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# Obesity and Hypertension among School-going Adolescents in Peru

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**Background:** Adolescent obesity and hypertension are global public health issues. The burden of adolescent obesity and hypertension in Peru is unclear. The aim of this study was to determine the prevalence of obesity and hypertension and their relationship among school-attending adolescents and to assess the need for health-promoting school programs in the study area.

**Methods:** A cross-sectional school-based survey was conducted in a randomly selected sample of 952 secondary school adolescents from 11 schools in Lima or Callao, Peru, in 2014. Weight, height, and blood pressure (BP) were measured and categorized. Obesity was defined as $\geq 95^{th}$ percentile in body mass index (BMI) for age and sex. Hypertension was defined as average systolic blood pressure and/or diastolic blood pressure $\geq 95^{th}$ percentile in BP for sex, age, and height. Chi-square test and univariate logistic regressions were used at a 5% significance level to determine the relationship between BMI and BP category.

**Results:** The mean age of subjects was 14.6 years; 46.4% were boys and 53.6% were girls. The prevalence of overweight and obesity was 20.2% and 9.5% overall, 17.4% and 11.1% for boys, and 22.5% and 8.0% for girls, respectively. The prevalence of hypertension was 26.7% overall, 34.8% for boys, and 19.6% for girls. In both sexes, BMI was strongly associated with BP ($p < 0.01$).

**Conclusion:** The prevalence of obesity and hypertension observed in the study area is relatively high. Overweight and obesity are strongly associated with BP status among adolescents. Health-promoting school programs may reduce the burdens of obesity and hypertension among school-going adolescents.

**Key Words:** Obesity, Hypertension, Adolescent, School health, KOICA, Peru

## INTRODUCTION

Non-communicable diseases (NCD) killed 38 million people globally in 2012, accounting for 68% of total annual death; and cardiovascular diseases alone were responsible for 17.5 million deaths in the year [1]. Hypertension is a major risk factor of cardiovascular disease [1-3]. The global prevalence of high blood pressure in adults is approximately 22%, and high blood pressure is estimated to cause 9.4 million deaths annually [1,2]. Recent studies have indicated that high blood pressure is also becoming an issue for children and adolescents, although it has historically been considered a disease of adults [4-6]. Obesity is an important modifiable risk factor for prevention of a large number of

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NCDs, including hypertension [1,2]. Globally, 39% of adults older than 18 years in 2014 were overweight, and 13% were obese [7]. In recent decades, the prevalence of childhood obesity has become an important global health concern [8-10].

Obesity increases the risk of cardiovascular diseases among school-attending children and adolescents [11,12]. Overweight status and low physical activity in adolescents are also associated with metabolic disorders, including insulin resistance and lipid profile alteration [13]. In addition, childhood obesity and hypertension are associated with a number of adult non-communicable diseases and conditions, such as obesity, hypertension, cardiovascular diseases, diabetes, and premature death [7,14-17]. Cardiovascular risk factors, including hypertension, are highly prevalent in Latin America [18]. In Peru, NCDs are estimated to account for 66% of total deaths, and cardiovascular diseases alone cause 22% of all deaths [19]. According to national estimates, 15.7% of Peruvian adults in 2008 were obese, and 21.0% had high blood pressure [20]. A study in Peru found that 8% of boys and 3.3% of girls were obese [21]. However, the burden of obesity and hypertension among Peruvian school students is unknown, as only a small number of studies have examined these issues. Moreover, schools are considered suitable places for the screening of obesity and hypertension and for promoting a healthy lifestyle to prevent and control obesity and hypertension among children and adolescents [22]. To promote health through schools, the World Health Organization (WHO) has made recommendations to schools, including education regarding critical health and life skills [23].

Thus, the objective of this study was to determine the prevalence of overweight, obesity, and hypertension and to examine the relationship between obesity and hypertension among Peruvian school-going adolescents. In addition, this study aims to assess the need for health-promoting school programs in the study area.

