Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i2.4576

PREVALENCE OF BODY MASS INDEX AND ITS ASSOCIATION WITH INTERPERSONAL FAMILY-LEVEL FACTORS AMONG SCHOOL-AGED CHILDREN AND ADOLESCENTS IN PAKISTAN

Moazzam Tanveer[1*], Umar Tanveer[2], Asifa Zeba[3] and Maximilian Siener[4]

[1*]School of Physical Education and Sport Training, Shanghai University of Sport, Shanghai 200438, China; *moazzam12146@gmail.com (M.T.);*
[2]Department of Mass Communication, University of Lahore, Lahore, Pakistan;
[3]Department of Education, International Islamic University, Islamabad, Pakistan;
[4]Department of Training Science & Kinesiology, BaySpo – Bayreuth Centrum of Sport Science, University of Bayreuth, Bayreuth, Germany;

[*]**Corresponding Author:** Moazzam Tanveer
*E-mail: moazzam12146@gmail.com (M.T.)

Abstract

Background: Underweight, overweight and obesity are one of the biggest issues of the 21st century. Small and medium income countries are particularly affected by these risks. Therefore, it is surprising that the last study on the situation in Pakistan was conducted 10 years ago. An update on the BMI of Pakistani students and possible reasons is therefore highly needed.

Methods: A cross-sectional study was conducted to investigate the prevalence of body mass index (BMI) among 4,201 Pakistani students. The results were analyzed using chi-square tests and logistic regression analysis to explore the association between BMI and various demographic and family-level factors, elucidating weight status.

Results: One in five children in the study exhibited underweight (23%), while overweight and obesity were diagnosed in 5.5% and 5.6% of Pakistani schoolchildren, respectively. Significant associations were found between weight status and socio-demographic characteristics such as gender, school type, age, and family-level factors including the number of siblings and parents' job nature. However, neither educational status nor parental income showed significant effects on the risks of underweight, overweight, or obesity.

Conclusions: The prevalence of underweight, overweight, and obesity in Pakistan surpasses that of many other countries, with only 65% of children achieving a normal BMI status. Particularly concerning is the worsening situation regarding underweight. However, these findings provide valuable insights for establishing targeted intervention programs aimed at improving nutrition and increasing physical activity, especially among vulnerable student groups.

Keywords: BMI, Pakistan, Children, Adolescents, Socio demographic, SES, Obese, CDC-US 2000

1. Introduction

Obesity in children is a difficult problem to solve.[1] Due to the harmful effects on children's health, well-being, and growth, obesity and physical inactivity in children and adolescents have become a global public health issue.[2-3] Obesity in children is one of the most pressing public health concerns of the twenty-first century, affecting every country. Obesity has more than tenfold increased among school-aged children and adolescents in recent decades.[4-5] and is associated with numerous of demographic risk factors.[6,7,8]

In 2004, the World Health Assembly in Geneva called for immediate action to combat the disease, which has expanded across developing countries, including Pakistan, and is largely impacting the affluent urban population.[9-10] About 40 million children under the age of five – 6.7% of the global population [11,12] – and almost 340 million children and adolescents aged 5 to 19 were overweight or obese in 2020 [13,14]. Obesity is becoming more prevalent in every country.[15] Both (overweight and obesity) were also on the rise in low- and middle-income countries. The problem is particularly prevalent in regions where obesity was previously thought to be a problem only in high-income countries and where people are therefore ill-prepared to deal with such issues.[16] Rural increases in BMI, on the other hand, accounting for more than 55% of the global increase in mean BMI between 1985 and 2017—and more than 80% in some low- and middle-income regions.[17-18] Obesity-related illnesses attack them more frequently.[19]

Pakistan is a low- and middle-income country [20] It is placed 92nd out of 116 countries, having a major hunger problem, [21] and is dealing with the twin issues of over-nutrition and poor nutrition. Pakistan is ranked tenth out of 188 countries in terms of obesity, with 50% of the population overweight or obese. In Pakistan, the frequency of early mortality linked to being overweight in both males and girls has steadily increased over time.[22] By 2030, the World Obesity Federation estimates that 5.4 million Pakistani school-aged children would be obese.[23] According to the WHO Diabetes country profiles, Pakistan has failed to adopt an operational policy to tackle overweight and obesity, as well as physical inactivity, according to the WHO Diabetes country profiles.[24] Compared to China,[2,3,25] Italy,[8,26] America,[7,27,28,29] Brazil,[30] India,[31] Saudi Arabia,[32] Cyprus,[33] and Poland [34] very few data on BMI of school children and adolescents are available for Pakistan. The only study on Pakistani school-aged children was published in 2011 by Mushtaq et al[9]. Despite the modest research that has been done on the topic, there is still a gap in this context.

The most international studies are covering primary schools or bigger cities.[35,41-42] In addition, many studies focused only on urban [9,16,19] or rural areas,[18,30,31] a few on public and private schools,[54,57] gender [32] or age.[36,45] Hardly any study considers all these factors at once and thus background and causation are lacking.[9,35,41-42]. As a result, actual baseline data is needed to estimate the prevalence of obesity and also underweight among Pakistani school-aged children and adolescents.[9,35] These findings can then be used to target interventions to reduce the risk of underweight, overweight, and obesity in Pakistani school children.

Therefore, the aim of this study was to determine the distribution of underweight, overweight, and obesity among Pakistani children and adolescents and to evaluate the influence of socio-demographic characteristics on these weight statuses.

