Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i3.4706

# INTRAPERSONAL LEVEL UNHEALTHY BEHAVIORS (SMOKING, DRINKING ALCOHOL, AND TOBACCO USE) AND THEIR ASSOCIATION WITH BODY MASS INDEX AMONG SCHOOL-AGED CHILDREN AND ADOLESCENTS IN PAKISTAN

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**Abstract**

**Purpose:** The association between Unhealthy Behaviors (Smoking, Drinking Alcohol, and Tobacco Use) and body mass index (BMI) is a significant public health concern due to their roles as preventable risk factors for cardiovascular disease and various other conditions. Despite numerous previous studies, no consensus has emerged regarding the effect of Unhealthy Behaviors on BMI. Therefore, we conducted a novel study to evaluate the relationship between Unhealthy Behaviors and BMI in Pakistani school-aged children and adolescents aged 9 to 17 years.

**Methods:** A cross-sectional study was conducted involving 4108 Pakistani schoolchildren aged 9 to 17 years from 62 schools across seven districts in central Punjab province. Body mass index (BMI) categories were defined using the CDC US 2000 growth charts: underweight as < 5th percentile, overweight as > 85th to < 95th percentile, and obese as equal to or greater than the 95th percentile. The Chi-square test was employed to analyze categorical variables, and the Pearson correlation coefficient (r) was used to determine correlations. 95% confidence intervals (CI) were calculated, and statistical significance was set at $p < 0.05$.

**Results:** The prevalence of weight, overweight, and obesity among the participants was 19.4%, 10.7%, and 10.7%, respectively. Smoking within the last 7 days showed an odds ratio (OR) of 1.79 (95% CI: 0.91-3.55) for overweight status, while the use of tobacco products other than cigarettes demonstrated an OR of 1.61 (95% CI: 1.03-2.52) for overweight. Drinking alcohol within the last 7 days was associated with an OR of 2.78 (95% CI: 0.43-5.05) for obesity. Witnessing someone smoke in front of students for three or more days was associated with an OR of 0.90 (95% CI: 0.76-1.07) for overweight. Additionally, having a father or male guardian who smokes showed higher odds ratios for overweight, with an OR of 1.21 (95% CI: 1.02-1.44).

**Conclusion:** This study sheds light on the alarming prevalence of overweight and obesity among Pakistani school-aged children and adolescents, emphasizing the need for urgent intervention. Nonetheless, it is reassuring to find relatively low rates of smoking and alcohol consumption within this demographic. The majority of students are not involved in these unhealthy behaviors, and importantly, no significant associations were observed between these behaviors and weight status. These findings underscore the effectiveness of ongoing initiatives aimed at promoting healthy lifestyles and discouraging smoking and alcohol consumption among young individuals.

**Keywords:** Obesity; Overweight; Children and Adolescents; Body Mass Index; Unhealthy Behaviors; Smoking, Drinking Alcohol, And Tobacco Use

## 1. Introduction

Smoking and obesity pose significant public health challenges. Smoking is linked to an increased risk of cardiovascular diseases, cancer, and respiratory illnesses [1], while obesity is associated with numerous comorbidities, including type 2 diabetes, cancer, and cardiovascular diseases [2]. Central obesity, as measured by waist circumference (WC), is recognized as a more accurate predictor of various health issues related to obesity, such as hypertension, diabetes, and cardiovascular diseases, compared to traditional obesity defined by body mass index (BMI) [3]. Over the years, excess body weight during childhood and adolescence has emerged as one of the most serious public health problems globally [4]. Childhood obesity has reached epidemic proportions, both in high and low-income countries, with the number of overweight and obese children having doubled or even tripled since 1970 [5]. According to the World Health Organization (WHO), in 2016, 18% of children and adolescents aged 5–19 years were overweight and obese worldwide, while significant geographical variations in obesity rates were noted [6]. Most importantly, overweight and obesity have important short and long-term adverse consequences on physical, mental, and emotional health of the child and future adult.[1] Understanding the factors contributing to overweight and obesity during childhood and adolescence has become increasingly important, as these behaviors and habits are formed early in life but also have the potential to be modified, albeit with difficulty, in the future. Furthermore, addressing obesity and weight loss during adulthood is much more challenging, especially after the age of 35 [7].

