Prevalence of obesity and its comorbidities among schoolchildren in Taiwan

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To evaluate the prevalence of obesity and its comorbidities among a representative sample of elementary schoolchildren in Taiwan, the Nutrition and Health Survey in Taiwan Elementary School Children used a stratified, multi-staged complex sampling scheme. In total 2,405 children (1,290 boys and 1,115 girls) were included. The prevalence of overweight and obesity was 15.5 and 14.7% in boys and 14.4 and 9.1% in girls. With respect to geographic differences, the prevalence of obesity for boys was highest in the southern area (23.3% for the 3rd stratum) and lowest in the mountain area (4.3%). For girls, the prevalence of overweight and obesity was highest in the central area (13.0% for the 3rd stratum) and lowest in the southern area (2.6% for the 3rd stratum). The obese children had higher mean levels of blood pressure, triglyceride, low density lipoprotein-cholesterol, uric acid and serum glutamic pyruvic transaminase, but lower level of high density lipoprotein-cholesterol when compared with the normal weight children. For obese and normal weight boys, the prevalence was 12.9 % vs. 0.3 % for high blood pressure, 31.4 % vs. 19.6 % for dyslipidemia, and 6.4 % vs. 0.8 % for abnormal serum glutamic pyruvic transaminase level. In conclusion, we found that about one third of the boys and one quarter of the girls were overweight and/or obesity in Taiwan. Furthermore, the prevalence of obesity-related comorbidities was significantly increased for obese and/or overweight elementary schoolchildren in the Taiwan area.

Key Words: schoolchildren, obesity, prevalence, comorbidities, Taiwanese

INTRODUCTION

Obesity is a widespread and growing problem in the world with significant medical, psychosocial and economic consequences. The prevalence of obesity has increased substantially over the last several decades and indications are such that this trend will continue not only in developed but also in developing countries.¹⁻⁶

Childhood obesity is a potential health problem because it is an important predictor of adult obesity.⁷⁻¹¹ About one third of obese preschool children and one-half of obese school children become obese adults. However, whether or not obesity persists into adulthood, obesity in childhood appears to increase the risk of subsequent morbidity.¹²,¹³ The development of obesity is associated with the simultaneous deterioration in chronic disease risk profiles.⁴,¹²⁻¹⁴ Excess weight in childhood is the leading cause of pediatric hypertension. In addition, overweight children are at a high risk for developing long-term chronic conditions, including dyslipidemia, impaired glucose tolerance, adult-onset diabetes mellitus, hepatic gastrointestinal disturbance, coronary heart disease, orthopedic disorders and respiratory disease.¹¹,¹³⁻¹⁵

Although, there is substantial evidence suggesting that obesity in childhood lags the metabolic groundwork for adult cardiovascular disease,¹⁴⁻¹⁶ the obesity related consequences may be preventable if we can control the body weight starting from childhood. Therefore the purpose of this study is to evaluate the prevalence of obesity and its comorbidities among schoolchildren in Taiwan in order to provoke public health actions against this high impact health risk.

MATERIALS AND METHODS

This study is based on the Nutrition and Health Survey in Taiwan Elementary School Children (NAHSIT Children, 2001-2002). Children aged 6 to 13 who lived in the Taiwan area were the target population of the survey. After applying a stratified, multistaged, and clustered sampling method, 2,405 school children (1,290 boys and 1,115 girls) were included in this survey. Base on specific ethnic and geographical characteristics in Taiwan, we designated the Hakka areas; the Mountain areas; the Eastern stratum; the Penghu Islands, and the Northern, the Central, the Southern areas, which in turn were divided into three strata in each area based on population density (the 3rd stratum is with relative low population density area).
Details of the sampling method and health examination including anthropometry and blood pressure measurement are described and referenced elsewhere. \(^{17}\) Height and weight were measured using the German SECA 707 continuous display electronic scales (and the SECA 220 height rod). Participants were asked to first remove their shoes and the weight of their clothes was estimated by categorizing them into appropriate cloth types. Body weight was measured to the nearest 0.1 kg, and body height was measured to the nearest 1mm. BMI was measured from calculated weight and height as weight (kg)/height\(^2\) (m\(^2\)). Blood pressures were measured after the subject had rested for at least 5 minutes, using the Omega 1400 Non-Invasive Blood Pressure Monitor (In vivo Reach Inc., Orlando, Florida, USA) with cuffs of appropriate sizes. The subject’s arm was placed at the same height as the heart. Two measurements were recorded. If the first and second measurements differ by more than 10mmHg, a third measurement was performed. Mean values of the two or the two closest pressures were used for data analyses.

