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# Factors Associated with Body Mass Index among Junior High School Students

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## ABSTRACT

Overweight and obesity in adolescents have adverse consequences on premature mortality and physical morbidity in adulthood. In Indonesia, the prevalence of overweight or obesity among adolescents is higher than was predicted. Gaining a better understanding of overweight/obesity and its gender specified correlates will provide the recommendation of the best way to control body weight among adolescents. This study aimed to investigate the factors associated with the BMI between males dan females junior high school students. This cross sectional study used data from a school health survey in eight junior high schools which were selected using cluster random sampling and included 590 students aged 11 to 16 years old. Multinomial logistic regression was used to analyze the association between the related factors and the BMI. The result showed that more females (66.7%) were underweight than males (58.6%), but fewer females (3.5%) than males (7.2%) were overweight or obese. Among male students, active school transport was associated with being underweight (OR: 3.34; 95% CI: 1.737 – 6.431), while adequate fruits consumption was associated with smaller odds of being overweight/obese (OR: 0.24; 95% CI: 0.097 – 0.838). No association was found among females. Active school transport and adequate fruit consumption might help male students in junior high schools had lower BMI than female students.

**Keywords**: body mass index; physical activity; sedentary behavior; diet; adolescents

## INTRODUCTION

Obesity and overweight have become a global pandemic faced by all level income countries, including Indonesia as one of the mega-countries facing the rising prevalence of overweight and obesity among children, adolescents, and adults [1, 2]. Indonesia also has the highest rate (12%) of overweight/obesity in children under five years compared to other southeast Asian countries [3]. It has long been observed that overweight or obesity in children tends to remain for the next ages. Around 55% of children with obesity are predicted to be adolescents with obesity and the higher number of adolescents with obesity (80%) will also persistent to be obese when they are adults [4]. In Indonesia, the prevalence of overweight or obesity among adolescents age 13-15 years old is 10.8% (comprises of 8.3% overweight and 2.5% obesity), even more than 55% of the predicted prevalence [5]. Overweight and obesity in adolescents have adverse consequences on premature mortality and physical morbidity in adulthood [6]. Helping adolescents to gain their normal weight is an investment in preventing more severe problems during adulthood.

Many studies suggested that physical activity, sedentary behaviors, and diet are strongly related to overweight and obesity [7-9]. Those three are also the most easily modified factors among adolescents, especially for Indonesian students as around 78.4% of adolescents are participating in Junior High Schools [10]. Finding students' daily habits related to the factors that potentially protect them from being overweight or obese will help the schools provide appropriate health promotion and prevention for their students.

Related to physical activity, students in some parts of Indonesia regions may still be benefited from the traditional mode of transportation to/from school. While generally the traditional mode of transportation such as walking or cycling to/from school (also known as active school transport) have been replaced by motorized transports (passive mode), many junior high school students in Pekalongan, a city in Central Java, still rely on this traditional school transports. There is strong evidence for the association between active school transport and higher physical activity [11], but there is still unclear evidence about the association between active school transport and body weight status. A systematic review investigated the impact of active school transport on the indicators of body composition [11]. Twenty-two of the 38 studies found no BMI differences between active and passive travelers while only 13 studies found that active travelers had lower BMI. They found a conflicting result and very low-quality evidence on the association between active school transport and body composition indicators.

However, a previous systematic review [12] reported that 11 of 23 studies have shown that active school transport was associated with lower body fat. The more recent study that investigated the relationship between active school transport and adiposity indicators among children aged 9-11 years concluded that active school transport was associated with lower body mass index [13]. Another study also investigated the influence of gender on the association between active school transport and weight status among adolescents [14]. They reported that the association was only found in the males' population. To our knowledge, no further study investigates the gender differences on the association between active school transport and weight status among adolescents, but there was an investigation on the other factor such as fruit and vegetable consumption.