The relationship between smoking and obesity presents a significant public health concern due to their shared risk factors for cardiovascular disease and other health conditions. However, consensus regarding this association remains elusive. Findings from the World Health Organization Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) Project suggested that regular smokers generally exhibit lower body mass index (BMI) compared to never-smokers [8]. Similarly, a cross-sectional study in the United Kingdom indicated a lower likelihood of obesity among current smokers compared to never-smokers [9]. Nevertheless, conflicting evidence exists, with some studies failing to establish a significant correlation between BMI and smoking status [10]. Moreover, certain studies have even suggested an association between smoking and central obesity rather than obesity defined by BMI [10-11]. Despite these varied findings, smoking is unequivocally linked to numerous health risks, including cancer, respiratory illnesses, and cardiovascular diseases. Cigarette smoke contains chemicals that promote the production of free radicals and plaques, heightening the risk of

atherosclerosis and cardiovascular ailments [12] Particularly concerning are the alarmingly high smoking rates in Russia, with approximately 30% of women and 65% of males in the 15-19 age group reported as smokers. On average, they consume 7 and 12 cigarettes per day, respectively, with 2.5 million males and 0.5 million females under 18 being smokers. Furthermore, a significant proportion of secondary vocational school students, 64% of females and 75% of males, are smokers, potentially leading to long-term smoking habits in adulthood [13]. Compounding these risks, most teenagers exhibit unhealthy dietary habits, which, combined with smoking, elevate the likelihood of deviations from normal body weight among adolescent smokers [14]. Research from the United States underscores those adolescent smokers are less likely to participate in sports activities and consume adequate calcium-rich foods and beverages [15].

Obesity is becoming increasingly prevalent worldwide [16], and Pakistan, classified as a low- and middle-income country [17], has not been spared from this trend. With 54 percent of its population aged 0 to 19 years [18], Pakistan faces significant challenges related to nutrition, evident from its ranking of 92nd out of 116 countries in the global hunger index for 2021 [19]. The country struggles with the dual burden of overnutrition and poor nutrition, ranking tenth out of 188 countries with 50% of its population classified as overweight or obese [20]. Alarmingly, Pakistan has witnessed a steady rise in early fatalities attributed to excess weight, affecting both males and females [21,42]. Projections from the World Obesity Federation estimate that by 2030, 5.4 million Pakistani school-aged children will be obese [22]. Despite these concerning statistics, Pakistan has yet to implement operational policies to address overweight, obesity, and physical inactivity, as highlighted by the WHO Diabetes country profiles [23]. Given the scarcity of research on this topic within Pakistan, there exists a critical gap in understanding. Therefore, it is imperative to gather baseline data to assess the prevalence of obesity among school-aged children and adolescents in Pakistan [24].

The aim of this study was to analyze the prevalence of unhealthy behaviors, including smoking, alcohol consumption, and tobacco use, among a nationally representative sample of adolescents aged 9 to 17 years in Pakistan. Furthermore, the study sought to investigate the association between these behaviors and body mass index (BMI) to contribute to evidence-based recommendations for the prevention and management of unhealthy behaviors, overweight, and obesity in this demographic.

## 2. Methods

### *2.1 Study design, setting, and participants*

In the summer of 2023, a population-based cross-sectional study was conducted in seven randomly selected districts of Pakistan, targeting school-going children and adolescents aged 9 to 17 years. The primary objective was to assess the prevalence of overweight and obesity within this demographic. Employing a stratified multistage random cluster sampling method, the study enrolled a total of 4,200 school-aged children and adolescents, along with their parents, from 62 schools across the selected districts. The sampling strategy involved multiple stages, beginning with the random selection of the seven districts, followed by stratification based on population and educational system characteristics. Stratification was further refined according to the four educational levels defined by the Pakistan educational framework, encompassing primary (grades 4-5), middle (grades 6-8), secondary (grades 9-10), and higher secondary (grades 11-12) levels. Of the 4,200 students invited to participate, 4,108 (97.80%) completed useful questionnaires, while 92 students (2.2%) were disqualified due to insufficient information.

Public schools were selected following authorization from the Punjab School Education Department, which provided a formal permission letter. Private school administrations, on the other hand, granted permission independently. The Punjab School Education Department, accessible at *https://sis.punjab.gov.pk/*, facilitated the compilation of a comprehensive list of schools from urban and rural areas [25]. To address socioeconomic disparities, a fee structure was established, with a charge of 20 PKR in public schools and 10,000.00 PKR in private schools [26]. In instances where school management declined participation, an alternative institution was chosen randomly. The

survey also involved collaboration with the education and rescue 1122 departments, both of which volunteered to participate.

The study protocol was approved by the Shanghai University of Sport Institutional Review Board under protocol number 1816111009. Permission to conduct the study was obtained from the teachers and principals of the participating schools. Prior to participation, all children, adolescents, parents, or guardians were informed that involvement in the study was entirely voluntary.

### *2.2 Measure Weight status*

On predetermined dates, selected schools were visited by Rescue-1122 professionals to conduct anthropometric measurements of weight and height in classroom settings. The questionnaire, written in English, was orally presented to children in lower grades. Direct data collection methods were employed to ensure the confidentiality of participants' responses. Initially, students' body weight and height were measured with precision, followed by the completion of survey questionnaires in the classroom [27]. BMI weight to the nearest 0.1 kg for the purpose of the measured weight and height to the nearest 0.5 cm [28,29]. BMI was calculated by multiplying a person's weight in kilograms by their height in meters squared (kg/m2). Underweight, normal weight, overweight, and obese classifications were based on BMI percentiles based on age and gender (CDC-US 2000). Underweight (≤5th percentile), healthy weight (5th BMI to <85th percentile), overweight (85th BMI <95th percentile), and obese (>95th percentile) BMI for children and adolescents aged 2 to 20 years [30,31]. Trained rescue professionals took all of the measurements.

