

# The Practical Guidelines for Physical Activity in Preventing Abnormal Body Weight in Asian Adolescents

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## Abstract

**Background:** Lack of physical activity is one of the major risk factors for obesity in adolescents. Before adopting the guidelines of the World Health Organization, The Ministry of Education in Taiwan recommended 210 minutes of moderate physical activity weekly for adolescents, equivalent to 840 METs-min/wk. An additional 90 min of vigorous physical activity weekly is recommended for those who are more fit, equivalent to a total of 1560 METs-min/wk. The purpose of this study was to investigate the association between meeting the previous Taiwanese guidelines and the risk for being overweight, obese, and underweight, in adolescents.

**Methods:** The participants include 421 boys and 405 girls from middle schools. A multinomial logit model was adopted to simultaneously compare all weight categories.

**Results:** Meeting the level of 840 METs-min/wk was associated with lower risks for obesity (odds ratio, OR = 0.41,  $p < .1$ ) and being underweight (OR = 0.51,  $p < .1$ ) in boys, while meeting the level of 1560 METs-min/wk was associated a lower risk for obesity (OR = 0.30,  $p < .05$ ) in girls.

**Conclusions:** The lower levels of physical activity can be a more practical, yet still effective, goal for policy implementation in Asian countries.

## Introduction

Obesity in children and adolescents has become one of the major global health issues. The World Health Organization (WHO) estimated that 42 million children worldwide were overweight or obese in 2013 [1]. According to a recent national survey in Taiwan, 9.5% of the youth aged 13-17 years old are overweight, and another 6.9% are obese [2]. This prevalence is similar to that in many developed Western and Asian countries [3]. Lack of physical activity is one of the major risk factors for obesity in children and adolescents [4]. Childhood and adolescence are crucial periods for shaping an individual's lifestyle, such as being physically active. Not only can physical activity improve weight status, cardiometabolic and bone health, cognitive function, and reduce the risk of depression in youth [5], but its benefits can also be carried over to adulthood. Past studies showed that a higher level of physical activity in adolescence was associated with a higher level of physical activity in adulthood [6]. Youth who were regularly active also had fewer risk factors for cardiovascular diseases and diabetes later in life [5].

Although obesity has received the most attention in academic research and public policy, being underweight in adolescence is also an important health issue. Underweight adolescents are more susceptible to various physiological and psychological conditions such as bone loss [7] and psychiatric disorders [8]. The prevalence of adolescents being underweight ranges from 7.8% to 27.8% in developed Asian countries such as Taiwan, Japan, and South Korea [9].

The WHO recommends that children and adolescents aged 5-17 years should engage in 60 minutes or more of moderate- to vigorous-intensity physical activity each day. As part of physical activity, the vigorous and muscle- and bone-strengthening physical activity should be included at least 3 times a week [10]. Many western countries have adopted the same guidelines. It has been shown that meeting these national physical activity guidelines could reduce the risk for obesity in adolescents in the US [11] and Europe [12]. Meeting the guidelines

was also associated with better physical, psychological, social, and cognitive health indicators in children and adolescents [11]. Despite the tremendous efforts by governments, schools, and private sectors in many countries, 81% adolescents in the world failed to meet the WHO guidelines in 2016 [13].

Most 7<sup>th</sup>-12<sup>th</sup> graders in Taiwan spend more than 9 hours in schools on weekdays. Many of them also spend several hours attending after school classes on weekdays and weekends. With the limited time available for physical activity, adolescents in Taiwan have one of the lowest prevalence in the world in meeting the WHO guidelines [14,15]. Therefore, Taiwanese government established its own physical activity guidelines for children and adolescents with relatively modest goals. The Ministry of Education established Happy Living Project in 2007-2011, with the aim to accumulate 30 minutes of physical activity per day, equivalent to 210 minutes per week in 6- to 18-year-old students. Starting from 2014, The Ministry of Education implemented Sports Health 150 (SH150) Project to encourage all schools to provide at least 150 minutes of physical activity per week in campus for all 6- to 18-year-old students, in addition to the regular physical education classes [16]. This regulation was incorporated into the National Sports Act in 2017. Before adopting the WHO guidelines in 2018, The Ministry of Education in Taiwan recommends that children and adolescents should engage in at least 210 minutes of moderate physical activity per week. An additional 90 minutes of vigorous physical activity per week is recommended for those who are

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more fit. The Taiwanese guidelines were lower than those of the WHO and most of the Western countries, which recommend at least 420 minutes of physical activity per week.