2. Methods

2.1 Study design, setting, and participants

In the summer of 2023, a cross-sectional study was conducted among school-aged children and adolescents from Pakistan's Punjab Region (the sampling procedure involved administrative cities and districts, towns, and local community districts that represented a mix of rural and urban areas). School children aged 9–11 years old and adolescents aged 12–17 years old took part in this study.[27] In total, 4,201 participants and their parents or guardians (N = 3,406) from 85 schools volunteered for this study.

2.2 Measurements

Rescue-1122 professionals conducted anthropometric measurements of body weight and height in the classroom setting. Following the measurements, students completed a paper-based survey questionnaire within the classroom environment. For students in lower grades, the questionnaire was read aloud in English. Additionally, parents and guardians were welcomed to the schools, where they were required to complete an additional questionnaire.

2.2.1 Weight status

Body weight was measured to the nearest 0.1 kg and body height to the nearest 0.5 cm.[36] Trained rescue professionals took all of the measurements. The digital CERTEZA weight machine *(https://www.certeza-medical.com)* to measure body weight to the nearest 0.1 kg was used. Body height and weight both dimensions were taken from students wearing light summer school uniforms without shoes and without a cap with correct standing position during early mornings or early in the afternoons. A SECA scale *(https://www.seca.com/patents)* was used for the measurements of body height.

2.2.2 The demographics and socioeconomic status (SES)

The student self-report questionnaire includes the categories: public or private schools, school levels (primary school [grades 4–5], middle school [grades 6–8], secondary school [grades 9–10], and higher secondary school [grades 11–12]), gender, age, Religion (Muslim or Non-Muslim), and residence location (urban or rural). Information on socioeconomic status (SES) was collected using the parent questionnaire. It was divided into the categories: Siblings (single child, two children, three children, four children, five or more), Guardians education level (low education level [consisting of: illiterate, five years schooling, eight years schooling, ten years schooling] & high education level [consisting of intermediate, Graduate, Postgraduate]), Guardians occupation (Civil servant, Private job, Own business, Daily laborer), Family living (Single-family, Joint family), and Family's income (Pakistani currency [PKR]: ≤ 9,000 PKR [low SES], 9,000–300,000 PKR [middle SES], and > 300,000 PKR [high SES]).

The questionnaire has been used in previous international studies and has a reliability for school-aged children of $\alpha = 0.78$ (Cronbach's alpha).[2 ,37]

2.3 Statistical Analysis

IBM SPSSv.26 Statistical Analysis was used to analyze the data. The statistical significance was determined using $p < 0.05$.

BMI was calculated by dividing a person's body weight in kilograms by their height in meters squared (kg/m^2). Underweight, normal weight, overweight, and obesity classifications were based on BMI percentiles of the CDC-US 2000 for children and adolescents between the ages of 2 and 20[38]. The weight status categories were set as follows: Underweight (BMI <5th percentile), healthy weight (5th < BMI <85th percentile), overweight (85th ≤ BMI < 95th percentile), and obese (BMI ≥ 95th percentile).[39,38]

For the present prevalence of body mass index (underweight, healthy weight, overweight, and obesity), a frequency distribution analysis was performed. A chi-square test was used to compare the prevalence of body mass index (dependent variable) with demographic and interpersonal parameters[40] The simultaneous influence of SES factors on the body weight status was estimated using a binary logistic regression analysis.[2] Odds ratios (OR) within a 95% confidence intervals (CI) were calculated.

3. Results

The figure 1 illustrates the prevalence of body weight status among Pakistani school-aged children and adolescents (N = 4,201), with the following distribution: underweight n = 965 (23.0%), healthy weight n = 2,768 (65.9%), overweight n = 236 (5.6%), and obesity n = 232 (5.5%).

The distribution of demographic factors within the four possible weight groups is shown in **Table 1**. The risk of underweight is more common for boys (26.6%) than for girls (18%). The fact that Pakistani boys have a lower age-related BMI than girls is also seen in the values of overweight and obesity. Here, girls have higher percentages than boys. The differences found between boys and girls are significant on average across all four weight status groups.

Age also has a significant influence on the distribution within the four weight groups. Thus, younger children tend to have a comparatively lower risk of overweight and obesity than older children, but at the same time the risk of underweight is slightly higher at younger ages.

The relationship between place of residence and weight status of students shows significant correlations overall. The problem of underweight is greater among students in urban areas (24.8%) than among students in rural areas (20.2%). Overweight and obesity is more prevalent among urban students (5.8% and 6.1%, respectively) than rural area students (5.3% and 4.7%, respectively). On the other hand, what tended to have only a significant effect on the four weight groups was the religion. The correlation between religion and weight status is $p = 0.086$. Nevertheless, the non-Muslim children show significantly higher values than Muslim children, especially in the borderline areas (obesity and underweight). However, these case numbers of this religion group are very small.

The problem of underweight was greater in public school students (24.0%) than in private school students (19.6%). Overweight and obesity are also a greater problem in private schools (8.6% and 6.1%) than in public schools (4.7% and 5.3%). The results regarding the four different school class types show a similar picture which was already evident from the different age groupings. Students in higher school grades tend to be significantly less underweight, but have a higher risk of being overweight. The age-related BMI thus shifts upward with increasing age and higher grades.