### *2.3 Unhealthy Behavior*

The study investigated the unhealthy behaviors of Pakistani school-age children and adolescents. The respondents provided information on the following behaviors: (1) When did you first light up a cigarette? The reliability coefficient for this question was 0.76 [32,33]. The respondents also reported the number of cigarettes consumed in the week before. (2) How many days in the previous week did you use tobacco products other than cigarettes, such as Niswar, Paan, Gutkha, Huqa, or shisha? The reliability coefficient for this question was 0.77 [33]. (3) How many days did you consume alcohol or beer in the previous week? The reliability coefficient for this question was 0.80 [32]. (4) Have you ever tried quitting smoking cigarettes in the past 12 months? The reliability coefficient for this question was 0.76 [33]. (5) How many times has someone smoked in your presence over the past seven days? The reliability coefficient for this question was 0.79 [33]. (6) Which of your parents or guardians use tobacco in any way? The reliability coefficient for this question was 0.75 [33]. (7) Would you smoke a cigarette if one of your closest friends offered one? The reliability coefficient for this question was 0.75 [33]. Respondents who reported "never" drinking alcohol and never smoking were considered to lead healthy lifestyles.

The study drew upon the Pakistan GSHS Questionnaire from the Global School-based Student Health Survey (GSHS) as a primary reference for questionnaire items and reliability coefficients [34]. Additionally, studies by Liu et al. [32] and Ziaei et al. [33] were consulted for further validation and refinement of the questionnaire. The questionnaire was adapted from the Global School-based Student Health Survey (GSHS) 2016 Pakistan GSHS Questionnaire, which is accessible through the CDC and WHO websites at http://www.cdc.gov/gshs and http://www.who.int/chp/gshs/en, respectively.

### 2.4 Statistical Analysis

IBM SPSSv.26 Statistical Analysis was used to analyze the data. Underweight (≤5th percentile), healthy weight (5th BMI to <85th percentile), overweight (85th BMI <95th percentile), and obese (>95th percentile) BMI calculated using the CDC US 2000 BMI chart Children and adolescents between the ages of 2 and 20 [35]. For the present prevalence of body-weight status, a frequency distribution analysis was performed. Bivariate analysis was used to compare the prevalence of body-weight status (dependent variable) with demographic parameters such as gender, age, residence, and

religion (independent variables) using the chi-square test as the trend test [36]. To measure the relationship between the dependent and independent variables, The Pearson correlation coefficient (*r*) was used to determine the degree of correlation between independent variables with body-weight dependent variable. Linear regression analysis was used to explore the predictive power of, demographic factors as (independent variables) in relation to body-weight (dependent variable). The simultaneous influence of numerous factors on the dichotomous outcome was estimated using multinomial logistic regression analysis [25]. The odds ratios (OR) with 95 % confidence intervals were calculated. The statistical significance was determined using $p < 0.05$.

## 3. Results

The demographic information presented in **Table 1** provides valuable insights into the sample characteristics of the study. While the specific total number of participants is not provided, the gender distribution indicates a higher representation of boys, accounting for 59.3% of the sample, compared to females at 40.7%. Age-wise, the participants were categorized into children aged 9 to 11, comprising 18.6% of the population, and adolescents aged 12 to 17, making up the remaining proportion. The majority of the participants identified as Muslims (96.2%), with a minority belonging to other religious groups. Geographically, the study included both metropolitan (59.9%) and rural (40.1%) participants, showcasing a diverse representation. In terms of school types, 22.2% attended private schools, while the majority (77.8%) were enrolled in public schools, reflecting the varied educational settings within the sample.

**Table 1 Demographic characteristics of Pakistani school-aged children and adolescents aged 9–17 years, descriptive statistics (n (%).**

| Characteristics | Primary School | Middle School | Secondary School | Higher Secondary School | *p*-value |
|---|---|---|---|---|---|
| Sample size, n (%) | 844 (20.5) | 1580 (38.5) | 1227 (29.9) | 457 (11.1) | |
| Age (year, mean ± SD) | 10.91 ± 1.23 | 13.15 ± 1.35 | 15.30 ± 1.13 | 16.82 ± 0.44 | |
| Sex, n (%) | | | | | |
| Boy | 463 (54.9) | 902 (57.1) | 816 (66.5) | 256 (56.0) | <0.001 |
| Girl | 381 (45.1) | 678 (42.9) | 411 (33.5) | 201 (44.0) | |
| Age Category, n (%) | | | | | |
| Children 9-11 years | 594 (70.4) | 168 (10.6) | 1 (0.1) | 0 (0.0) | <0.001 |
| Adolescent 12-17 years | 250 (29.6) | 1412 (89.4) | 1226 (99.9) | 457 (100.0) | |
| Religion, n (%) | | | | | |
| Muslim | 799 (94.7) | 1513 (95.8) | 1191 (97.1) | 449 (98.2) | 0.003 |
| Non-Muslims | 45 (5.3) | 67 (4.2) | 36 (2.9) | 8 (1.8) | |
| Residence, n (%) | | | | | |
| Urban | 656 (77.7) | 869 (55.0) | 759 (61.9) | 176 (38.5) | <0.001 |
| Rural | 188 (22.3) | 711 (45.0) | 468 (38.1) | 281 (61.5) | |
| School Type, n (%) | | | | | |
| Public | 650 (77.0) | 1196 (75.7) | 902 (73.5) | 446 (97.6) | <0.001 |
| Private | 194 (23.0) | 384 (24.3) | 325 (26.5) | 11 (2.4) | |
| BMI (kg/m2, mean ±SD) | 17.01 ± 3.35 | 19.06 ± 4.07 | 21.01 ± 4.70 | 22.41 ± 4.46 | |