Fruits and vegetables which are rich in water and fiber are potentially slow the weight gain in overweight adults reported in a systematic review, but the effect among children or adolescents was still unclear [15]. A study among adolescents reported that vegetable consumption was associated with a lower risk of being overweight and obese in males only [16]. Among females, another study reported that fruit and vegetable intake was not associated with central adiposity measured using waist circumference [17].

The findings indicated that different factors may be associated with body mass index between males and females adolescents. To the best of our knowledge, there has been no published research on the factors influencing body mass index of adolescents by gender in Indonesia. A better understanding of body mass index and its gender specified factors will provide the recommendation of the best way to control body weight. This study aimed to investigate the factors associated with the BMI between males and females junior high school students.

## METHODS

### Subject

This cross sectional study used data from a school health survey performed on junior high school students in Pekalongan City from June to August 2016. The survey adopted the concept from Global School Health Survey (GSHS) which was developed by the World Health Organization (WHO) in collaboration with United Nations' UNICEF, UNESCO, and UNAIDS; and with technical assistance from CDC [18]. GSHS is a school-based survey conducted primarily among students aged 13–17 years. It uses a self-administered questionnaire to obtain data on young people's health behavior and protective factors related to the leading causes of morbidity and mortality among children and adults worldwide, including Indonesia.

In the present survey, the schools were selected using cluster random sampling from four regions of Pekalongan (west, north, east, and south). One public school and one private school were randomly selected in each region. Thus, 8 of 38 schools were invited to participate in the survey. Similar to Indonesia GSHS, only students in their second and third year (equal to grade 8 and grade 9) were included in the survey. For each school, the classes (both grade 8 and 9) were chosen by the schools. All students belong to the selected classes were included in the survey. Following the informed consent, as many as 590 students participated in the survey.

### Measurement

The data were obtained from a self-administered questionnaire derived from GSHS questionnaires. The GSHS questionnaires have been translated into the appropriate language of instruction for the students and pilot tested for comprehension, including in Bahasa Indonesia. Permitted by WHO, the survey used GSHS Questionnaire in the Bahasa Indonesia version.

*Demographic Information.* Students' age, sex, and grade were obtained using self-report. The students were asked to state how old they are in the range age of 11-16 years old. Sex was categorized into female and male; while grade was categorized into grade 8 and 9. The schools were categorized into public and private.

*Body Mass Index (BMI).* Body mass index (BMI) was derived as the ratio of weight in kilograms and height in meters squared (kg/m2). Students' weight and height were based on self-reports. The BMI classification in this study follows the WHO definition of overweight, obesity, and thinness for children aged between 5-19 years. Overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median (equivalent to BMI 25 $kg/m^2$), while obesity is greater than 2 standard deviations above the WHO Growth Reference median (equivalent to BMI 30 $kg/m^2$), while thinness (here is classified as underweight) for BMI less than 2 standard deviations below the WHO Growth Reference median [19]. Then, students with BMI values of $\leq$ 18.5 $kg/m^2$ were classified as underweight, BMI value of 18.5-24.9 $kg/m^2$ were classified as normal weight, BMI values of 25-29.9 $kg/m^2$ were classified as overweight, and students with BMI values of $\geq$ 30 $kg/m^2$ were classified as obese. Due to the small number of overweight and obese students, we pooled both categories into one category.

*Physical Activity*. Physical activity was measured using three questions asking the number of days of being active and walking/riding a bicycle. The students were asked how many days during the past 7 days they were active for a total of at least 60 minutes per day. The same question was also used to assess total active days during a typical or usual week. The possible answer was 0 days, 1 day, 2 days to 7 days. The physical activities were categorized into "low" (0-4 days) or high (5-7 days). They were also asked how many days during the past 7 days they walked or ride a bicycle to/from school (active school transport) with a yes/no response.

*Sitting Activities*. The students were asked how much time they spend during a typical or usual day sitting and watching television, playing computer games, talking with friends, or doing other sitting activities such as playing play station. The possible answer was less than 1 hour per day, 1 to 2 hours per day, 3 to 4 hours per day, 5 to 6 hours per day, 7 to 8 hours per day, more than 8 hours per day. The sitting activities were categorized into "low" (0-3 hours per day) or "high" (>3-7 hours per day).