**Definition of overweight and obesity in children**

Obesity is in general defined as the presence of excess adipose tissue accumulated in the body to such a degree that it may lead to health hazards. \(^{1,2}\) The operational definition of overweight and obesity often relates to applying sex- and age-specific percentile cut-points of a reference population (most use the 85\(^{\text{th}}\) percentile for overweight and 95\(^{\text{th}}\) percentile for obesity). \(^{3,5}\) The Department of Health (DOH) childhood obesity expert panel has defined overweight (≥ the 85\(^{\text{th}}\) percentile value of body mass index) and obesity (≥ the 95\(^{\text{th}}\) percentile value of body mass index) using gender- and age-specific criteria. Each age group from 2 to 18 years has its own cut-off point for overweight and obesity. \(^{21}\)

**Definition of comorbidities among children**

**Abnormal blood pressure:** the cut-off point for abnormal blood pressure (BP) for systolic BP is ≥ 120 mmHg and for diastolic BP is ≥ 80 mmHg. Abnormal blood pressure was defined as either SBP or DBP meet the criteria. \(^{22}\)

**Abnormal biochemical parameters:** abnormal blood glucose we defined as ≥ 200 mg/dl, abnormal total cholesterol (TC) is defined as ≥ 200 mg/dl; normal high density lipoprotein-cholesterol (HDL-C) is defined as ≤ 35 mg/dl; abnormal low-density lipoprotein cholesterol (LDL-C) is defined as ≥ 150 mg/dl; abnormal triglyceride is defined as ≥ 120 mg/dl; abnormal uric acid is defined as ≥ 7.0 mg/dl; abnormal liver function is defined as either SGOT or SGPT ≥ 35 IU/L. \(^{22}\)

**Statistics**

For continuous data, mean and standard error (s.e.) were described; for categorical data, frequency and percentage were calculated. All data were weighted using the SUDAAN version 8.0 (Research Triangle Institute; 2001) to account for the effect of complex sampling design. Abnormal blood pressure and biochemical data were compared among different weight status with gender-specification using one-way analysis of variance (ANOVA) after adjusting for age and post-comparison with Scheffe test. All statistical analyses were performed using SUDDAN. \(p\)-value less than 0.05 were considered as statistically significant.

**RESULTS**

The prevalence of overweight and obesity among school children with gender- and age-stratification are shown in Table 1. The overall prevalence of overweight and obesity was 15.5 and 14.7% in boys and 14.4 and 9.1% in girls. For boys, the prevalence was the highest at age 11 (20.2%) and lowest at age 7 (10.8%); for girls, the prevalence was the highest at the age 12 (14.8%) and lowest at age 10 (6.7%).

Table 2 presents the prevalence of overweight and obesity in different sampling strata defined by gender- and age-specific cut-off points. For example, the prevalence of obesity for boys was the highest in the southern area (23.3% in the 3rd stratum) and lowest in the mountain area (4.3%). For girls, the prevalence of obesity was the highest in the central area (about 13.0% in the 3rd stratum) and the lowest in the southern area (about 2.6% in the 3rd stratum).

The gender-specific characteristics of blood pressures and biochemical parameters among different weight status are presented in Table 3. Aggravating trends were observed from normal body mass index group, overweight group, to obese group for all parameters except for heart rate and serum cholesterol. For example, the triglyceride levels among normal, overweight and obese boys were 64.6±1.6, 79.3±3.5, 92.2±4.0 mg/dl (\(p < 0.05\) when compared with normal). For girls, the triglyceride

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**Table 1. Prevalence of overweight and obesity by age among elementary schoolchildren in Taiwan**