BMI (body mass index)

**Table 2 Chi-square test to assess the association of unhealthy behavior at the intrapersonal level with overweight and obesity by sex-specific trend.**

| | | **Weight Status** | | | | | |
|---|---|---|---|---|---|---|---|
| **Characteristics** | **Sex** | **Underweight** *n (%)* | **Healthy** *n (%)* | **Overweight** *n (%)* | **Obesity** *n (%)* | $\chi^2$ | ***p-value*** |
| **Smoking for the first time.** | | | | | | | |
| Never smoked cigarettes | Boys | 407 (18.6) | 1194 (54.6) | 386 (17.7) | 198 (9.1) | 40.99 | <0.001 |
| | Girls | 244 (15.1) | 834 (51.4) | 329 (20.3) | 214 (13.2) | | |
| 7 to 11 | Boys | 16 (16.5) | 53 (54.6) | 25 (25.8) | 3 (3.1) | 14.94 | 0.002 |
| | Girls | 1 (2.9) | 18 (52.9) | 9 (26.5) | 6 (17.6) | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 12 to 17 | Boys | 21 (13.5) | 72 (46.5) | 44 (28.4) | 18 (11.6) | 3.12 | 0.373 |
| | Girls | 2 (12.5) | 8 (50.0) | 4 (25.0) | 2 (12.5) | | |
| **Smoking last 7 days.** | | | | | | | |
| 0 days | Boys | 426 (18.0) | 1289 (54.4) | 439 (18.5) | 215 (9.1) | 44.09 | <0.001 |
| | Girls | 245 (14.8) | 853 (51.5) | 336 (20.3) | 222 (13.4) | | |
| 1 - 2 days | Boys | 9 (26.5) | 16 (47.1) | 7 (20.6) | 2 (5.9) | 1.05 | 0.789 |
| | Girls | 1 (11.1) | 5 (55.6) | 3 (33.3) | 0 (0.0) | | |
| ≥ 3 days | Boys | 9 (26.5) | 14 (41.2) | 9 (26.5) | 2 (5.9) | 9.69 | 0.021 |
| | Girls | 1(16.7) | 2 (33.3) | 3 (50.0) | 0 (0.0) | | |
| **Use tobacco other than cigarettes.** | | | | | | | |
| None | Boys | 382 (18.3) | 1135 (54.4) | 386 (18.5) | 184 (8.8) | 42.71 | <0.001 |
| | Girls | 233 (14.6) | 822 (51.4) | 329 (20.6) | 216 (13.5) | | |
| Gutkha, Paan, Niswar | Boys | 47 (18.5) | 141 (55.5) | 43 (16.9) | 23 (9.1) | 3.35 | 0.341 |
| | Girls | 13 (19.4) | 38 (56.7) | 11 (16.4) | 5 (7.5) | | |
| Shisha, Huqa | Boys | 15 (15.6) | 43 (44.8) | 26 (27.1) | 12 (12.5) | 2.33 | 0.505 |
| | Girls | 1 (25.0) | 0 (0.0) | 2 (50.0) | 1 (25.0) | | |
| **Tobacco products in the last 7 days.** | | | | | | | |
| 0 days | Boys | 402 (18.2) | 1203 (54.5) | 410 (18.6) | 194 (8.8) | 42.41 | <0.001 |
| | Girls | 239 (14.7) | 833 (51.3) | 335 (20.6) | 216 (13.3) | | |
| 1 - 2 days | Boys | 22 (15.2) | 79 (54.5) | 25 (17.2) | 19 (13.1) | 2.88 | 0.409 |