## MATERIALS AND METHODS

### 1. Study design, population, and sampling

A cross-sectional school-based survey was conducted among school-going adolescents. The field study was conducted from September 15 to October 31, 2014, in collaboration with Korea International Cooperation Agency (KOICA), Peru office. The survey was conducted in one district of Lima (Comas) and two districts of Callao (Bellavista and Ventanilla). Three areas from Comas (Santa Luzmila II, Laura Rodriguez Dulanto, and Carlos Philips), one area from Bellavista (Bellavista), and two areas from Ventanilla (Pachacutec and Mi Peru) were selected for the survey. The target population was secondary school students. Of 17 secondary schools in the study areas, 11 were randomly selected for the survey. Five secondary grade levels were considered as strata. One stratum from each school and students from each stratum were selected randomly. Samples from each school were chosen using proportionate simple random sampling technique. Total calculated sample size was 975 using the following formula: $m = [Z^2 \times V \times M] / [d^2 (M - 1) + Z^2 \times V] \times (def) \times (tnr)$, where m is students to be estimated, Z is value of the normal distribution (Z = 1.96), P is prevalence is  of smoking or alcohol among school students [24]. (p = 0.23), $V = P \times Q$ (Q = 1 − P = 0.77), M is total number of students in the study area (M = 14,787), d is margin of error (d = 0.0307), def is clustering effect of the distribution of estimates (def = 1.2), and tnr is an adjustment factor due to non-response (tnr = 1.18). A total of 981 students were randomly selected and invited to participate in the study. Of those invited to participate, 5 did not complete the questionnaire items about socio-demographics or were absent on the day of information collection. During analysis, data from 18 participants were excluded due to missing values or inconsistent information.

### 2. Instrumentation and procedure

Socio-demographic characteristics were assessed using an anonymous self-administered questionnaire. Trained enumerators provided questionnaires to the randomly selected students in their classrooms during regular school hours. Teachers and school staff were not allowed in the classroom during information collection. After the questionnaire was completed, anthropometric features and blood pressure were measured. Eight registered nurses were assigned to measure blood pressure (BP), and 8 nutritionists collected the anthropometrics of all randomly selected students. Weight and height were measured with a digital scale and extensometer, respectively. BP was measured in all subjects with a validated

automatic blood pressure monitor (Omron HEM-7113, Omron Corporation, Kyoto-Shi, Japan). For analysis, measured BP was categorized according to the standard for age, sex, and height. Prehypertension was defined as systolic blood pressure (SBP) and/or diastolic blood pressure (DBP) greater than or equal to the 90$^{th}$ percentile but less than the 95$^{th}$ percentile; hypertension was defined as SBP and/or DBP greater than or equal to the 95th percentile of BP for age, sex, and height [25]. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. BMI was classified based on its distribution by sex and age according to the growth chart developed by the Center for Disease Control and Prevention into underweight (less than the 5$^{th}$ percentile), normal (greater than or equal to the 5$^{th}$ percentile and less than the 85$^{th}$ percentile), overweight (greater than or equal to the 85$^{th}$ percentile and less than the 95$^{th}$ percentile), and obese ($\geq$ the 95$^{th}$ percentile) [26].

### 3. Ethical considerations

Ethical approval for this study was obtained from the Institutional Review Board of Wonju Campus, Yonsei University (1041849-201410-BM-048-02) and the DIRESA Callao (local government of Peru). Prior consent was obtained from each school administration. Informed consent was obtained from parents/guardians prior to study enrollment. Informed consent was obtained from individual participants, and an anonymous questionnaire was used.

### 4. Data analysis

Data were entered and analyzed using SPSS for Windows, version 21. The prevalence of overweight, obesity, and hypertension were presented as frequencies. The Chi-square test was conducted to examine the association between BMI and BP category. To determine the relationship between BMI and BP level, BP was categorized into two groups, normal and elevated (those with prehypertension or hypertension). Odds ratios were calculated to examine the relationship between elevated BP and BMI categories using univariate logistic regression analysis. BMI status was also categorized into two groups, normal BMI and elevated BMI (overweight and obese students). Prevalence of elevated BP and elevated BMI was calculated by sex, age group, and area, and associations were observed according to p-values at a 95% confidence interval (CI).

