

BMI but not with weight at the age of 6 years, whereas ethnicity was significantly associated with all 3 variables at the age of 9 years. The location of the school was significantly associated with body height but not with weight or BMI status at 6 or 9 years old.

### 3.4. Comparison of growth patterns

The distribution of height, weight, and BMI according to the standards (Table 2) published by the Department of Health of Taiwan are shown in Fig. 1. The pattern of height distribution of the aboriginal boys was significantly different from that of the other 2 ethnic groups, whereas both patterns of the aboriginal girls and daughters of the transnational couples were different from the Han Taiwanese counterpart at both ages. Aboriginal boys had a different weight distribution pattern compared with the other 2 ethnic groups at 6 and 9 years old. For girls, no difference in weight distribution was observed at the age of 6 years, whereas both ethnic minority groups were different from that of the Han counterpart at the age of 9 years. There was no difference in BMI distribution for boys among the 3 ethnic groups at the age of 6 years. The distribution patterns of the aboriginal girls were significantly different from that of the daughters of marital immigrants but not from that of the Han Taiwanese girls at the age of 9 years.

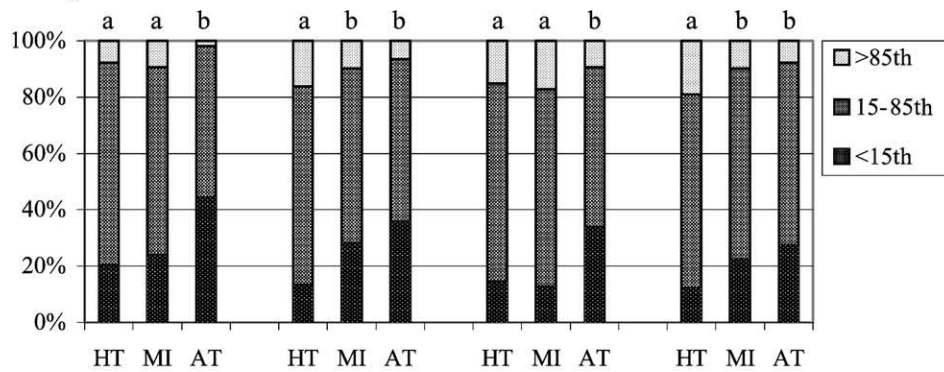
## 4. Discussion

Results suggest that significant ethnicity- and sex-related disparities in height, weight, and BMI status exist among these schoolchildren. The concern that inadequate acculturation of the marital immigrants may have an impact on the growth status of their children is confirmed in the present study. Although sons of the marital immigrants grow equally well compared with Han Taiwanese boys, daughters of the

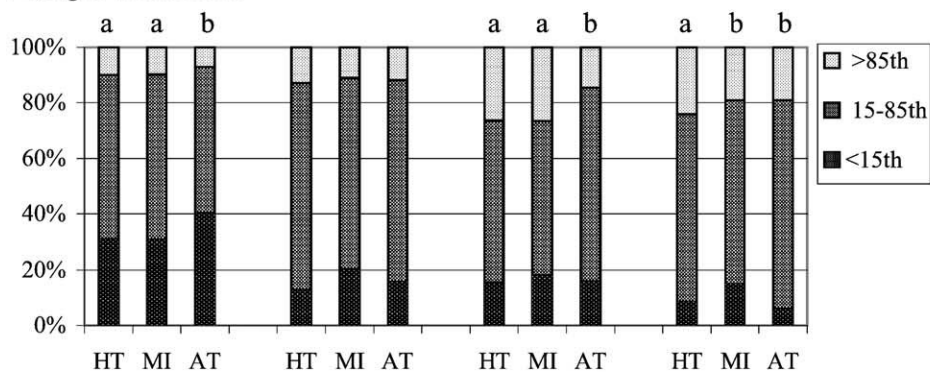
marital immigrants grow significantly shorter and lighter in stature compared with Han Taiwanese counterparts. The marital immigrants are almost exclusively married to Han Taiwanese men. The fact that daughters but not sons of marital immigrants grow slower relative to their Han Taiwanese counterparts suggests the existence of sex disparity in transnational marriage families. This issue is of interest and deserves further investigation. Although direct evidence is lacking, we speculate that it might be the result of cultural influences. Government statistics shows that many men who seek transnational marriages are socioeconomically, environmentally, or physically disadvantaged [6], and many of them are also older and under great pressure to have children, especially sons to "carry on" the family bloodline according to traditional Chinese culture. Many of these men are also less formally educated and less exposed to Western culture and, thus, are under a strong influence of the traditional male-preference culture. Thus, in those families, children could receive differential treatments from their parents or grandparents because of sex. Boys are often preferentially treated with foods, daily needs, education, and even healthcare, resulting in sex disparities in growth and other health-related issues.