| | Girls | 6 (17.1) | 20 (57.1) | 5 (14.3) | 4 (11.4) | | |
| ≥ 3 days | Boys | 20 (24.1) | 37 (44.6) | 20 (24.1) | 6 (7.2) | 34.84 | <0.001 |
| | Girls | 2 (15.4) | 7 (53.8) | 2 (15.4) | 2 (15.4) | | |
| **Drink alcohol in the last 7 days.** | | | | | | | |
| 0 days | Boys | 436 (18.2) | 1303 (54.3) | 445 (18.5) | 215 (9.0) | 26.10 | <0.001 |
| | Girls | 246 (14.8) | 857 (51.6) | 339 (20.4) | 219 (13.2) | | |
| 1 - 2 days | Boys | 4 (18.2) | 11 (50.0) | 5 (22.7) | 2 (9.1) | 3.38 | 0.337 |
| | Girls | 1 (16.7) | 1 (16.7) | 2 (33.3) | 2 (33.3) | | |
| ≥ 3 days | Boys | 4 (25.0) | 5 (31.3) | 5 (31.3) | 2 (12.5) | 1.69 | 0.638 |
| | Girls | 0 (0.0) | 2 (50.0) | 1 (25.0) | 1 (25.0) | | |
| **Try to quit smoking within a year.** | | | | | | | |
| Not smoke last year | Boys | 411 (18.6) | 1215 (54.9) | 382 (17.3) | 205 (9.3) | 26.93 | <0.001 |
| | Girls | 240 (14.9) | 831 (51.6) | 327 (20.3) | 212 (13.2) | | |
| Yes | Boys | 15 (18.5) | 35 (43.2) | 26 (32.1) | 5 (6.2) | 2.23 | 0.525 |
| | Girls | 0 (0.0) | 4 (57.1) | 3 (42.9) | 0 (0.0) | | |
| No | Boys | 18 (12.6) | 69 (48.3) | 47 (32.9) | 9 (6.3) | 7.59 | 0.055 |
| | Girls | 7 (13.0) | 25 (46.3) | 12 (22.2) | 10 (18.5) | | |
| **Someone has been smoking in front.** | | | | | | | |
| 0 days | Boys | 87 (15.8) | 286 (51.8) | 113 (20.5) | 66 (12.0) | 4.54 | 0.216 |
| | Girls | 87 (13.0) | 341 (51.0) | 136 (20.4) | 104 (15.6) | | |
| 1 - 2 days | Boys | 36 (18.6) | 101 (52.1) | 34 (17.5) | 23 (11.9) | 1.54 | 0.401 |
| | Girls | 44 (16.9) | 126 (48.3) | 55 (21.1) | 36 (13.8) | | |
| ≥ 3 days | Boys | 321 (19.0) | 932 (55.1) | 308 (18.2) | 130 (7.7) | 11.60 | 0.009 |
| | Girls | 116 (15.6) | 393 (53.0) | 151 (20.4) | 82 (11.1) | | |
| **Guardians smoke.** | | | | | | | |
| Neither | Boys | 332 (19.1) | 925 (53.1) | 311 (17.9) | 173 (9.9) | 36.75 | <0.001 |
| | Girls | 189 (14.9) | 654 (51.6) | 248 (19.6) | 177 (14.0) | | |
| Father or male guardian | Boys | 112 (16.2) | 390 (56.4) | 144 (20.8) | 46 (6.6) | 10.65 | 0.014 |
| | Girls | 55 (14.1) | 199 (51.0) | 91 (23.3) | 45 (11.5) | | |
| Female guardian | Boys | 0 (0.0) | 4 (100.0) | 0 (0.0) | 0 (0.0) | 0.88 | 0.643 |
| | Girls | 3 (23.1) | 7 (53.8) | 3 (23.1) | 0 (0.0) | | |
| **Total** | | 691 (16.8) | 2179 (53.0) | 797 (19.4) | 441 (10.7) | | |