## RESULTS

### 1. Anthropometric measurements, BP and BMI categories by sex

Table 1 summarizes anthropometric outcomes and distribution of blood pressure and BMI status among survey

**Table 1.** Anthropometric measurements, BP and BMI categories by sex

| Outcome measure | Boys [n = 442 (46.4%)] | | Girls [n = 510 (53.6%)] | | Total (n = 952) | |
|---|---|---|---|---|---|---|
| | Mean | ± SD | Mean | ± SD | Mean | ± SD |
| Age (years) | 14.6 | 1.6 | 14.5 | 1.5 | 14.6 | 1.6 |
| Weight (kg)* | 56.5 | 11.3 | 52.6 | 9.6 | 54.4 | 10.6 |
| Height (cm)* | 160.6 | 8.2 | 153.3 | 5.9 | 156.7 | 7.9 |
| BMI (kg/m$^2$) | 21.6 | 3.6 | 22.3 | 3.6 | 22.1 | 3.6 |
| Systolic BP (mmHg)* | 122.1 | 13.7 | 113.2 | 12.4 | 117.3 | 13.8 |
| Diastolic BP (mmHg) | 65.0 | 10.2 | 64.5 | 10.0 | 64.8 | 10.1 |
| BMI | N | % | N | % | N | % |
| Underweight | 8 | 1.8 | 6 | 1.2 | 14 | 1.5 |
| Normal | 308 | 69.7 | 348 | 68.2 | 656 | 68.9 |
| Overweight | 77 | 17.4 | 115 | 22.5 | 192 | 20.2 |
| Obese | 49 | 11.1 | 41 | 8.0 | 90 | 9.5 |
| Blood pressure | | | | | | |
| Normal | 245 | 55.4 | 364 | 71.4 | 609 | 64.0 |
| Prehypertension | 43 | 9.7 | 46 | 9.0 | 89 | 9.3 |
| Hypertension | 154 | 34.8 | 55 | 19.6 | 128 | 26.7 |

BMI: body mass index, BP: blood pressure, SD: standard deviation, N: number. *significant difference ($p < 0.05$).

respondents by sex. Of the 952 subjects included in this study, 46.4% were boys and 53.6% were girls. Participant age range was 12-18 years (mean ± SD, 14.6 ± 1.6). The mean weight in kg (56.53 ± 11.31 vs. 52.60 ± 9.55), height in cm (160.57 ± 8.18 vs. 153.34 ± 5.87), and SBP in mmHg (122.07 ± 13.72 vs. 113.22 ± 12.40) were higher in boys than in girls. In total, 20.2% and 9.5% of participants were overweight and obese, respectively. The prevalence of overweight and obesity was 17.4% and 11.1% among boys and 22.5% and 8.0% among girls, respectively. Overall, 9.3% and 26.7% of students had prehypertension and hypertension, respectively. The prevalence of hypertension was 34.8% among boys and 19.6% among girls.

## 2. BMI and BP

Table 2 shows the distribution and associations of blood pressure by sex and BMI status. The prevalence of hypertension in boys and girls was 29.5% and 16.1% for normal weight subjects, 45.5% and 25.2% for overweight subjects, and 55.1% and 36.6% for obese subjects, respectively. The relationship between BMI and BP was statistically significant in both boys and girls ($p < 0.01$).

## 3. Elevated BP and BMI

Table 3 shows the prevalence of elevated BP by sex, age, BMI status, and study area. Boys were more likely to have elevated blood pressure than girls [(44.6% vs. 28.6%); OR, 2.00; CI 1.53-2.62]. The prevalence of elevated BP among age groups was very similar. Overweight and obese students had a greater chance of having elevated BP [(OR, 1.69; CI, 1.22-2.36 for overweight subjects) and (OR, 2.98; CI, 1.90-4.68 for obese subjects)]. The prevalence of elevated BP was lowest in Santa Luzmilla II (15.3%) and highest in Mi Perú (54.5%). Table 4 shows the prevalence of elevated BMI by sex, age group, and study area. The prevalence of elevated BMI was slightly lower among boys (29% vs. 31%)

**Table 2.** Distribution and association of blood pressure by BMI and sex (N = 938)

| Sex, BMI level | Normal BP N (%) | Pre-hypertension N (%) | Hypertension N (%) |
|---|---|---|---|
| Boys* | | | |
| Normal weight | 185 (60.1) | 32 (10.4) | 9 (29.5) |
| Overweight | 35 (45.5) | 7 (9.0) | 35 (45.5) |
| Obese | 18 (36.7) | 4 (8.2) | 27 (55.1) |
| Girls† | | | |
| Normal | 265 (76.1) | 27 (7.8) | 56 (16.1) |
| Overweight | 73 (63.5) | 13 (11.3) | 29 (25.2) |
| Obese | 20 (48.8) | 6 (14.6) | 15 (36.6) |

*Chi square, 16.58, $p < 0.01$, †Chi square, 17.63, $p < 0.01$.