A clear ethnic disparity in growth status is observed between the aboriginal and Han Taiwanese schoolchildren. The aboriginal boys and girls are approximately 3 cm shorter at both 6 years old (grade 1) and 9 years (grade 4) old compared with the Han Taiwanese counterparts. Although the aboriginal boys are slightly lighter than their Han Taiwanese counterparts, the aboriginal girls are the same in weight compared with their Han Taiwanese counterparts. As a result, the aboriginal boys have similar BMI as the Han Taiwanese boys, whereas the aboriginal girls have greater BMI compared with the Han Taiwanese girls. Similar findings were observed by Han et al [20] who observed a greater difference in BMI between the aboriginal

## A. Height distribution



## B. Weight distribution



## C. BMI distribution

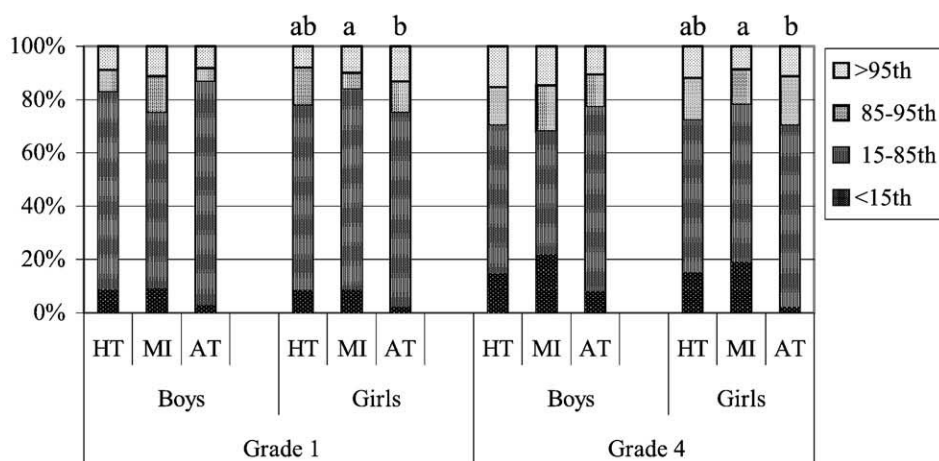


Fig. 1. Body height, weight, and BMI distributions during grade 1 (6 years old) and grade 4 (9 years old) of subjects classified according to age-specific percentile standards for Taiwanese children published by the Department of Health of Taiwan. Distribution patterns not carrying the same letter on the distribution bars are significantly ( $P < .05$ ) different from each other within the same age and sex group on basis of  $\chi^2$  test. HT indicates Han Taiwanese; MI, marital immigrant; AT, aboriginal Taiwanese.

(20.7 kg/m<sup>2</sup>) and the Han Taiwanese girls (17.8 kg/m<sup>2</sup>) compared with results of the present study. They also observed no significant differences in BMI in boys, although the aboriginal boys were significantly shorter than the Taiwanese boys. The greater difference in girl's BMI observed in their study compared with that observed in

the present study could be due to the fact that they compared the aboriginal children residing in mountainous areas of Nantou County to Han children residing in Taichung City, a metropolitan area. Thus, in addition to ethnicity, the differences in living location could contribute to the observed differences.