Based on the information provided in **Table 2**, the prevalence of weight status among school-aged children and adolescents in Pakistan is compared with measures of interpersonal-level unhealthy behavior, including smoking and alcohol consumption. Here are the key findings: Smoking: The majority of students did not smoke, indicating a low prevalence of smoking among Pakistan school-aged children and adolescents. Girls with a prevalence of 20.3% being overweight and boys with a prevalence of 17.7% being overweight were non-smokers. Similarly, among girls, the prevalence of being overweight and obese (20.3% and 13.4%, respectively) indicated that they had not smoked in the last seven days. A significant percentage of girls who were overweight and obese reported exposure to people smoking three or more days in front of them. Girls with a smoking father or male

guardian had higher rates of being overweight and obese compared to boys. Alcohol consumption: The majority of students did not consume any alcohol in the last seven days, indicating a low prevalence of alcohol consumption. Only a few students from the sample reported alcohol consumption. Unhealthy behavior factors and weight status: The results of the chi-square test indicate that there are no significant differences between the weight status categories for most of the examined unhealthy behavior factors, including smoking and alcohol consumption.

**Table 3 Correlation of intrapersonal level unhealthy behavior and weight status.**

| | Characteristics | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Weight-status | — | | | | | | | | |
| **2** | The first time you smoke. | 0.034* | — | | | | | | | |
| **3** | Smoked for last 7 days. | -0.018 | 0.308** | — | | | | | | |
| **4** | Used in the last 7 days Tobacco products. | 0.010 | 0.252** | 0.259** | — | | | | | |
| **5** | Use Tobacco products other than cigarettes. | -0.007 | 0.177** | 0.261** | 0.561** | — | | | | |
| **6** | For last 7 days, drinking. | 0.017 | 0.120** | 0.281** | 0.183** | 0.272** | — | | | |
| **7** | Trying to quit smoking within a year. | 0.033* | 0.193** | 0.162** | 0.112** | 0.104** | 0.115** | — | | |
| **8** | People smoke in front of them. | -0.083** | 0.085** | 0.043** | 0.093** | 0.066** | 0.002 | 0.038* | — | |
| **9** | The guardian smokes. | -0.012 | 0.043** | 0.038* | 0.061** | 0.061** | 0.052** | 0.086** | 0.229** | — |

Note: $N$ = 4,108; *$p$ < 0.05, **$p$ < 0.01.

In **Table 3**, the bivariate correlations between various unhealthy behaviors and weight status are presented. Key findings reveal that smoking showed a weak positive correlation with weight status ($r$ = 0.034*), suggesting a slightly higher prevalence of smoking associated with increased likelihood of being overweight. Individuals attempting to quit smoking also displayed a weak positive correlation with weight status ($r$ = 0.033*), indicating a slightly elevated risk of being overweight among those attempting to quit. Conversely, recent smoking in the previous seven days exhibited a weak negative correlation with weight status ($r$ = -0.018), suggesting a slightly lower likelihood of being overweight among those who reported recent smoking. Tobacco product use and alcohol consumption displayed weak negative correlations with weight status, with tobacco product use ($r$ = -0.007) and beer/alcohol consumption ($r$ = -0.018) suggesting slightly lower likelihoods of being overweight among users. Exposure to smoking showed a weak negative correlation with weight status ($r$ = -0.083**), indicating a slightly reduced risk of being overweight among students who reported witnessing others smoking.

**Table 4 Linear regression analysis of intrapersonal level unhealthy behavior and weight status.**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | **Characteristics** | ***B*** | **SE** | ***β*** | ***t*** | **Sig** |
| | (Constant) | 2.305 | 0.105 | | 22.009 | <0.001 |
| **1** | The first time you smoke. | 0.089 | 0.033 | 0.044 | 2.644 | 0.008 |
| **2** | Smoked for the last 7 days. | -0.143 | 0.067 | -0.037 | -2.135 | 0.033 |
| **3** | Used in the last 7 days Tobacco products. | 0.014 | 0.041 | 0.006 | 0.335 | 0.738 |
| **4** | Use Tobacco products other than cigarettes. | -0.031 | 0.046 | -0.013 | -0.664 | 0.507 |
| **5** | For the last 7 days, drinking bear alcohol. | 0.109 | 0.088 | 0.021 | 1.236 | 0.216 |
| **6** | Trying to quit smoking within a year. | 0.059 | 0.031 | 0.031 | 1.937 | 0.053 |
| **7** | Last 7 days, People smoke in front of them. | -0.083 | 0.015 | -0.087 | -5.424 | <0.001 |
| **8** | The guardian smokes. | 0.013 | 0.030 | 0.007 | 0.415 | 0.678 |

SE = Standard error

The linear regression analysis in **Table 4** revealed significant effects of six out of the eight unhealthy behavior characteristics on weight status. Smoking at first exhibited a positive association with weight

status ($\beta$ = 0.04, SE = 0.03, $p$ = 0.008), indicating that individuals who initiated smoking at an earlier age had a slightly higher likelihood of being overweight. Conversely, people smoking in front had a negative association with weight status ($\beta$ = -0.08, SE = 0.01, $p < 0.001$), suggesting that students who observed others smoking had a slightly lower risk of being overweight. However, smoking in the previous seven days ($\beta$ = -0.03, SE = 0.06, $p$ = 0.033) and attempts to quit smoking ($\beta$ = 0.03, SE = 0.03, $p$ = 0.053) did not significantly affect weight status. Additionally, variables related to recent tobacco product use, guardian smoking, tobacco product consumption, and alcohol consumption did not show a significant association with weight status ($p > 0.05$). Overall, the analysis demonstrated a low $R^2$ value of 0.011, indicating that the included unhealthy behavior characteristics explain only a small portion of the variance in weight status. Although the $F$-statistic of 5.569 was statistically significant ($p < 0.001$), suggesting overall model significance, the predictive power remained limited.