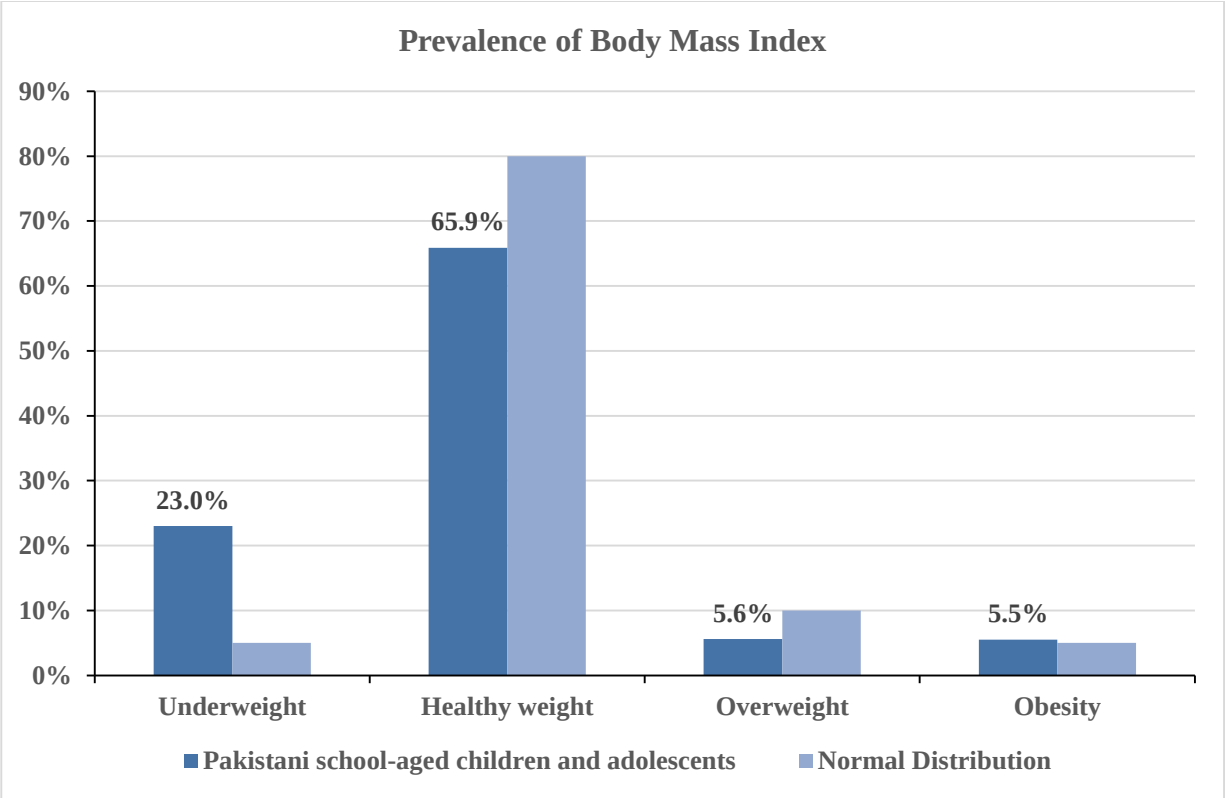

Figure 1. Descriptive Statistics analysis for Prevalence of body mass index among Pakistani school-aged children and adolescents (N = 4,201: Underweight n = 965, Healthy weight n = 2,770, Overweight n = 234, and obesity n = 232).

Table 1. Chi-square test to compare the prevalence of body weight status with demographic parameters (gender, age, residence, religion, school type, and school level)

Characteristics	*Body Mass Index*					
	Under Weight *n (%)*	**Healthy Weight** *n (%)*	**Over Weight** *n (%)*	**Obesity** *n (%)*	χ^2	**P-value**
Gender[1]						
Boys	650 (26.6)	1566 (64.0)	117 (4.8)	115 (4.7)	50.60	0.001
Girls	315 (18.0)	1202 (68.6)	119 (6.8)	117 (6.7)		
Age[2]						
Children (9-11)	185 (23.7)	535 (68.4)	37 (4.7)	25 (3.2)	11.71	0.008
Adolescent (12-17)	780 (22.8)	2233 (65.3)	199 (5.8)	207 (6.1)		
Residence[3]						
Urban	622 (24.8)	1585 (63.3)	146 (5.8)	152 (6.1)	19.61	0.001
Rural	343 (20.2)	1183 (69.8)	90 (5.3)	80 (4.7)		
Religion[4]						
Muslim	922 (22.8)	2667 (66.0)	233 (5.7)	220 (5.4)	6.59	0.086
Non-Muslim	43 (27.0)	101 (63.5)	3 (1.9)	12 (7.5)		
School-type[5]						
Public	776 (24.0)	2136 (66.0)	153 (4.7)	173 (5.3)	26.95	0.001
Private	189 (19.6)	632 (65.6)	83 (8.6)	59 (6.1)		
School-level[6]						
Primary	253 (29.2)	550 (63.6)	35 (4.0)	27 (3.1)	50.98	0.001
Middle	352 (21.7)	1100 (67.9)	88 (5.4)	79 (4.9)		
Secondary	264 (21.2)	80x6 (64.7)	77 (6.2)	98 (7.9)		
Higher Secondary	96 (20.3)	312 (66.1)	36 (7.6)	28 (5.9)		
Total	965 (23.0)	2770 (65.9)	236 (5.6)	232 (5.5)		

Looking at the distribution of the weight statistics regarding the different results of the parent questionnaire (**Table 2**.), it is noticeable that only the two items "number of children in the family" (p=0.037) and "job nature" (p=0.041) become significant in the chi-square test. The three variables education level (p=0.466), family income (p=0.168) and family living situation (p=0.811) turn out to be non-significant.