<table>
<thead>
<tr>
<th>Age (n=203)</th>
<th>Total</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Overweight</td>
<td>Obesity</td>
</tr>
<tr>
<td>6 (n=203)</td>
<td>70.2</td>
<td>17.8</td>
<td>12.0</td>
</tr>
<tr>
<td>7 (n=413)</td>
<td>78.6</td>
<td>12.2</td>
<td>9.2</td>
</tr>
<tr>
<td>8 (n=405)</td>
<td>75.8</td>
<td>14.1</td>
<td>10.1</td>
</tr>
<tr>
<td>9 (n=391)</td>
<td>67.5</td>
<td>19.5</td>
<td>13.0</td>
</tr>
<tr>
<td>10 (n=408)</td>
<td>73.2</td>
<td>15.5</td>
<td>11.3</td>
</tr>
<tr>
<td>11 (n=403)</td>
<td>70.5</td>
<td>13.8</td>
<td>15.7</td>
</tr>
<tr>
<td>12 (n=182)</td>
<td>73.4</td>
<td>12.6</td>
<td>14.0</td>
</tr>
<tr>
<td>Total (n=2405)</td>
<td>73.0</td>
<td>15.0</td>
<td>12.0</td>
</tr>
</tbody>
</table>

\(^{1}\) The reference group for total children is the 9 years old. \(^{2}\) The reference group for boys is the 10 years old. \(^{3}\) The reference group for girls is the 10 years old.
In this study, we found that the prevalence of obesity was 14.7% in boys and 9.1% in girls. The prevalence of obesity was the highest in the southern area (the 3rd stratum) in boys and in the central area (the 3rd stratum) in girls. In general, there were more overweight and obese children in southern Taiwan, central Taiwan in that order than in the northern and other specific areas. Furthermore, the obese children generally had higher levels of BP, triglyceride, uric acid levels, liver enzymes, but lower level of HDL-C when compared with the normal weight children.

Childhood obesity is an important predictor of adult obesity. In addition, obesity in childhood appears to increase the risk of subsequent morbidity, whether or not obesity persists into adulthood. Preventing excess weight gain and obesity among children and adolescents is important in obesity control and will lead to a decreased risk of chronic diseases among adults.

Over the past 30 years, there were escalating prevalence rates of overweight and obese children and adolescents in both genders in the western countries. For example, in US, from 1963 to 1991, the prevalent overweight children (based on 85th percentile BMI) increased from 15.1 to 21.7% for boys and 15.2 to 21.2% for girls at 12 to 17 years old. The prevalence of obesity (≥ 95th percentile of BMI) increased from 5.1% in the 1960’s to 11.7% in 1988-1994 in the 6-11 years age group and from 4.8% to 10% in the 12-17 years age group. The NHANES III survey showed that the prevalence of overweight among children ages 6-11 was around 9.2 to 17.4% and was 8.5 to 15.7% among ages 12-17, in 1988-94. The prevalence rates of overweight and obese

### Table 2. Prevalence of overweight and obesity by stratum among elementary school children in Taiwan

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Total (n=900)</th>
<th>Boys (n=500)</th>
<th>Girls (n=400)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overweight (%)</td>
<td>Obesity (%)</td>
<td>Overweight (%)</td>
</tr>
<tr>
<td>Hakkas (n=189)</td>
<td>13.7</td>
<td>8.5</td>
<td>14.6</td>
</tr>
<tr>
<td>Mountain areas (n=185)</td>
<td>10.5</td>
<td>6.3</td>
<td>11.2</td>
</tr>
<tr>
<td>Eastern areas (n=190)</td>
<td>11.5</td>
<td>11.1</td>
<td>16.2</td>
</tr>
<tr>
<td>PengHu islands (n=189)</td>
<td>10.2</td>
<td>6.5</td>
<td>9.7</td>
</tr>
<tr>
<td>Northern areas:1st stratum (n=167)</td>
<td>16.5</td>
<td>12.2</td>
<td>17.3</td>
</tr>
<tr>
<td>Northern areas:2nd stratum (n=178)</td>
<td>16.4</td>
<td>10.4</td>
<td>15.8</td>
</tr>
<tr>
<td>Northern areas:3rd stratum (n=187)</td>
<td>11.3</td>
<td>10.6</td>
<td>10.0</td>
</tr>
<tr>
<td>Central areas:1st stratum (n=190)</td>
<td>17.9</td>
<td>9.9</td>
<td>15.8</td>
</tr>
<tr>
<td>Central areas:2nd stratum (n=199)</td>
<td>15.2</td>
<td>13.5</td>
<td>18.8</td>
</tr>
<tr>
<td>Central areas:3rd stratum (n=163)</td>
<td>12.9</td>
<td>13.5</td>
<td>18.6</td>
</tr>
<tr>
<td>Southern areas:1st stratum (n=188)</td>
<td>13.7</td>
<td>13.3</td>
<td>15.1</td>
</tr>
<tr>
<td>Southern areas:2nd stratum (n=189)</td>
<td>14.3</td>
<td>15.8</td>
<td>16.4</td>
</tr>
<tr>
<td>Southern areas:3rd stratum (n=191)</td>
<td>15.6</td>
<td>15.5</td>
<td>13.7</td>
</tr>
</tbody>
</table>