Although meeting the WHO guidelines have been shown to be associated with numerous physiological and psychological benefit in children and adolescents, more than 4 out of 5 youth worldwide still do not reach that level of physical activity. Many efforts have been made at school, community, and family levels with limited long-term success in helping youth to meet the WHO guidelines. One has to wonder whether lower levels of physical activity, compared to the WHO guidelines, can still provide the similar effects on reaching healthy body weight in youth. The previous Taiwanese guidelines in children and adolescents may provide a basis for re-considering lower guidelines for physical activity. The purpose of this study was to investigate the association between meeting the previous Taiwanese physical activity guidelines and the risk for abnormal body weight, including the conditions of being overweight, obese, and underweight, in adolescents. A multinomial logit model [17] was adopted to simultaneously compare these 4 weight categories of underweight, normal, overweight, and obese.

## Materials & Methods

### Participants

The survey for this study was performed in 17 public junior high schools in the metropolitan area of Taichung, Taiwan, during October 2011 and January 2012. There are 8 districts in the metropolitan area. One of the districts was not included in this study because it did not have a public junior high school. The number of total participants in each district was determined according to the distribution of adolescents in that area. Second, the number of classes to be sampled in each district was determined assuming that each class contained 30 students. Third, no more than 3 classes were sampled in each public

junior high school, with 1 class in each grade. The sampled classes and schools were randomly selected. A total of 1165 questionnaires were collected. Among them, 826 questionnaires, representing 421 boys and 405 girls, with complete information were used for model analysis. This study protocol complies with the ethical guidelines of the Helsinki Declaration.

### Questionnaire design

Information on the participants' physical activity in the 7 days prior to completing the survey was collected using the Taiwanese short version of the International Physical Activity Questionnaire [18]. Physical activities associated with physical education, housework, and part-time jobs were excluded. The total amount of physical activity was calculated by multiplying the time of each activity with the level of intensity, that is 8 METs for vigorous, 4 METs for moderate and 3.3 METs for light intensity [19]. According to the Taiwanese guidelines, the physical activity levels were categorized as below 840 (210 minutes x 4 METs), 840-1560 (840 with an additional 90 minutes x 8 METs) and above 1560 METs-min/wk.

The purpose for engaging in physical activity included 4 options: maintaining a physically active lifestyle, seeking the accompaniment of family or friends, having fun, and spending free time. The participants could select as many options as they wished.

Self-reported height and body weight were collected to calculate BMI. Whether they were underweight, normal weight, overweight, or obese was determined based on the age-specific BMI criteria from Administration of Health Promotion, Taiwan [20]. It is noteworthy that the criteria are slightly different from the International Obesity Task Force reference [21]. Self-assessed health status and chronic diseases; parents' height, weight, and working status; combined household income; monthly allowance; and residence address were also collected.

Variable	
Weight category	Underweight = 1; normal weight = 2; overweight = 3; obese = 4
PA1	= 1 if physical activity < 839.99 METs-min/wk; otherwise = 0, reference group
PA2	= 1 if physical activity 840-1559.99 METs-min/wk; otherwise = 0
PA3	= 1 if physical activity > 1560 METs-min/wk; otherwise = 0
Age	Continuous variable
Paternal BMI	Continuous variable
Maternal BMI	Continuous variable
Tutor class	Went to tutoring class after school = 1; otherwise = 0
Father working	Father working fulltime in the past year = 1; otherwise = 0
Mother working	Mother working fulltime in the past year = 1; otherwise = 0
Sibling	With any number of siblings = 1; otherwise = 0
Living with parents	Living with both parents = 1; otherwise = 0
Income	Monthly household income > 70,000 NT = 1; otherwise = 0
Allowance	With sufficient monthly allowance = 1; otherwise = 0
Active lifestyle	Participating in physical activity as a lifestyle = 1; otherwise = 0
Accompaniment	Participating in physical activity to be with family or friend = 1; otherwise = 0
Fun	Participating in physical activity because it is fun = 1; otherwise = 0
Spend time	Participating in physical activity to spend the free time = 1; otherwise = 0

Table 1: Definition of variables.