With increasing number of siblings, the chance of suffering from underweight is higher than in families with few children. The fact that children in families with few children have a comparatively higher age-related BMI is also reflected in the number of cases of overweight and obesity. Here, as well, children in these two groups are more often found in families with fewer number of children. On average, the risk of being underweight increases by 0.5% with each additional child in the family, and the risk of suffering from overweight or obesity decreases by 1.5%.

The results in the weight status of children whose parents had different levels of education were almost identical. The chi-square test was accordingly non-significant.

Parents' income does affect the distribution of underweight and overweight - for example, children of very low-income parents are more likely to be underweight than children of high-income parents, who in turn are more likely to be overweight - but the results of the chi-square test are not significant (p=0.168).
Also, the family living situation of the children had no direct influence on the weight groups in the test.

Table 2. Chi-square test to compare the prevalence of body weight status and parental parameters (family income, family living, siblings, parental job, and parental education)

Characteristics	*Body Mass Index*				χ^2	P-value
	Under Weight *n (%)*	**Healthy Weight** *n (%)*	**Over Weight** *n (%)*	**Obesity** *n (%)*		
Siblings[7]						
Single child	44 (22.9)	118 (61.5)	17 (8.9)	13 (6.8)		
Two children	46 (22.7)	125 (61.6)	15 (7.4)	17 (8.4)		
Three children	130 (22.5)	370 (64.1)	40 (6.9)	37 (6.4)	22.09	0.037
Four children	204 (23.6)	571 (66.2)	40 (4.6)	48 (5.6)		
Five or more children	378 (24.1)	1053 (67.0)	74 (4.7)	66 (4.2)		
Parental education[8]						
Low education level	512 (23.7)	1429 (66.0)	108 (5.0)	115 (5.3)	2.55	0.466
High education level	290 (23.3)	808 (65.1)	78 (6.3)	66 (5.3)		
Parental job nature[9]						
Government servant	178 (27.1)	423 (64.4)	32 (4.9)	24 (3.7)		
Private job	154 (25.6)	377 (62.6)	29 (4.8)	42 (7.0)	17.53	0.041
Own business	233 (21.2)	745 (67.2)	62 (5.6)	61 (5.5)		
Daily laborer	237 (22.7)	692 (66.2)	63 (6.0)	54 (5.2)		
Socioeconomic status (SES)[10]						
Low SES	513 (23.2)	1479 (66.9)	110 (5.0)	109 (4.9)		
Middle SES	230 (25.2)	576 (63.0)	56 (6.1)	52 (5.7)	9.10	0.168
High SES	59 (21.0)	182 (64.8)	20 (7.1)	20 (7.1)		
Family living[11]						
Single family	492 (23.9)	1345 (65.4)	115 (5.6)	105 (5.1)	0.96	0.811
Joint family	310 (23.0)	892 (66.1)	71 (5.3)	76 (5.6)		
Total	802 (23.5)	2237 (65.7)	186 (5.5)	181 (5.3)		

Binary logistic regression can be used to determine which (demographic) factors have a direct influence on the risk of being underweight or overweight/obese. However, the two analyses only achieve a low model quality (Nagelkerke's $R^2 \approx 0.05$). Nevertheless, the calculated odds ratios (OR) give an impression of which factors have a significant effect (and in which magnitude) on the corresponding risks in weight status.

For example, gender (boys coded 0, girls coded 1) has a significant influence on both the risk of underweight[1] and the occurrence of overweight/obesity[2]. Also, the age[3] and the grade[4] of the students has a significant effect on the occurrence of underweight. The variable school type (public coded 0, private coded 1) only tends to be significant in the regression analysis with respect to underweight[5]. However, a significant value is seen in the analogous analysis for overweight/obesity[6]. If the factors of the parenting questionnaire are considered, it can be seen that for both the occurrence of underweight and overweight/obesity, the two variables "number of children/siblings" and "job nature"[7,8] achieve significant results. Accordingly, the chance of suffering from underweight is higher for children with many siblings[9] than for single children or children with only a few siblings. This is also associated with the higher risk of children with few siblings suffering from overweight/obesity[10]. While the education level of the parents has no significant influence on the occurrence of

[1] $p = 0.001$, $X^2 = 30.968$, OR = 0.609, 95% Confidence Interval (CI) 0.511–0.725
[2] $p = 0.001$, $X^2 = 20.139$, OR = 1.692, CI 1.345–2.128
[3] $p = 0.001$, $X^2 = 11.494$, OR = 1.162, CI 1.065–1.267
[4] $p = 0.001$, $X^2 = 19.272$, OR = 0.727, CI 0.636–0.841
[5] $p = 0.082$, $X^2 = 3.034$, OR = 0.873, CI 0.685–1.023
[6] $p = 0.008$, $X^2 = 7.052$, OR = 1.406, CI 1.093–1.807
[7] $p_{underweight} = 0.02$, $X^2 = 5.53$, OR = 0.91, CI 0.84–0.98
[8] $p_{overweight} = 0.02$, $X^2 = 5.36$, OR = 1.13, CI 1.02–1.26
[9] $p = 0.018$, $X^2 = 5.551$, OR = 1.090, CI 1.015–1.170
[10] $p = 0.001$, $X^2 = 27.98$, OR = 0.783, CI 0.716–0.857

underweight, there is a direct correlation between the education level and overweight/obesity[11]. All other factors are insignificant.