*Fruits Consumption and Vegetable Consumption.* The participant was asked how many times per day during the past 30 days they usually eat fruit, such as pineapple, papaya, banana, or watermelon? They were also asked for vegetable consumption such as carrot, cabbage, spinach, or kale. As recommended by the Indonesia Ministry of Health that minimum fruits consumption was 2 times a day and vegetable consumption was 3 times a day, the fruit consumption was classified into "less adequate" (less than 2 times/day) and "adequate" (2 or more times/day). The vegetable consumption was classified into "less adequate" (less than 3 times/day) or "adequate" (3 or more times/day).

**Data Analysis**

Univariate statistics (frequency and percentage) were computed for describing the character of the students and the related variables. The Chi-square test was applied to analyze the different characteristics, physical activity, fruit consumption, vegetable consumption, and BMI prevalence among the students based on gender. All the related factors then were tested using the Spearman correlation test to check any collinearity between independent variables, resulted in that grade was correlated with age (p-value <0.05) and physically active during the past 7 days was correlated with physically active in usual weeks (p-value <0.05). Therefore, grade and physical activity during the past 7 days were excluded from the multivariate analysis.

Multivariate analysis was performed using multinomial logistic regression to analyze the association between BMI as the dependent variable and the related factors, controlled with the demographic factors (table 2). Additional multinomial logistic regression was performed to analyze the gender-specific outcomes. All statistical analysis was performed using SPSS version 16 (SPSS Inc., Chicago, IL).

## RESULTS

The characteristic of the students was shown in table 1. More female students (58.1%) participated in this study, and more females also (61%) aged 13 years old or younger compared to males (48.8%). Equal gender of students was studying in public and private schools. Overall, the prevalence of underweight was 63.2%, while the prevalence of overweight or obesity was 5.5%. The percentage of female students underweight (66.7%) are higher compared to males (58.6%), but fewer females (3.5%) than males (7.2%) for overweight or obesity. The majority of the students were physically active every day (76.7% of males; 82.1% females). Both females and males also had an equal proportion (65.2% males; 66% females) of walking or cycling to/from school. However, a higher proportion of males (48.3%) spent three hours or more on sitting activities than females (38.9%). More than half of students had inadequate fruits consumption, and more males (73.7%) had inadequate vegetable consumption than females (63.2%).

Table 1. Sample characteristics based on gender ( N= 590)

| | Total Students | Male - N (%) | Female - N (%) | p |
|---|---|---|---|---|
| Age | | | | |
| ≤ 13 years old | 328 (55.8) | 120 (48.8) | 208 (61) | 0.003 |
| ≥ 14 years old | 260 (44.2) | 126 (51.2) | 133 (39) | |
| School type | | | | |
| Public | 280 (47.5) | 119 (48.4) | 161 (47.2) | 0.781 |
| Private | 310 (52.5) | 127 (51.6) | 180 (52.8) | |
| BMI | | | | |
| Underweight | 321 (63.2) | 130 (58.6) | 190 (66.7) | 0.067 |
| Normal weight | 161 (27.3) | 76 (34.2) | 85 (29.8) | |
| Overweight or obese | 26 (5.1) | 16 (7.2) | 10 (3.5) | |
| Physically active every day | | | | |
| High | 465 (79.9) | 188 (76.7) | 276 (82.1) | 0.108 |
| Low | 117 (20.1) | 57 (23.3) | 60 (17.9) | |
| Active school transport | | | | |
| Yes | 383 (65.7) | 159 (65.2) | 223 (66) | 0.839 |
| No | 200 (34.3) | 85 (34.8) | 115 (34) | |
| Sitting activities | | | | |
| High | 250 (43) | 117 (48.3) | 132 (38.9) | 0.024 |
| Low | 332 (57) | 125 (51.7) | 207 (61.1) | |
| Fruits consumption | | | | |
| Adequate | 243 (42.1) | 89 (36.9) | 154 (46) | 0.30 |
| Inadequate | 334 (57.9) | 152 (63.1) | 181 (54) | |
| Vegetable consumption | | | | |
| Adequate | 188 (32.4) | 64 (26.3) | 124 (36.8) | 0.008 |
| Inadequate | 393 (67.6) | 179 (73.7) | 213 (63.2) | |