Table 3. Characteristics of blood pressure and biochemical variables by obesity status among elementary schoolchildren in Taiwan

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Normal (n=853)</th>
<th>Overweight (n=161)</th>
<th>Obesity (n=1115)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±s.e.</td>
<td>Mean±s.e.</td>
<td>Mean±s.e.</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>95.2±0.4</td>
<td>102.0±1.0</td>
<td>107.1±1.0</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>55.9±0.3</td>
<td>58.7±0.6</td>
<td>61.6±0.8</td>
</tr>
<tr>
<td>Heart rate (beat/min)</td>
<td>93.6±0.6</td>
<td>92.8±0.8</td>
<td>92.4±1.1</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>96.4±0.5</td>
<td>98.1±0.8</td>
<td>98.8±0.6</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>177±2.4</td>
<td>177±2.3</td>
<td>181±3.4</td>
</tr>
<tr>
<td>Triglyceride (mg/dl)</td>
<td>64.6±1.6</td>
<td>79.3±3.5</td>
<td>92.2±4.0</td>
</tr>
<tr>
<td>HDL-C (mg/dl)</td>
<td>62.0±0.5</td>
<td>55.2±0.9</td>
<td>52.0±0.9</td>
</tr>
<tr>
<td>LDL-C (mg/dl)</td>
<td>106±2.1</td>
<td>110±2.1</td>
<td>115±2.5</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>0.6±0.0</td>
<td>0.6±0.0</td>
<td>0.6±0.0</td>
</tr>
<tr>
<td>Uric acid (mg/dl)</td>
<td>5.7±0.1</td>
<td>6.4±0.2</td>
<td>7.3±0.2</td>
</tr>
<tr>
<td>SGOT (IU/L)</td>
<td>22.3±0.4</td>
<td>20.3±0.6</td>
<td>20.7±0.8</td>
</tr>
<tr>
<td>SGPT (IU/L)</td>
<td>11.7±0.3</td>
<td>13.8±0.7</td>
<td>19.7±1.7</td>
</tr>
</tbody>
</table>

*p <0.05 when compared with normal; **p <0.05 when compared with overweight. Abbreviations: SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL-C: High Density Lipoprotein – Cholesterol; LDL-C: Low Density Lipoprotein – Cholesterol; SGOT: Serum Glutamic Oxaloacetic Transaminase; SGPT: Serum Glutamic Pyruvic Transaminase.

Table 4. Gender-specific prevalence of obesity-related comorbidities among different weight status. For example, the prevalence of abnormal liver function (either SGOT or SGPT \( ≥ 35 \text{IU/L} \)) was 2.5, 3.6 and 6.4% for normal weight, overweight and obese children and was 3.1, 4.1 and 7.5% for normal weight, overweight and obese boys and was 3.1, 4.1 and 7.5% for normal weight, overweight and obese girls.

**DISCUSSION**

In this study, we found that the prevalence of obesity was 14.7% in boys and 9.1% in girls. The prevalence of obesity was the highest in the southern area (the 3rd stratum) in boys and in the central area (the 3rd stratum) in girls. In general, there were more overweight and obese children in southern Taiwan, central Taiwan in that order than in the northern and other specific areas. Furthermore, the obese children generally had higher levels of BP, triglyceride, uric acid levels, liver enzymes, but lower level of HDL-C when compared with the normal weight children.
Table 4. Prevalence of abnormal blood pressure and biochemical variables by obesity status among elementary schoolchildren in Taiwan