**Table 3.** Elevated BP by sex, age, BMI, and study area

| Variable (n = 952) | Normal BP [N (%)] | Elevated BP [N (%)] | p-value |
|---|---|---|---|
| Sex* | | | |
| Boys | 245 (55.4) | 197 (44.6) | <0.001 |
| Girls | 364 (71.4) | 146 (28.6) | |
| Age in years | | | |
| 12-13 | 181 (65.1) | 97 (34.9) | |
| 14-15 | 234 (62.4) | 141 (37.6) | 0.477 |
| 16-18 | 194 (64.9) | 105 (35.1) | 0.955 |
| BMI level† | | | |
| Normal | 450 (68.6) | 206 (31.4) | |
| Overweight | 108 (56.3) | 84 (43.8) | 0.002 |
| Obese | 38 (42.2) | 52 (57.8) | <0.001 |
| Study Area | | | |
| Bellavista | 125 (71) | 51 (39) | |
| Laura Rodríguez | 80 (65.6) | 42 (34.4) | 0.319 |
| Carlos Philips | 83 (62.9) | 49 (37.1) | 0.132 |
| Santa Luzmilla II | 116 (84.7) | 21 (15.3) | 0.005 |
| Pachacutec | 144 (57.4) | 107 (42.6) | 0.004 |
| Mi Perú | 61 (45.5) | 73 (54.5) | <0.001 |

*OR, 2.00; CI, 1.53-2.62, †[(OR, 1.69; CI, 1.22-2.36 for overweight and (OR, 2.98; CI, 1.90-4.68 for obese)].
OR: odds ratio, CI: confidence interval.

**Table 4.** Elevated BMI by sex, age, and study area

| Variable (n = 938) | Normal BMI [N (%)] | Elevated BMI [(N (%)] | p-value |
|---|---|---|---|
| Sex | | | |
| Boys | 308 (71.0) | 126 (29.0) | 0.523 |
| Girls | 348 (69.0) | 156 (31.0) | |
| Age (in years) | | | |
| 12-13 | 164 (60.3) | 108 (39.7) | <0.000 |
| 14-15 | 269 (72.3) | 103 (27.7) | 0.302 |
| 16-18 | 223 (75.9) | 71 (24.1) | |
| Study Area | | | |
| Bellavista | 111 (64.2) | 62 (35.8) | |
| Laura Rodríguez | 89 (73.6) | 32 (26.4) | 0.090 |
| Carlos Philips | 86 (66.2) | 44 (33.8) | 0.719 |
| Santa Luzmilla II | 89 (65.0) | 48 (35.0) | 0.884 |
| Pachacutec | 188 (76.1) | 59 (23.9) | 0.008 |
| Mi Perú | 93 (71.5) | 37 (28.5) | 0.176 |

and was highest among participants aged 12-13 years (39.7%) and lowest among those aged 16-18 years (24.1%). The prevalence of elevated BMI was highest in the Bellavista area (35.8%) and lowest in the Pachacutec area (23.9%).

## DISCUSSION

The present study found a higher prevalence of obesity (9.5%) relative to the results of previous studies focused on different locations, such as South East Nigeria (1.9%) [27], Portugal (5.3%) [6], South Iran (7%) [28], India (4.8%) [29], and China (4.1% and 8.7%) [30,31]. However, a similar prevalence of obesity was found in Nigeria (9.4%), and a higher prevalence was observed in Nepal (11.3%) [32,33]. In contrast, a study conducted in South China revealed that more than one-third of students were underweight [34]. Similar to our study, a higher prevalence of obesity was found among boys [6,29,30].