**Table 5 Odds ratios from two logistic regression analyses of intrapersonal level unhealthy behavior and risk factors associated with overweight and obesity.**

| | **Overweight vs. Non-Overweight** | **Obese vs. Non-Obese** |
|---|---|---|
| **Characteristics** | **Unadjusted OR (95% CI)** | **Unadjusted OR (95% CI)** |
| **Smoking in the last 7 days.** | | |
| 0 days | Ref. | Ref. |
| 1-2 days | 1.27 (0.62-2.58) | 0.40 (0.97-1.66) |
| ≥ 3 days | 1.79 (0.91-3.55) | 0.43 (0.10-1.79) |
| **Use tobacco other than cigarettes.** | | |
| 0 days | Ref. | Ref. |
| Gutkha, Paan, Niswar | 0.84 (0.62-1.13) | 0.78 (0.52-1.17) |
| Shisha, Huqa | 1.61 (1.03-2.52)* | 1.22 (0.67-2.21) |
| **Drink alcohol in the last 7 days.** | | |
| 0 days | Ref. | Ref. |
| 1-2 days | 1.39 (0.59-3.28) | 1.39 (0.48-4.03) |
| ≥ 3 days | 1.79 (0.68-4.67) | 2.78 (0.43-5.05) |
| **Someone has been smoking in front.** | | |
| 0 days | Ref. | Ref. |
| 1-2 days | 0.94 (0.72-1.24) | 0.92 (0.67-1.26) |
| ≥ 3 days | 0.90 (0.76-1.07) | 0.59 (0.47-0.73)*** |
| **Guardians smoke.** | | |
| Neither | Ref. | Ref. |
| Father or male guardian | 1.21 (1.02-1.44) | 0.69 (0.54-0.88)** |
| Mother or female guardian | 0.93 (0.26-3.27)* | 0.01 (0.01-0.01) |

Level of significance *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$, CI = Confidence Interval, OR = Odds Ratio; Note: Reference category (respectively): Ref.

The logistic regression analysis presented in **Table 5** revealed several key findings regarding the association between unhealthy behavior variables and weight status. For overweight, the use of tobacco products with shisha and Huqa was significantly associated with higher odds of being overweight (OR 1.61, 95% CI 1.03-2.22, p < 0.05). Conversely, the presence of a female guardian who smokes showed a slight protective effect against overweight (OR 0.93, 95% CI 0.26-3.27, p < 0.05). However, other unhealthy behavior variables such as smoking, beer/alcohol consumption, and exposure to people smoking around were not significantly associated with overweight. For obesity, exposure to someone smoking in front of students for three or more days in a week was significantly associated with lower odds of being obese (OR 0.59, 95% CI 0.47-0.73, p < 0.001). Similarly, having a male guardian who smokes demonstrated a slight protective effect against obesity (OR 0.69, 95% CI 0.54-0.88, p < 0.01). However, other unhealthy behavior variables did not show a significant association with obesity.

## 4 Discussion

The findings of this study reveal a positive trend regarding the prevalence of smoking and alcohol consumption among school-aged children and adolescents in Pakistan, with encouragingly low rates observed. The majority of students do not engage in these unhealthy behaviors, and importantly, no significant differences in weight status were observed across the factors related to smoking and alcohol consumption. These results suggest that ongoing efforts to promote healthy lifestyles and discourage the initiation of smoking and alcohol consumption among this demographic are having a beneficial impact. However, it is essential to recognize that despite the low prevalence, preventive measures must be maintained and strengthened to ensure that these unhealthy behaviors remain minimal. Continued education and awareness campaigns are crucial in further reducing the initiation of smoking and alcohol consumption among school-aged children and adolescents. By focusing on promoting healthy behaviors and providing information about the associated risks, young individuals can be empowered to make informed decisions and maintain a healthy lifestyle. Collaborative efforts involving schools, families, and community stakeholders are necessary to create a supportive environment that encourages healthy choices and reinforces the importance of maintaining a smoke-free and alcohol-free lifestyle among the youth in Pakistan.

According to current estimates, 19.4% of Pakistani school-aged children and adolescents were overweight, and 10.7% were obese. For instance, a study conducted in Lahore among primary school children found that 17% of children aged 5 to 12 were overweight, and 7.5% were obese [37]. Similarly, another study from the Hyderabad urban region in 2013 found that 12% of students in grades 6 to 10 were obese, and 8% were overweight [38]. Furthermore, a study conducted in Karachi among school children aged 11 to 15 years old found that 19.1% of the children were overweight, and 10.8% were obese [24]. Additionally, a local survey conducted in Lahore found that 11.9% of students in private schools in grades 6 and 7 were obese, while 21.8% were overweight [39]. In 2018, another local study conducted on children aged 3 to 18 years in Multan revealed that 10% of the students were overweight, and 5% were obese [40]. Moreover, the World Obesity Federation estimated in 2018 that 6.6% of Pakistani children were obese, and 10.7% were overweight [41]. The current study underscores the increasing prevalence of overweight and obesity among children and adolescents over time, with various unhealthy behaviors contributing to this trend.