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n=2405)</th>
<th>Boys (n=1290)</th>
<th>Girls (n=1115)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal blood pressure†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP ≥120mmHg</td>
<td>0.3</td>
<td>2.2</td>
<td>9.4</td>
</tr>
<tr>
<td>DBP ≥80mmHg</td>
<td>0.1</td>
<td>0.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Abnormal blood glucose (≥100mg/dl)</td>
<td>25.9</td>
<td>35.4</td>
<td>29.0</td>
</tr>
<tr>
<td>Abnormal blood lipid ‡</td>
<td>21.9</td>
<td>22.5</td>
<td>35.1</td>
</tr>
<tr>
<td>Blood TG ≥120mg/dl</td>
<td>18.2</td>
<td>16.8</td>
<td>24.4</td>
</tr>
<tr>
<td>HDL-C ≤35mg/dl</td>
<td>5.3</td>
<td>9.0</td>
<td>21.9</td>
</tr>
<tr>
<td>LDL-C ≥150mg/dl</td>
<td>6.2</td>
<td>5.8</td>
<td>8.7</td>
</tr>
<tr>
<td>Abnormal liver function§</td>
<td>2.8</td>
<td>3.8</td>
<td>6.8</td>
</tr>
<tr>
<td>SGOT ≥35IU/L</td>
<td>2.8</td>
<td>2.9</td>
<td>3.1</td>
</tr>
<tr>
<td>SGPT ≥35IU/L</td>
<td>0.5</td>
<td>2.4</td>
<td>6.1</td>
</tr>
<tr>
<td>Abnormal blood uric acid (≥7.0mg/dl)</td>
<td>14.5</td>
<td>29.7</td>
<td>43.3</td>
</tr>
</tbody>
</table>

†:Definition of abnormal blood pressure is systolic blood pressure ≥120mmHg or diastolic blood pressure ≥80mmHg; ‡:Definition of abnormal blood lipid level is cholesterol ≥200mg/dl or triglyceride ≥120mg/dl; §:Definition of abnormal liver function is Glutamic Oxaloacetic Transaminase (SGOT) ≥35 IU/L or Glutamic Pyruvic Transaminase (SGPT) ≥35 IU/L. Abbreviations: SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HDL-C: High Density Lipoprotein – Cholesterol; LDL-C: Low Density Lipoprotein – Cholesterol; SGOT: Serum Glutamic Oxaloacetic Transaminase; SGPT: Serum Glutamic Pyruvic Transaminase.
creased about 2 folds among the Hispanic children from
1986 to 1998.18

According to NAHSIT 1993-1996, the prevalence rates
of overweight and obesity among 7 to 12 year-old child-
ren were 12.8% and 4.9% for boys and 10.8% and 6.9% for
girls, respectively (unpublished data). However, in the
NAHSIT Children 2001-2002, the obesity prevalence
tripled for boys and doubled for girls. About one-third of
boys and one-fourth of girls were associated with either
overweight or obesity. Furthermore, the boys had higher
prevalence of overweight and obesity than girls. In this
survey, the girls had lower prevalence of overweight and
obesity which may be associated with the greater empha-
sis placed on body image at this age period.

From Table 2, among different geographic areas, the
prevalence of obesity and overweight among boys was
highest in the first stratum of southern area (with the rate
of 38.4%), and lowest in the mountain area (around
15.5%). For girls, the highest was in the third stratum of
southern area (with the rate of 33.2%), and lowest in the
first stratum of southern area (around 14.8%). In general,
the Penghu area (with the rate of 16.7%) and the moun-
tain area (16.8%) had the lowest prevalence of over-
weight and obesity. However, the third stratum of the
southern area had highest prevalence of overweight and
obesity (31.1%). The prevalence of obesity in different
geographic areas was significantly different. Taking aside
those remote strata in this study, in western Taiwan, the
areas with less urbanization had higher prevalence of
overweight and obesity, which was different from the
results of the NAHSIT (1993-1996) in that the urbanized
areas had higher prevalence of overweight and obesity.
These changes may be due to more health information
flow and related activities in the urban area so that more
attention is paid on the health and weight issues of the
children.