4. Discussion

The aim of this study was to determine the distribution of underweight, overweight, and obesity among Pakistani school-aged children and adolescents and to examine how the different risks depend on a number of important sociodemographic factors. This information is important for developing targeted community- and family-based policies and interventions.

The results of the present study show that only a total of 5.6% (4.8% of boys and 6.4% of girls) of Pakistani school children are overweight. In addition, 5.5% (4.8% of boys and 6.2% of girls) of all tested subjects are obese. Since the categories of overweight and obese are based on BMI percentile curves, it would be expected that approximately 10% of all school children are overweight and 5% are obese. While the percentage of obese children is approximated, the actual number of overweight children falls below the averages. This is surprising as another study among primary school students in Lahore found that 17% of children aged 5 to 12 were overweight and 7.5% were obese.[9] Another study conducted in 2013 also examined the weight of students in grades 6 to 10 through a survey in the Hyderabad metropolitan area. According to their findings, 14% of all students were overweight and 8% were obese[41]. A smaller study among school children aged 11 to 15 years in Karachi found that 19.1% of all children tested were overweight and 10.8% were obese.[35] The results of another local study conducted in 2018 in Multan on children aged 3 to 18 years, showed that 10% of students were overweight and 5% were obese.[42] These percentages in the last study are consistent with the normative values identified in the CDC-US 2000.[43]

However, the study results of the aforementioned studies predominantly included smaller subject numbers, local surveys, or were limited to children from metropolitan areas.

The fact that schoolchildren from metropolitan areas are more prone to overweight and obesity than children from rural areas was also demonstrated in our study. For larger cities such as Islamabad, it is to be expected that the gap between overweight and underweight will widen even further. Thus, it is also not surprising that the World Obesity Federation estimated in 2018 that 6.6% of Pakistani children are obese and 10.7% are overweight.[44] However, these data estimates are still comparatively low considering the numbers from other countries. For example, according to an article by Ogden et al, 15.5% of adolescents and 15.3% of children in the United States were overweight.[27] This value is 5% higher than the WHO estimate and even 10% more than in the results of the Punjab region presented here. Also, data from China show much higher percentages. For example, Cai et al. conducted a survey among Chinese school children aged 9 to 17 years. Overall, 14.4% of children and adolescents were overweight and 11.9% were obese.[2] This indicates that the risk of obesity is much more prevalent in industrialized nations than in low-income countries such as Pakistan. In these countries with lower Gross Domestic Product, on the other hand, the risk of underweight appears to be significantly higher. This is evidenced by the high incidence of underweight students in Punjab. The risk of students suffering from underweight seems to be very high in Pakistan. For example, the results show that every fourth boy of school age is underweight. Similar trends were also shown in studies by Mushtaq et al. (2012). They compared the BMI of children from Pakistan with the WHO and US CDC 2000 BMI benchmark tables, showing that the BMI of children from Pakistan is far below the reference values. These trends were also confirmed in the present results. However, the risk of underweight was significantly higher than previously expected.

The results of the logistic regression indicate that boys differ significantly from girls in terms of body weight status. Megan et al. came to the same results in Canadian children and indicated a significant relationship between body weight and gender.[45] Also, recent studies from India[46] and Bangladesh[47] found similar outcomes. However, there are other results as well. According to a study from Pakistan[35] and another from Ghana[48], body weight and gender did not show a significant

[11] $p = 0.01$, $X^2 = 6.586$, OR = 1.099, CI 1.022–1.180

relationship. However, the findings from Pakistan ($p = 0.063$) already tended to be significant ($p < 0.1$) and were just above the significance level ($p = 0.05$).

The results also show that, on the one hand, boys have a higher risk of suffering from underweight than girls and, on the other hand, the risk of overweight and obesity is higher in girls than in boys. This is surprising, as the results of some previous studies show that boys are more likely to be overweight than girls.[2,3,49,50,51,52]

Private school students showed significantly higher BMI than public school students in the chi-square test. This goes hand in hand with the results of a study from Lahore[9,53]. Here, too, the percentages of overweight and obese children from private schools were higher than those from public schools. However, the difference of up to 5% shown there could not be duplicated to this extent in our studies. Nevertheless, in other countries the relation is also reversed. For example, studies from India[54] show a slightly higher percentage for obesity for public school students (2.9%) than private school students (2.1%).

In addition to gender and school type, the characteristic values for the number of siblings also showed significant results. This confirms the findings of previous studies, according to which a single child is more likely to be obese while, on the other hand, two or more children were more likely to be underweight.[55]

The findings of previous studies[56] that underweight is more common in low-income families, while overweight is more common in high-income families, were not confirmed. Family circumstances were also insignificant, contrary to recent studies.[57]

The current study had a few limitations. We calculated students' BMI and utilized the CDC US 2000 BMI chart for both boys and girls to determine their weight status.[38] For older adolescents who participate in a gym routine maybe different technique should be used to determine their body weight status, e.g., body fat percentage.[2] BMI alone cannot represent body fat percentage, which may distort individual results of body weight status. However, this relates to only a very small proportion of the sample.

5. Conclusions

The risk of suffering from underweight is very high for Pakistani students. In total, one in four boys is affected by this risk. While underweight occurs significantly less in girls than in boys, their percentages are also significantly higher than the CDC-US 2000 averages. However, the prevalence of obesity is also average despite the seemingly low BMI of Pakistani students. These results shown cause for concern, as only 65% of all students have a comparatively normal body weight. A number of SES factors were found to have a direct impact on the weight status of students. The factors that stand out are gender, age, residency, type of school, number of siblings, and parents' job nature. Neither family income nor parents' Education status had a significant effect on health risks among Pakistani children. It is particularly important to protect the young age groups of students, who often find it difficult to provide for their own needs from a financial perspective. Interventions should therefore be planned on the basis of the findings and attempts should be made, for example, to improve the students' nutrition. However, only further scientific (longitudinal) studies can show whether the health of Pakistani schoolchildren will improve in the long term as a result of these interventions.