## Data analysis

Table 1 shows the definitions of variables used in the multinomial logit model. Dependent variables were the conditions of being underweight, normal weight, overweight, and obese. A multinomial logit model [17] was adopted to simultaneously compare these 4 weight categories of underweight, normal, overweight, and obese. All statistical analyses were done using Stata Release 13 (College Station, TX, USA).

## Results

Less than half (46.9%) of the boys and 60.3% of the girls reported normal body weight. There were 29.5% boys and 15.5% girls were obese or overweight, while approximately 1 in 5 boys and girls reported being underweight (Table 2). The self-reported total amount of physical activity showed great variations among the participants. Approximately one-third of the boys and half of the girls failed to meet the physical activity guidelines of Taiwan (Table 3).

	All		Boys		Girls	
	N	%	N	%	N	%
Underweight	243	20.9	120	20.1	123	21.7
Normal weight	622	53.4	280	46.9	342	60.3
Overweight	142	12.2	93	15.6	49	8.6
Obesity	122	10.5	83	13.9	39	6.9
Missing value	36	3.1	21	3.5	14	2.5
Total	1,165	100	597	100	567	100

Table 2: The number and percentage of participants in each weight category.

For boys who reported physical activity levels of 840-1560 METs-min/wk, the risk for obesity and being underweight was significantly lower than those reporting lower or higher levels of weekly physical activity (Table 4). However, self-reported physical activity exceeding 1560 METs-min/wk was not correlated with the abnormal body weight. Paternal BMI was positively associated with a higher risk for obesity, while the BMI of both parents was negatively associated with the risk for being underweight.

In girls, a physical activity level exceeding 1560 METs-min/wk was associated with a lower risk of obesity (Table 4). Participating in physical activity with the aim of maintaining an active lifestyle also was also negatively associated the risk of obesity. Physical activity levels had no effect on the risk of being underweight or overweight. Maternal BMI was positively correlated with girls' risk of obesity, while parental BMI was positively correlated with the risk of being overweight. Similar to boys, the BMI of both parents was negatively associated with the risk of being underweight. The father's working full-time had a negative association with the risk of obesity in girls, while the mother's working full-time had a positive association. Low household income was also positively associated with the risk for obesity in girls. When all participants were pooled together, meeting or exceeding the physical activity guidelines of 840 METs-min/wk was correlated with a lower risk of obesity (Table 5).

Table 6 shows the odds ratios for being underweight, overweight, and obese in boys and girls. Meeting the recommended physical activity level of 840-1560 METs-min/wk was associated with statistically important reductions in the risk for obesity by 59% and the risk for being underweight by 49% in boys, but the effect was not statistically significant for girls. Only a self-reported physical activity