The increasing prevalence of obesity has been observed
in Taiwanese adults and children, which may be in part
explained by an imbalance between energy intake and
expenditure. In Taiwan, the availability of a high-fat and
high-energy diet has steadily increased over the past few
decades among general population, while the lifestyle has
also become more sedentary and physically inactive. Al-
though, total energy available increased from 2661.7 to
2992.9 calories/day and fat availability rose from 63.5 to
128.4 g/day from 1970 to 1989 in the Taiwan, the energy
intake level did not increase.24,25 Rather the quality of diet
has been gradually modified. This information suggests
that increasingly sedentary lifestyles including excessive
TV watching and physical inactivity are partly to blame
for this trend, indicating lifestyle as well as dietary factors
are associated with the development of obesity among
children in the Taiwan area. However, further nutritional
studies on youths are needed to evaluate the association
between diet patterns and food intakes on the develop-
ment of obesity among this specific population.

Obesity is associated with the occurrence of diabetes,
cardiovascular disease, hypertension, gallbladder disease
and certain cancers.5,11-13,26-28 There are many studies link-
ing obesity in youth with adult morbidity and mortality.
Adults who had been overweight as children had 20%
higher prevalence of chronic disease such as cardiovascu-
lar disease, hypertension and diabetes when compared
with those normal weight children.7 The Bogalusa Heart
Study has provided detailed information on cardiovascu-
lar disease risk factors in overweight and obese childhood
and their persistence into adulthood. Adults overweight
since their adolescence were 3.0 to 5.8 times as likely to
have at least two or more cardiovascular disease risk fac-
tors as lean adults who had been lean adolescents.8 Adults
who had been overweight during childhood had higher
levels of fasting blood glucose, systolic and diastolic
blood pressure in adulthood 40 years later.9

In this study, the prevalence of obesity-related comor-
bidities was significantly increased among overweight or
obese children. The prevalence increased significantly as
the BMI increased. However, there are some interesting
points such as that the prevalence of abnormal blood
pressure, abnormal blood glucose and abnormal uric acid
are more common in obese boys than in obese girls. Ab-
normal blood lipids and abnormal liver function are more
common in obese girls than in obese boys.

Many studies have shown that in addition to genetic
factors, environmental factors such as dietary patterns and
lifestyles are associated with the occurrence of obesity
and its-related comorbidities.8,29 Most importantly, ad-
verse dietary patterns such as high-energy, high-fat, and
low-fiber diets are also associated with development of
high blood pressure, dyslipidemia, hyperglycemia and
other comorbidities.25,29 These may be associated with
increased risk of developing cardiovascular disease later
in life. Systematic approach to provide adequate nutrition
education, dietary intervention and to encouragement of
regular physical activities are needed to prevent the oc-
currence of obesity and to halt the increase of obesity-
related disorders among children.

From this survey, we found that overweight and obese
children had higher prevalence of obesity-associated co-
morbidities. The efforts and programs combating obesity
problems should be incorporated into existing health
promotion programs organized by local community, re-
gion, country and international parties in order to alleviate
the problem of obesity efficiently. Further studies are also
needed to collect more data and develop the guidelines
for preventing and managing obesity in Taiwan.

In conclusion, obesity in adults is associated with the
development of many chronic disorders. We believe that
the most appropriate way to manage obesity in Taiwan is
to support the notion and strategy to prevent excess
weight gain and obesity early in life which may in turn
decrease the risk of chronic diseases later in life.

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AUTHOR DISCLOSURES
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REFERENCES
22. Reference 19.
24. Reference 17.
25. Reference 16.
27. Reference 14.
29. Reference 12.
30. Reference 11.
32. Reference 9.
33. Reference 8.
34. Reference 7.
35. Reference 6.

Appendix 1. Definition of overweight and obesity among children in Taiwan

<table>
<thead>
<tr>
<th>Age</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Underweight (BMI&lt;)</td>
<td>Overweight (BMI≥)</td>
</tr>
<tr>
<td>6</td>
<td>13.9</td>
<td>17.9</td>
</tr>
<tr>
<td>7</td>
<td>14.7</td>
<td>18.6</td>
</tr>
<tr>
<td>8</td>
<td>15.0</td>
<td>19.3</td>
</tr>
<tr>
<td>9</td>
<td>15.2</td>
<td>19.7</td>
</tr>
<tr>
<td>10</td>
<td>15.4</td>
<td>20.3</td>
</tr>
<tr>
<td>11</td>
<td>15.8</td>
<td>21.0</td>
</tr>
<tr>
<td>12</td>
<td>16.4</td>
<td>21.5</td>
</tr>
</tbody>
</table>

Prevalence of obesity and its comorbidities among schoolchildren in Taiwan

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Original Article

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