Ethics approval and consent to participate

The Shanghai University of Sport, Institutional Review Board authorized the study protocol [1816111009], and permission to conduct the study was acquired from the participating schools' teachers and principals. Everyone in the study, including the children and adolescents, as well as their parents or guardians, was assured that participation was completely voluntary. All parents or guardians gave their informed consent, and all children gave their positive assent, prior to data collection. The information was gathered and processed in an anonymous manner.

Consent for publication
Not applicable

Availability of data and materials
The corresponding author can provide the data and materials used in this work upon reasonable request

Competing interests
The authors declare that they have no competing interests.

Funding
Not applicable.

Authors' contributions
The study was planned and implemented by M.T. M.T and M.S drafted the manuscript; U.T and A.Z provided intellectual guidance in improving the manuscript; A.Z, M.T, U.T, and M.S. assisted in revising the manuscript; U.T. and A.Z. edited the final version of the manuscript. All authors reviewed and approved the final revised manuscript and agree on the authors' presentation order.

Acknowledgments
The authors wish to thank the children, parents, guardians, and teachers for their participation in this study. We owe the department of Rescue 1122 a great debt of gratitude for grant support for data collecting. We appreciate the education department grant Permission for data collecting, as well as the ISO Shanghai University of Sport employees, dean, vice dean, and directors. School of Physical Education and Sport Training, Shanghai University of Sport, Shanghai 200438, China, provided partial financial support.

Authors' information
(*M.T.*) Ph.D. Scholar School of Physical Education and Sport Training; (*A.Z.*) Ph.D. scholar International Islamic University, Islamabad Pakistan; (*U.T.*) The MPhil student university of Lahore, Lahore Pakistan; (*M.S.*) Research Assistant, Department of Training and Movement Science, BaySpo – Bayreuth Centrum of Sport Science, University of Bayreuth.

References

1 Skjåkødegård, H. F., Danielsen, Y. S., Frisk, B., Hystad, S. W., Roelants, M., Pallesen, S., Conlon, R., Wilfley, D. E., & Juliusson, P. B. (2021). Beyond sleep duration: Sleep timing as a risk factor for childhood obesity. *Pediatric obesity*, *16*(1), e12698.

2 Cai, Y., Zhu, X., & Wu, X. (2017). Overweight, obesity, and screen-time viewing among Chinese school-aged children: National prevalence estimates from the 2016 Physical Activity and Fitness in China-The Youth Study. *Journal of sport and health science*, *6*(4), 404–409.

3 Zhu, Z., Yang, Y., Kong, Z., Zhang, Y., & Zhuang, J. (2017). Prevalence of physical fitness in Chinese school-aged children: Findings from the 2016 Physical Activity and Fitness in China-The Youth Study. *Journal of sport and health science*, *6*(4), 395–403.

4 World obesity federation (2021, 09) https://*www.worldobesity.org/what-we-do/our-policy-priorities/childhood-obesity*

5 Haththotuwa, R. N., Wijeyaratne, C. N., & Senarath, U. (2020). Worldwide epidemic of obesity. In *Obesity and obstetrics* (pp. 3-8). Elsevier.

6 Tanveer, M., Hohmann, A., Roy, N., Zeba, A., Tanveer, U., & Siener, M. (2022). The current prevalence of underweight, overweight, and obesity associated with demographic factors among

Pakistan school-aged children and adolescents—An empirical cross-sectional study. *International Journal of Environmental Research and Public Health*, *19*(18), 11619.

7 Tanveer, M., Roy, N., Zeba, A., Haider, S., Albarha, N. S., Tanveer, N., ... & Tanveer, U. (2022). Prevalence of Body Mass Index and Associated with Demographic Factors among Pakistan School-Aged Adolescents. *Pakistan Journal of Medical & Health Sciences*, *16*(06), 212-212.

8 Pelusi, C., Altieri, P., Gambineri, A., Repaci, A., Cavazza, C., Fanelli, F., Morselli-Labate, A. M., Pagotto, U., & Pasquali, R. (2019). Behavioral, socio-environmental, educational and demographic correlates of excess body weight in Italian adolescents and young adults. *Nutrition, metabolism, and cardiovascular diseases : NMCD*, *29*(3), 279–289.

9 Mushtaq, M. U., Gull, S., Mushtaq, K., Shahid, U., Shad, M. A., & Akram, J. (2011). Dietary behaviors, physical activity and sedentary lifestyle associated with overweight and obesity, and their socio-demographic correlates, among Pakistani primary school children. *The international journal of behavioral nutrition and physical activity*, *8*, 130..

10 Tanveer, M., Tanveer, U., Afzal, M., Rana, N., Nagra, R., Anjum, W., & Haseeb, M. (2022). Community-Level Factors Associated with Body Mass Index Among Pakistani School-Aged Adolescents. *Pakistan Journal of Medical & Health Sciences*, *16*(09), 463-463.

11 Kilic, E., Özer, Ö. F., Erek Toprak, A., Erman, H., Torun, E., Kesgin Ayhan, S., Caglar, H. G., Selek, S., & Kocyigit, A. (2016). Oxidative Stress Status in Childhood Obesity: A Potential Risk Predictor. *Medical science monitor : international medical journal of experimental and clinical research*, *22*, 3673–3679.