Variables	All		Boys		Girls	
	Mean	SD	Mean	SD	Mean	SD
PA (METs-minutes/week)	1981.6	2934.4	2415.4	3492.2	1524.0	2106.3
PA1 <sup>a</sup>	0.43	0.50	0.35	0.48	0.52	0.50
PA2 <sup>b</sup>	0.19	0.39	0.18	0.39	0.20	0.40
PA3 <sup>c</sup>	0.37	0.48	0.47	0.50	0.28	0.45
Age	13.34	0.95	13.34	0.94	13.33	0.96
Paternal BMI	24.30	9.98	24.56	13.53	24.04	3.56
Maternal BMI	21.87	3.61	21.89	3.62	21.84	3.61
Tutor class	0.62	0.49	0.60	0.49	0.63	0.48
Father working	0.90	0.31	0.88	0.32	0.91	0.28
Mother working	0.71	0.46	0.68	0.47	0.72	0.45
Siblings	0.90	0.30	0.89	0.31	0.90	0.29
Living with parents	0.88	0.33	0.87	0.33	0.88	0.33
Income	0.21	0.41	0.21	0.40	0.20	0.40
Allowance	0.70	0.46	0.67	0.47	0.73	0.44
Reasons for PA						
Active lifestyle	0.29	0.45	0.34	0.47	0.23	0.42
Accompaniment	0.33	0.47	0.31	0.47	0.34	0.48
Fun	0.61	0.49	0.73	0.44	0.55	0.50
Spend time	0.44	0.50	0.49	0.50	0.39	0.49
N		1165		597		567

Table 3: Descriptive statistics of dependent variables.

<sup>a</sup>PA1: physical activity < 839.99 METs-min/wk; <sup>b</sup>PA2: physical activity 840-1559.99 METs-min/wk; <sup>c</sup>PA3: physical activity > 1560 METs-min/wk.

Variables	Boys			Girls		
	Underweight	Overweight	Obesity	Underweight	Overweight	Obesity
	Coefficient	SE <sup>c</sup>	Coefficient	SE <sup>c</sup>	Coefficient	SE <sup>c</sup>
PA2 <sup>a</sup>	-0.666*	0.403	-0.196	0.417	-0.894*	0.500
PA3 <sup>b</sup>	-0.256	0.303	0.350	0.355	-0.377	0.357
Age	0.014	0.138	-0.139	0.161	0.156	0.167
Paternal BMI	-0.095***	0.035	0.028	0.039	0.075*	0.040
Maternal BMI	-0.085**	0.038	0.007	0.019	0.004	0.020
Tutor class	0.065	0.271	0.163	0.319	-0.073	0.327
Father working	-0.620	0.443	-0.480	0.508	-0.148	0.575
Mother working	0.251	0.287	-0.287	0.316	0.268	0.357
Siblings	-0.037	0.483	-0.252	0.530	-0.540	0.504
Living with parents	-0.148	0.455	-0.244	0.552	-0.438	0.515
Income	0.063	0.296	-0.193	0.369	-0.470	0.401
Allowance	-0.305	0.266	0.269	0.332	-0.350	0.320
Active lifestyle	0.427	0.280	0.263	0.326	0.048	0.345
Accompaniment	-0.396	0.288	-0.128	0.337	0.286	0.335
Fun	0.080	0.301	-1.045***	0.316	-0.497	0.345
Spend time	-0.208	0.263	-0.013	0.310	-0.151	0.323
Intercept	4.057*	2.187	1.495	2.510	-3.501	2.644
N			421		405	
Pseudo R <sup>2</sup>			0.066		0.125	
Log likelihood			-488.87		-361.62	

Table 4: Results of multinomial logistic regression in boys and girls.

<sup>a</sup>PA2: physical activity 840-1559.99 METs-min/wk; <sup>b</sup>PA3: physical activity > 1560 METs-min/wk; SE: standard error \*p < .1; \*\*p < .05; \*\*\*p < .01.