The findings of this study deviate from previous research in some aspects, particularly regarding the association between smoking status and weight status. While some earlier studies have reported that current smokers are less likely to be overweight compared to never-smokers [9], our study aligns with others that have found no significant associations between smoking status and obesity [1,10]. Additionally, while certain studies have suggested that smoking status is not significantly linked to increased central obesity [10], our findings are consistent with those indicating an association between smoking status and central obesity [1,11]. Specifically, the use of tobacco products such as shisha and Huqa demonstrated high odds with overweight, suggesting a potential contribution to weight gain. Moreover, exposure to someone smoking in front of students was significantly associated with obesity, indicating a potential environmental influence on weight status. Interestingly, the presence of guardians who smoke showed significant odds in children with overweight and obesity, highlighting the potential influence of familial smoking habits on weight status. These results underscore the complex interplay between smoking behaviors and weight status, warranting further investigation into the mechanisms underlying these associations and their implications for public health interventions [1,9-11].

The study possesses several strengths that contribute to its significance and potential impact. Firstly, it provides actual data on Intrapersonal Level Unhealthy Behaviors (Smoking, Drinking Alcohol, and Tobacco Use) and Their Association with Body Mass Index (BMI) among school-aged children and adolescents in Pakistan. This data can serve as a valuable resource for supporting, refuting, or refining existing theories regarding BMI issues in this population. Secondly, the study offers a comprehensive analysis covering all unhealthy behaviors and their associations with BMI, filling a gap in the existing literature. While previous studies have focused on specific behaviors or subsets of the population,

this study examines the prevalence and relationships of all unhealthy behaviors across various demographic factors such as urban and rural areas, public and private schools, and different age groups. Moreover, the study's large sample size, encompassing participants from both large cities and villages, enhances its generalizability and robustness. By including a diverse range of participants, the study provides insights into the BMI correlates of unhealthy behaviors across different contexts, allowing for the development of targeted intervention programs and official guidelines for the prevention and management of BMI-related issues among Pakistani school-aged children and adolescents. Additionally, the study highlights the role of schools in addressing the rising BMI trends among children and adolescents, emphasizing the importance of implementing strategies to promote healthy behaviors and mitigate the negative impact of unhealthy behaviors within educational settings. Overall, these strengths underscore the study's potential to inform public health policies and interventions aimed at addressing BMI difficulties among Pakistani school-aged children and adolescents.

The current study faced several notable limitations. Firstly, the method of determining students' weight status using BMI calculations based on the CDC US 2000 BMI chart may not have been entirely accurate, particularly for athletes or individuals with higher muscle mass. BMI does not account for differences in body composition, which could lead to misclassification, especially among those with a higher muscle-to-fat ratio. Moreover, adolescents engaged in regular gym routines may have different body fat percentages that BMI does not capture accurately. Additionally, the exclusion of classes 1 to 3 from the study may have introduced a potential bias, as factors influencing weight status could differ at the primary level. This exclusion may have limited the generalizability of the study's findings to younger age groups and primary school settings. Future research should consider employing more precise methods for assessing body composition and include a broader range of age groups to enhance the validity and applicability of the findings.

## 5 Conclusions

In conclusion, the study highlights the concerning prevalence of overweight and obesity among Pakistani school-aged children and adolescents, underscoring the urgency of addressing this issue. However, the findings also reveal encouragingly low rates of smoking and alcohol consumption among this population. It is promising to note that the majority of students do not engage in these unhealthy behaviors, and there are no significant associations between these behaviors and weight status. These findings suggest that ongoing efforts to promote a healthy lifestyle and deter smoking and alcohol consumption are having a positive impact. Nevertheless, it remains crucial to maintain and enhance preventive measures to ensure these unhealthy behaviors remain minimal. Continued education and awareness campaigns are essential in further reducing the initiation of smoking and alcohol consumption among school-aged individuals. Collaborative efforts involving schools, families, and community stakeholders are paramount in creating a supportive environment that fosters healthy choices and emphasizes the importance of maintaining a smoke-free and alcohol-free lifestyle among the younger population in Pakistan.

Based on the findings of the study, it is recommended to develop comprehensive school-based interventions targeting multiple levels of influence, including individual, interpersonal, organizational, and community factors. These interventions should focus on increasing physical activity, promoting healthy behaviors, and reducing obesity rates among Pakistani school-aged children and adolescents. Schools can play a pivotal role in promoting physical education, providing sports facilities, and raising awareness about healthy lifestyle habits. Additionally, public health campaigns and educational programs should emphasize the importance of regular physical activity, healthy eating habits, reduced sedentary behavior, adequate sleep, and avoidance of unhealthy lifestyle habits such as smoking and drinking.

**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.

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**Authors' contributions**
The study was planned and implemented by M.T, who also oversaw the entire project. M.T, E.A, and A.Z; drafted the manuscript; N.R, Z.H, and N.T provided intellectual guidance in improving the manuscript; M.T, U.T, N.T, and F.A.R assisted in revising the manuscript. E.A, Z.H, U.T, F.A.R and N.R. edited the final version of the manuscript; all authors reviewed and approved the final revised manuscript and agree on the authors' presentation order.

**Data Availability Statement**
The corresponding author can provide the data used in this work upon request.

**Competing interests**
The authors have declared they have no competing interests

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