12 De Sevilla, G. G. P., Lamana, R. Z., García-Merino, S., & Cuevas, I. C. Topic review Childhood Overweight and Cold Climates Subjects: Pediatrics View times: 16.

13 Danquah, F. I., Ansu-Mensah, M., Bawontuo, V., Yeboah, M., Udoh, R. H., Tahiru, M., & Kuupiel, D. (2020). Risk factors and morbidities associated with childhood obesity in sub-Saharan Africa: a systematic scoping review. *BMC nutrition*, *6*, 37.

14 World Health Organization. Obesity and overweight: Fact Sheet. 2020 Apr 01. *URL: https://www. who. int/news-room/fact-sheets/detail/obesity-and-overweight [accessed 2020-08-24]*.

15 Ford, N. D., Patel, S. A., & Narayan, K. M. (2017). Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges. *Annual review of public health*, *38*, 145–164..

16 Neuman, M., Kawachi, I., Gortmaker, S., & Subramanian, S. V. (2013). Urban-rural differences in BMI in low- and middle-income countries: the role of socioeconomic status. *The American journal of clinical nutrition*, *97*(2), 428–436.

17 NCD Risk Factor Collaboration (NCD-RisC) (2019). Rising rural body-mass index is the main driver of the global obesity epidemic in adults. *Nature*, *569*(7755), 260–264.

18 Tanveer, M., Tanveer, U., Tanveer, N., Roy, N., Zeba, A., & Razzaq, F. A. (2022). Parental Health Attitudes and knowledge Factors Associated with Body Mass Index among Pakistani School-Aged Adolescents. *Pakistan Journal of Medical & Health Sciences*, *16*(09), 479-479.

19 Al-Saeed, W. Y., Al-Dawood, K. M., Bukhari, I. A., & Bahnassy, A. (2007). Prevalence and socioeconomic risk factors of obesity among urban female students in Al-Khobar city, Eastern Saudi Arabia, 2003. *Obesity reviews : an official journal of the International Association for the Study of Obesity*, *8*(2), 93–99.

20 The World Bank (2021). Lower middle income data. *Retrieved from https://data.worldbank.org/country/XN*

21 Global hunger index (2021). Pakistan. *Retrieved from https://www.globalhungerindex.org › pakistan*

22 World Health Organization (2014). Noncommunicable Diseases (NCD) Country Profiles. Available from: *http://www.who.int/nmh/publications/ncd-profiles2014/en/*

23 Lobstein, T., & Brinsden, H. (2019). Atlas of childhood obesity. *World Obesity Federation*, 211.

24 World health organization (2016). Retrieved from *https://www.who.int/diabetes/country profiles/Pakistan*

25 Duan, J., Hu, H., Wang, G., & Arao, T. (2015). Study on Current Levels of Physical Activity and Sedentary Behavior among Middle School Students in Beijing, China. *PloS one*, *10*(7), e0133544.
26 Lazzeri, G., Azzolini, E., Pammolli, A., De Wet, D. R., & Giacchi, M. V. (2013). Correlation between physical activity and sedentary behavior with healthy and unhealthy behaviors in Italy and Tuscan region: a cross sectional study. *Journal of preventive medicine and hygiene*, *54*(1), 41–48.
27 Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA*, *295*(13), 1549–1555.
28 Multivariable two-sample Mendelian randomization estimates of the effects of intelligence and education on health DOI:
29 Ickovics, J. R., Duffany, K. O., Shebl, F. M., Peters, S. M., Read, M. A., Gilstad-Hayden, K. R., & Schwartz, M. B. (2019). Implementing School-Based Policies to Prevent Obesity: Cluster Randomized Trial. *American journal of preventive medicine*, *56*(1), e1–e11.
30 Dos Santos, F. K., Moura Dos Santos, M. A., Almeida, M. B., Nobre, I. G., Nobre, G. G., Ferreira E Silva, W. T., Gomes, T. N., António Ribeiro Maia, J., & Leandro, C. G. (2018). Biological and behavioral correlates of body weight status among rural Northeast Brazilian schoolchildren. *American journal of human biology : the official journal of the Human Biology Council*, *30*(3), e23096.
31 Dutta, K., Mukherjee, R., Das, R., Chowdhury, A., Sen, D., & Sahu, S. (2021). Scheduled optimal sleep duration and screen exposure time promotes cognitive performance and healthy BMI: a study among rural school children of India. *Biological Rhythm Research*, *52*(10), 1501-1513.
32 Effect of the Family Food Environment and Dietary Behaviors on Obese Children and Adolescents Article in Journal of Diabetes & Metabolism · January 2016 DOI: 10.4172/2155-6156.1000661
33 Charilaou, M., Karekla, M., Constantinou, M., & Price, S. (2009). Relationship between physical activity and type of smoking behavior among adolescents and young adults in Cyprus. *Nicotine & tobacco research : official journal of the Society for Research on Nicotine and Tobacco*, *11*(8), 969–976.
34 Czyż, S. H., Toriola, A. L., Starościak, W., Lewandowski, M., Paul, Y., & Oyeyemi, A. L. (2017). Physical Fitness, Physical Activity, Sedentary Behavior, or Diet-What Are the Correlates of Obesity in Polish School Children?. *International journal of environmental research and public health*, *14*(6), 664.
35 Mansoori, N., Nisar, N., Shahid, N., Mubeen, S. M., & Ahsan, S. (2018). Prevalence of obesity and its risk factors among school children in Karachi, Pakistan. *Tropical doctor*, *48*(4), 266–269.
36 Keykhaei, F., Shahraki, M., Sargolhosseinzadeh, E., Shahraki, T., & Dashipour, A. (2016). Correlation of Body Mass Index and Physical Activity Among 7- to 11-Year Children at Zahedan, Iran. *Food and nutrition bulletin*, *37*(3), 364–374.
37 Chen, S. T., Liu, Y., Tremblay, M. S., Hong, J. T., Tang, Y., Cao, Z. B., Zhuang, J., Zhu, Z., Wu, X., Wang, L., Cai, Y., & Chen, P. (2021). Meeting 24-h movement guidelines: Prevalence, correlates, and the relationships with overweight and obesity among Chinese children and adolescents. *Journal of sport and health science*, *10*(3), 349–359.
38 BMI, A. W. S. Stature Weight-for-age percentiles-for-age and. *AGE (YEARS)*, *16*(17), 18-19.
39 Kuczmarski, R. J., Ogden, C. L., Grummer-Strawn, L. M., Flegal, K. M., Guo, S. S., Wei, R., Mei, Z., Curtin, L. R., Roche, A. F., & Johnson, C. L. (2000). CDC growth charts: United States. *Advance data*, (314), 1–27.
40 Syahrul, S., Kimura, R., Tsuda, A., Susanto, T., Saito, R., & Ahmad, F. (2016). Prevalence of underweight and overweight among school-aged children and it's association with children's sociodemographic and lifestyle in Indonesia. *International Journal of Nursing Sciences*, *3*(2), 169-177.