Variables	Underweight		Overweight		Obesity	
	Coefficient	SE <sup>c</sup>	Coefficient	SE <sup>c</sup>	Coefficient	SE <sup>c</sup>
PA2 <sup>a</sup>	-0.410	0.260	-0.098	0.306	-0.818**	0.376
PA3 <sup>b</sup>	-0.280	0.218	-0.392	0.277	-0.530*	0.283
Age	0.172*	0.097	0.059	0.121	0.043	0.129
Paternal BMI	-0.106***	0.027	0.064**	0.032	0.095***	0.034
Maternal BMI	-0.102***	0.029	0.018	0.020	0.019	0.019
Tutor class	0.066	0.191	0.075	0.240	-0.150	0.253
Father working	-0.256	0.335	-0.348	0.388	-0.305	0.422
Mother working	0.147	0.203	-0.230	0.243	0.492*	0.296
Siblings	0.220	0.344	-0.340	0.372	-0.377	0.378
Living with parents	0.484	0.351	-0.033	0.408	-0.114	0.412
Income	0.209	0.212	-0.226	0.289	-0.557*	0.333
Allowance	-0.111	0.197	0.255	0.257	-0.258	0.255
Active lifestyle	0.394*	0.207	0.159	0.261	-0.309	0.304
Accompaniment	-0.121	0.200	0.003	0.255	0.507**	0.258
Fun	0.469**	0.204	-0.447*	0.243	-0.191	0.263
Spend time	-0.173	0.189	0.064	0.237	-0.107	0.254
Gender	0.215	0.191	0.956***	0.244	1.020***	0.265
Intercept	0.673	1.590	-3.845**	1.918	-4.459**	2.053
N				826		
Pseudo R <sup>2</sup>				0.071		
Log likelihood				-880.91		

Table 5: Results of multinomial logistic regression in all participants.

<sup>a</sup>PA2: physical activity 840-1559.99 METs-min/wk; <sup>b</sup>PA3: physical activity > 1560 METs-min/wk. <sup>c</sup>SE: standard error.

\*p < .1; \*\*p < .05; \*\*\*p < .01.

Variables	All			Boys			Girls		
	underweight	overweight	obesity	underweight	overweight	obesity	underweight	overweight	obesity
PA2 <sup>a</sup>	0.66	0.91	0.44**	0.51*	0.82	0.41*	0.81	1.17	0.48
PA3 <sup>b</sup>	0.76	0.68	0.59*	0.77	0.70	0.69	0.68	0.63	0.30**
Age	1.19*	1.07	1.04	1.01	0.87	1.17	1.46***	1.48**	0.72
Paternal BMI	0.90***	1.07**	1.11***	0.91***	1.03	1.08	0.87***	1.15**	1.12
Maternal BMI	0.90***	1.02	1.02	0.92**	1.01	1.00	0.89***	1.08	1.19***
Tutor class	1.07	1.08	0.86	1.07	1.18	0.93	1.06	0.96	0.90
Father working	0.77	0.71	0.74	0.54	0.62	0.86	1.63	0.96	0.27*
Mother working	1.16	0.79	1.63	1.28	0.75	1.31	0.99	0.89	2.83*
Siblings	1.25	0.71	0.69	0.96	0.78	0.58	1.52	0.67	1.09
Living with parents	1.63	0.97	0.89	0.86	0.78	0.65	3.92**	1.04	1.42
Income	1.23	0.80	0.57	1.06	0.82	0.63	1.52	0.86	0.35
Allowance	0.89	1.29	0.77	0.74	1.31	0.71	1.08	1.00	0.77
Active lifestyle	1.48	1.17	0.73	1.53	1.30	1.05	1.58	1.06	0.16*
Accompaniment	0.89	1.00	1.66**	0.67	0.88	1.33	1.09	1.01	2.62**
Fun	1.60	0.64*	0.83	1.08	0.35***	0.61	2.21***	1.62	1.09
Spend time	0.84	1.07	0.90	0.81	0.99	0.86	0.91	1.11	0.89
Gender	1.24	2.60***	2.77***						
N		826			421			405	

Table 6: The odds ratio of multinomial logistic regression in all participants, boys, and girls.

<sup>a</sup>PA2: physical activity 840-1559.99 METs-min/wk; <sup>b</sup>PA3: physical activity > 1560 METs-min/wk; <sup>c</sup>SE: standard error

\*p < .1; \*\*p < .05; \*\*\*p < .01.



level of more than 1560 METs-min/wk appeared to associate with a lower risk for obesity by 70% in girls. The most effective variable in girls was to maintain an active lifestyle, with an odds ratio of 2.62.