The current study observed a higher prevalence of hypertension, 26.7% of the study population, which is an alarming situation, particularly when compared with the prevalence reported by previous studies in other locations. The rate of adolescent hypertension was nearly equal to the national estimate of adult hypertension rates in Peru and far higher than the rate observed in a study of Peruvian adolescents [20,21]. In contrast to the present study, a prevalence ranging from 5.2% to 17.2% has been reported in other studies: 5.4% in southeast Nigeria [27], 8.12% in Brazil [5], 9.8% in Portugal [6], 11.8% in southern Iran [28], 12% in Nepal [35], and 17.2% in Israel [36]. In the present study, 34.8% of boys and 19.6% of girls had hypertension. A similar pattern was noted among Brazilian and Chinese children and adolescents [5,37]. In contrast, other studies have reported a higher prevalence of hypertension among girls relative to boys [6,21,27,35].

In the present study, BMI level was significantly associated with hypertension in both boys and girls. Overweight students were 1.6 times more likely and obese students were 2.9 times more likely to have elevated blood pressure. Evidence of obesity as a risk factor of adolescent hypertension has been documented by numerous studies conducted in varied geographical and socioeconomic contexts [21,27,31,34,36-41]. Limited exercise and sedentary lifestyle lead to obesity in school children and adolescents [42]. A similar prevalence of elevated BMI was observed in six different study areas, with the highest prevalence in the Bellavista area. Unlike elevated BMI, elevated BP varied greatly among the study areas, with the highest in the Mi Perú area. The area-wide variation in prevalence of hypertension requires further study in order to determine the specific risk factors present in these areas.

Obesity and hypertension monitoring and other specific measures are needed to prevent and control disease among children and adolescents [5,27]. School health programs should incorporate periodic screening and monitoring of blood pressure of students [27]. However, in a comprehensive model, screening programs alone are not sufficient to prevent health problems; many intervention studies of childhood obesity prevention have stressed the importance of holistic implementation of school health programs [22, 43-46]. The World Health Organization (WHO), in its action plan for the prevention and control of non-communicable diseases, has recognized schools as an important sector for the reduction of modifiable and preventable risk factors of non-communicable diseases [47]. Physical inactivity, harmful use of alcohol, tobacco consumption, and unhealthy diet are preventable and modifiable risk factors of non-communicable diseases [47]. School-based interventions such as nutrition, physical and lifestyle education, and physical activity promotion has the greatest impact on the prevention and reduction of childhood obesity-related problems [43,45,46,48]. As childhood obesity is the result of multiple factors, including socio-economic, cultural, and environmental factors, multi-level approaches that address individual factors, community characteristics, and governmental influences are essential [46,48]. As a result, school-based interventions that combine behavioral and environmental approaches to dietary intake and physical activity, as well as involvement of family and community, are necessary to promote and sustain healthy lifestyles. In addition, policy interventions are recommended to support healthy lifestyles for children and families [45-48].

## CONCLUSIONS

This study found relatively high prevalence of overweight, obesity, and hypertension among school-going adolescents in Peru. The prevalence of elevated BP was significantly higher among overweight and obese adolescents. Obesity prevention activities may help to reduce the burden of hypertension and other related disorders. It is essential to have health-promoting school programs to address the issues of obesity and hypertension among school-going adolescents in Peru.

This study indicates that obesity and hypertension among adolescents are serious public health issues. School administrations should consider the great burden of these problems and initiate coordinated efforts in all concerned sectors to conduct regular screening programs and other health-promoting school activities. In an effort to reduce the burdens of obesity and hypertension among children and adolescents, as well as adults, prevention and control activities should be incorporated into curricula, school environments, and activities. Schools, as principal institutions for the socialization of children, are ideal settings for these programs not only because children spend most of their time in school, but also because they are in a unique position to promote healthy lifestyles and prevent lifestyle-related problems [22,42,43]. Moreover, the Ministry of Health, the Ministry of Education, and other national and international organizations should initiate and support school development into health-promoting settings. A variety of evidence-based measures to reduce obesity and related problems among students can be successfully implemented in school settings [42,44,45,47]. Based on these findings, the KOICA and Yonsei Global Health Centre have developed health-promoting school programs for three years in the study areas. These programs include health screening and counseling on risk factors, nutrition education, physical education, and provision of mini gym facilities in schools to address these problems and promote better health among students and staff.

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