That the aboriginal children are less in stature compared with Han Taiwanese counterparts might have both biologic (genetic) and environmental causes. Genetically, the aboriginal Taiwanese are tribes of Malayo-Polynesian or the Austronesian origins [10,11], whereas the Han Taiwanese are descendants of Han Chinese migrated from mainland China throughout the generations. Aboriginal adults have also been observed to be 3 to 4 cm shorter in stature compared with Han counterparts [21]. However, other factors such as socioeconomic, lifestyle, and healthcare factors that can interact with the living environment could also have contributed to the differences in growth status [22]. The aborigines generally live in more remote and economically less developed areas, and they have unique culture and lifestyle. The role of nutrition in the observed differences in growth and BMI status in the present study cannot be determined with certainty. Based on the fact that the aboriginal children are at least equal in BMI compared with Han children, it appears that under-nutrition probably is not a major cause of the disparities in body height.

Results of the present study suggest that a tendency to become overweight is evident in aboriginal girls at 6 to 7 years old. The average BMI is significantly higher compared with their Han Taiwanese counterparts.  $\chi^2$  tests on the data show that BMI distribution patterns of the aboriginal girls are significantly different from that of the other 2 ethnic groups. Smaller proportions of aboriginal schoolchildren have their BMI below the 15th percentile value of the standard chart. These results are consistent with the observation of a population-based study showing that Taiwanese aboriginal adults, especially women, have higher BMI values and higher prevalence rates of overweight-obesity compared with Han Taiwanese counterparts [15]. It is of interest to note that although overweight-obesity is prevalent in both adult aboriginal men and women, the tendency to become overweight at 6 or 9 years old is evident only in girls but not in boys. Further studies are needed to determine the age at which the aboriginal boys start to show a tendency to become overweight.

Because obesity is a comorbidity of many diseases such as hypertension, dyslipidemia, hyperglycemia, hyperuricemia, type 2 diabetes mellitus, coronary heart disease, and even some types of cancer, it is important for the health authorities to promote preventive health at young age. The Taiwanese aborigines are known to have higher prevalence rates of these metabolic disturbances [14–18]. It is advisable that attempts be made to implement nutritional, lifestyle, and/or behavioral interventions during elementary or middle school years to minimize these health problems.

This study revealed significant ethnical differences in growth and body stature among children of the marital immigrants, the aborigines and the Han Taiwanese. Although the exact reasons for these disparities cannot be determined in the present study, biologic or socioeconomic reasons are suspected in the case of the ethnic differences,

whereas cultural factors are the most likely causes in the case of sex disparity in children of the transnational couples. Although genetic and environmental variables are usually presumed to be the major factors impacting on the stature and BMI of children [23], the present study has demonstrated that culture is an element that can interact with these factors. This study suggests that special attention must be given to correct the disparities in children's growth and development in populations where there is a strong preference toward a specific sex.

There are limitations to this study. Data of subjects were cluster sampled, and not all schools selected participated in the study. Although subjects were all from the same county, there were obvious environmental differences in the residential areas of the ethnic groups. Thus, some of the ethnicity-related differences could have been due to living locations. Health records were produced by school nurses and physicians of individual schools. Interrater variations in gathering these data among nurses and physicians were unavoidable. In some cases, the classification of ethnicity is ambiguous because of interracial marriages. The wives of transnational couples are from culturally diverse areas, but the result of the present study can only reflect a generalized outcome. Furthermore, because Nantou County is a less urbanized county compared with most other cities or counties in Taiwan, the generalizability of the study results needs to be interpreted with caution. The present study also raises one question: whether the same set of growth standard should be applied to all ethnic groups. Having a set of standard for each ethnic group might not be practical, but at least the ethnic differences should be recognized wherever applicable.

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