Table 2 shown the association between investigated variables and BMI among all the students. Controlled by all variables, active school transport was significantly associated with being underweight (OR: 1.85; 95% CI: 1.255-2.788), while adequate fruit consumption was associated with lower odds of being overweight or obese (OR: 0.23; 95% CI: 0.097-0.838). The fit model (table 3) which included only the males' subgroup revealed a stronger association between these two variables and BMI, as the model could explain 22.7% of the variance of the BMI (compare to only 9.7 % among total students). The male students who walked or cycled to/from school were more likely to be underweight than the other male students who did not (OR: 3.34; 95% CI: 1.737 – 6.431), and those among male students who had adequate fruits consumption also were less likely to be overweight/obese (OR: 0.24; 95% CI: 0.097 – 0.838). No association was found in the female subgroup model.

Table 2. Multinomial logistic regression analyses among total participants (N = 590)

| | Underweight | | | Overweight or obese | | |
|---|---|---|---|---|---|---|
| | OR | p-value | 95% CI | OR | p-value | 95% CI |
| Physically active usual week | | | | | | |
| High | 0.88 | 0.62 | 0.525 – 1.472 | 0.54 | 0.53 | 0.077 – 3.789 |
| Low (ref) | | | | | | |
| Active school transport | | | | | | |
| Yes | 1.85 | 0.003 | 1.255 – 2.788 | 0.44 | 0.29 | 0.108 – 1.779 |
| No (ref) | | | | | | |
| Sitting activities | | | | | | |
| High | 0.738 | 0.14 | 0.493 – 1.105 | 0.47 | 0.25 | 0.130 – 1.692 |
| Low (ref) | | | | | | |
| Fruits consumption | | | | | | |
| Adequate | 0.85 | 0.44 | 0.557 – 1.291 | 0.23 | 0.023 | 0.097 – 0.838 |
| Inadequate (ref) | | | | | | |
| Vegetable consumption | | | | | | |
| Adequate | 0.90 | 0.65 | 0.582 – 1.404 | 1.69 | 0.28 | 0.646 – 4.428 |
| Inadequate (ref) | | | | | | |

Data were adjusted for age and school type. Model Pseudo R2 = 0.097

Table 3. Multinomial logistic regression analyses among male subgroup (N=246)

| | Underweight | | | Overweight or Obese | | |
|---|---|---|---|---|---|---|
| | OR | p-value | 95% CI | OR | p-value | 95% CI |
| Physically active usual week | | | | | | |
| High | 1.67 | 0.28 | 0.650 – 4.308 | 0.54 | 0.53 | 0.077 – 3.789 |
| Low (ref) | | | | | | |
| Active school transport | | | | | | |
| Yes | 3.34 | < 0.001 | 1.737 – 6.431 | 0.44 | 0.29 | 0.108 – 1.779 |
| No (ref) | | | | | | |
| Sitting activities | | | | | | |
| High | 0.69 | 0.26 | 0.368 – 1.304 | 0.47 | 0.25 | 0.130 – 1.692 |
| Low (ref) | | | | | | |
| Fruits consumption | | | | | | |
| Adequate | 0.70 | 0.29 | 0.370 – 1.352 | 0.12 | 0.014 | 0.022 – 0.649 |
| Inadequate (ref) | | | | | | |
| Vegetables consumption | | | | | | |
| Adequate | 0.85 | 0.65 | 0.414 – 1.740 | 1.70 | 0.44 | 0.440 – 6.597 |
| Inadequate (ref) | | | | | | |