41 Ahmed, J., Laghari, A., Naseer, M., & Mehraj, V. (2013). Prevalence of and factors associated with obesity among Pakistani schoolchildren: a school-based, cross-sectional study. *Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit*, *19*(3), 242–247.

42 Khan, S., Abbas, A., Ali, I., Arshad, R., Tareen, M. B. K., & Shah, M. I. (2019). Prevalence of overweight and obesity and lifestyle assessment among school–going children of Multan.

43 BMI, A. W. S. Stature Weight-for-age percentiles-for-age and. *AGE (YEARS)*, *16*(17), 18-19.

44 Global Obesity Observatory (2021). *Pakistan. https://data.worldobesity.org/country/pakistan-167/#data_prevalence*

45 Ames, M. E., Holfeld, B., & Leadbeater, B. J. (2016). Sex and age group differences in the associations between sleep duration and BMI from adolescence to young adulthood. *Psychology & health*, *31*(8), 976–992.

46 Nayak, B. S., & Bhat, V. H. (2011). Prevalence of overweight/obesity among school children in Karnataka, South India. *International Journal of public health Research*, *35*(1), 180-184.

47 Saha, M., Adhikary, D. K., Parvin, I., Sharma, Y. R., Akhter, F., & Majumder, M. (2018). Obesity and Its Risk Factors of among School Children in Sylhet, Bangladesh. *Journal of Nepal Health Research Council*, *16*(2), 205–208.

48 Adom, T., De Villiers, A., Puoane, T., & Kengne, A. P. (2019). Prevalence and correlates of overweight and obesity among school children in an urban district in Ghana. *BMC obesity*, *6*, 14.

49 Azmatulla, S., & Garg, R. (2021). A comparison study on the prevalence of obesity and its associated factors among school Children. *International Journal of Health and Clinical Research*, *4*(1), 21-24.

50 Ashtekar, S. V., Mantri, S. B., & Wadagale, A. V. (2014). Prevalence and epidemiology of overweight and obesity among Upper Primary School Children in Latur City. *Int Med J*, *1*, 15-9.

51 Bacardi-Gascón, M., Jiménez-Cruz, A., Jones, E., Velasquez Perez, I., & Loaiza Martinez, J. A. (2009). Trends of overweight and obesity among children in Tijuana, Mexico. *Ecology of food and nutrition*, *48*(3), 226–236.

52 Smolej Narancic, N., Zivicnjak, M., Škaric-Juric, T., Bišof, V., Barbalic, M., & Rudan, P. (2005). Overweight and obesity among children and adolescents in Zagreb Croatia. *Auxology. Savaria University Press, Szombathely*, 89-95.

53 Anwar, A., Anwar, F., Joiya, H. U., Ijaz, A., Rashid, H., Javaid, A., & Mehmood, M. (2010). Prevalence of obesity among the school-going children of Lahore and associated factors. *Journal of Ayub Medical College, Abbottabad : JAMC*, *22*(4), 27–32.

54 Abraham, R. J., & Pillai, P. C. (2019). Survey of obesity among school children in rural Kerala, India.

55 Moreira, S., & Gonçalves, L. (2020). Overweight and Obesity in Children of Immigrant Versus Native Parents: Exploring a Local Setting in Portugal. *International journal of environmental research and public health*, *17*(21), 7897.

56 Ghrayeb, F. A., Rusli, M., Al Rifai, A., & Ismail, M. (2013). Prevalence of overweight and obesity among adolescents in Tarqumia, Palestine. *Canadian Journal of Basic and Applied Sciences*, *1*(1), 49-57.

57 Vohra, R., Bhardwaj, P., Srivastava, J. P., Srivastava, S., & Vohra, A. (2011). Overweight and obesity among school-going children of Lucknow city. *Journal of family & community medicine*, *18*(2), 59–62.