## Discussion

The results of this study indicated that 210 minutes of moderate physical activity per week, or 840 METs-min/wk, are associated with a lower risk for obesity and being underweight in boys. However, an additional 90-minute of vigorous physical activity per week, or a total of 1560 METs-min/wk, is associated with a lower risk for obesity in girls. The curriculum in most developed countries requires 2 to 3 physical education classes, a total of 90-135 minutes, each week. A meta-analysis revealed that students spent approximately 40-50% of the time in physical education classes engaging in moderate-to-vigorous activity [22]. Ideally, most adolescents could meet the guidelines of 210 minutes in schools by engaging in physical education and 150 minutes of physical activities outside regular classes.

It has been suggested that at least 46 minutes of moderate and 14 minutes of vigorous activity per day are required to reduce the risk for being overweight, while the same amount of moderate and 10 minutes of vigorous physical activity per day are required to reduce the risk for obesity [23]. Another study suggested that at least 67 minutes of moderate-to-vigorous physical activity daily are required for reducing the risk for being overweight and obese in boys, and 57 minutes for girls [24]. These cutoff levels are very close to the guidelines of 60 minutes of moderate-to-vigorous physical activity per day issued by North American and European countries. However, this study indicated that a lower level of physical activity is still sufficient for reducing the risk for obesity and being underweight in boys. With the global difficulty in meeting the WHO guidelines [13], the lower guidelines may provide a more practical, yet still effective, goal for policy implementation.

The gender differences in the effect of physical activity and weight categories in this study were also reported elsewhere [25,26]. Generally, boys tended to be at higher risk for being overweight and obese, to have a higher level of physical activity, and to have unhealthier diet behaviors than girls. The differences were the results of complicated biological, social, and cultural factors [27]. The higher physical activity level that was related to a lower risk for obesity in girls may be impractical in intervention programs as only 28% of the girls in this study met that level. Our results showed that engaging in exercise with the aim of maintaining a physically active lifestyle, after controlling for the physical activity level, is associated with a lower risk for obesity by 83.6% in girls. Therefore, it may be more effective to emphasize an active lifestyle rather than the total amount of physical activity in girls in order to prevent obesity.

In addition to physical activity, many factors such as diet, sedentary behavior, and sleep, also contribute to the development of obesity and health [11]. Among these intercorrelated factors, high physical activity was the most consistently associated with desirable physiological and psychological health indicators in youth [28]. The Youth Risk Behavior Surveillance Survey also revealed that physical inactivity led to increased odds of being obese in boys and girls, regardless of TV time and sleep duration [29].

Another interesting finding is that having a physical activity level above 840 METs-min/wk is strongly associated with a reduction in the risk for being underweight in boys by almost 50% (odds ratio = 0.51).

It is possible that sufficient physical activity can build more muscles and increase the appetite in adolescent boys. Another possibility is that boys who engage in sufficient physical activity have a healthier body image of themselves and would not focus on excessive thinness [30].

This study has several limitations. First, body weight and height were self-reported by the participants. Despite the possibility of underreporting, self-reported heights and weights still provide extremely reliable classification of weight status while saving time and money in large-scale data collections. Second, body image was not investigated but could be an important factor for being underweight, especially in adolescent girls. Third, the information on height and body weight of the parents and household income provided by the participants may not be reliable. The physical activity levels of parents, reported by the parents themselves or measured objectively, could also be included in future models. Lastly, due to the cross-sectional study design, our findings do not provide a causal interpretation on the relationship between physical activity and the risk for unhealthy weight status.

## Conclusions

Our results showed that 210 minutes of moderate physical activity per week was associated with a lower risk for obesity and being underweight in boys. On the other hand, emphasizing the importance of a physically active lifestyle may be more effective in preventing obesity in girls. Although it has been suggested that at least 420 minutes of moderate-to-vigorous physical activity per week are required to reduce the risk for being overweight and obese in western countries, this study provides the evidence for a more practical, yet still effective, goal for policy implementation in the Asian region. Such guidelines may be more applicable in high-income Asia-Pacific countries where the current physical activity levels in children and adolescents are among the lowest in the world [13].

## Competing Interests

The authors declare that they have no competing interest.

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