Data were adjusted for school type. Model Pseudo R2=0.227
Female (Model Pseudo $R^2$=0.053 with no significant association between variables)

## DISCUSSION

The present study investigated the factors associated with the BMI among representative samples of junior high school students in Pekalongan City. Among 590 students who participated in the survey, there were only 5.1% of students with overweight or obese. This number is far below the overweight/obesity prevalence of adolescents in the general Indonesia population which reached 10.8% (comprises of 8.3% overweight and 2.5% obesity) [(5)], but not far different from the overweight/obesity percentage (5.4%) of the people aged 15 years old or above visited the primary health centers in Pekalongan City [(20)]. Unfortunately, the official data did not cover people aged below 15 years old or above, further comparison for adolescents cannot be done. The low prevalence of overweight/obesity among adolescents in Pekalongan City may be due to the higher physical activity and/or the lower intake of nutrition, as was found in the students' characteristics in this study.

This study revealed that only among male students, active school transport was associated with being underweight. This finding corroborated the previous study [(14)] suggested that active transport were associated with lower BMI among adolescents based on the longitudinal finding. Consistent with the present study, the previous study also found no association between active school transport and BMI among females [(14)]. Without specifying the gender, another study also reported the association between cycling to school with lower BMI and lower odds of being overweight or obese, while walking was associated with lower odds of being overweight [(21, 22)]. Considering the equal proportion of active scool transport of both genders, a possible reason explaining the finding of the present study is that males and females may have a different need for physical activity level (such as

moderated vs vigorous activities) or a different type of activities on the same level to reduce their BMI. Further investigation of the different needs of physical activities among males and females is required.

Unexpectedly, this study did not find the association between active school trasnport and BMI in the group of students with overweight or obesity. The result was may due to the small number of students with overweight or obesity which results in low effect size. This cross-sectional study was also unable to interpret the direction of causation, whether active school transport helped reducing BMI or the underweight students were more likely to walk or cycling than the overweight or obese students.

This study also did not find the association between sitting activities and BMI among either male or female students. This result is not consistent with the others studies [9, 23] which indicated that sedentary behavior was associated with overweight or obesity. However, the result of the present study supported the previous study [16] reported that sedentary behaviors by spending time in television watching or working on the computer were not associated with obesity in either gender among adolescents. The finding may suggest that the risk of being overweight/obese caused by sitting activities can be minimalized by the other protective factors (such as increasing physical activities or healthy dietary behavior).

Concerning fruits consumption, only in the males' group, a significant association was found between adequate fruit consumption with lower odds of being overweight or obese. Similar but in the opposite way, the previous study suggested that a low frequency of fruit consumption was associated with being overweight [24]. However, the association was not found in the females' group nor between vegetable consumption and BMI. A similar finding was also reported by other study that vegetable consumption was associated with a lower risk of being overweight and obese in boys only [16]. These findings support the previous study [25] suggested that fruit consumption was the more accurate predictor for BMI than vegetable consumption as they found a negative relationship between fruit consumption and BMI (for older children and adults), but not with vegetable consumption. However, further prospective studies need to be addressed to investigate the effect of fruit and vegetable consumption in relation to BMI change among male and female adolescents.

Considering the small number of overweight or obese students in this study, further studies with a larger sample are needed to investigate the risk factors of overweight and obesity among adolescents. The result of this study suggested that there were different risk factors of being underweight, overweight, or obese among male and female students; then more variables are also needed to capture more variances of the BMI among males and females separately. Including sugar-sweetened foods and drinks into research is another suggestion for further study as these foods or drinks are well known as the predictors of BMI change.

## CONCLUSION

This study was designed to investigate the factors associated with the BMI among junior high school students; only active school transport and fruits consumption had an association with the BMI among male students. The findings of this study support the conclusion that walking or cycling can be used as a moderate physical activity that can help to reduce the BMI of male students in junior high schools. Adequate fruit consumption can also help male students to prevent being overweight or obese.

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