ORIGINAL ARTICLE

ANNALS OF PUNJAB MEDICAL COLLEGE

OPEN ACCESS

Childhood Obesity and Blood Pressure Patterns among School-Going Children in Hyderabad, Sindh: A Cross-Sectional Study

Shakil Ahmed Shaikh[1], Muhammad Ali Pir[2], Abdul Haq Shaikh[3], Hira Saeed Khan[4], Rizwan Channa[5], Aqeela Memon[6]

		Authors' Contribution
1	Associate Professor, Department of Physiology, Suleman Roshan Medical College, Tando Adam Pakistan	*Concept, Write-up, Final approval*
2	Assistant Professor, Community Ophthalmology Sindh Institute of Ophthalmology and Visual Sciences Hyderabad,	*Data curation, Data collection*
3	Assistant Professor, Department of Medicine, Suleman Roshan Medical College, Tando Adam Pakistan	*Data analysis*
4	Associate Professor, Department of Physiology, Suleman Roshan Medical College, Tando Adam Pakistan	*Critical analysis*
5	Associate Professor, Department of Medicine, Suleman Roshan Medical College, Tando Adam Pakistan	*Data collection*
6	Assistant Professor, Department of Community Medicine, Suleman Roshan Medical College, Tando Adam Pakistan	*Software analysis*

Correspondence: *Dr. Shakil Ahmed Shaikh*
Associate Professor, Department of Physiology, Suleman Roshan Medical College, Tando Adam Pakistan
Email: sshakilonly@hotmail.com

Submitted for Publication: 09-04-2026
Revision Received: 18-07-2026
Accepted for Publication: 31-07-2026

ABSTRACT

Background: Childhood obesity and high blood pressure are becoming issues of concern in low- and middle-income countries. **Objective:** To find out the rates of underweight, overweight, obesity, and hypertension and explain age- and sex-specific changes in body mass index (BMI) and blood pressure among school-going children. **Study Design:** Cross-sectional study. **Settings:** Hyderabad, Sindh Pakistan. **Duration:** September 2025 to February 2026. **Methods:** A cross-sectional study was conducted among schoolchildren aged 5-17 years, using stratified random sampling in public and private schools in Hyderabad. The standardized procedures were used in measuring height, weight, waist and hip circumference, and blood pressure. BMI was calculated according to World Health Organization standards, and blood pressure was categorized according to age- and sex-specific pediatric guidelines. The data analysis was conducted descriptively. **Results:** The total prevalence of hypertension was 1.44%, and none of the cases were found below the age of nine. The prevalence of hypertension also grew gradually with age, with the highest rate of 4.14 percent among adolescents aged 16-17 years. The prevalence of overweight grew continuously between early childhood and adolescence, but obesity was not common (total prevalence 0.98%). Underweight was reported in 9.56% of participants, with higher rates in mid-adolescence. The mean systolic and diastolic blood pressure rose with age in boys and girls. **Conclusion:** Among school-going children in Hyderabad, blood pressure increases progressively with age, overweight prevalence rises through adolescence, and undernutrition remains a substantial burden. These findings underscore the need for integrated school-based screening and dual-focused nutritional interventions targeting both undernutrition and excess weight gain from early childhood

Keywords: *Childhood obesity, Hypertension, Body mass index, Blood pressure, School-going children.*

How to Cite: Shaikh SA, Pir MA, Shaikh AH, Khan HS, Channa R, Memon A. Childhood Obesity and Blood Pressure Patterns among School-Going Children in Hyderabad, Sindh: A Cross-Sectional Study. APMC 2026;20(3):154-158. DOI: 10.29054/APMC/2026.1911

This is an open access article distributed under the terms of the Attribution Creative Commons-Noncommercial (CC BY-NC 4.0) (https://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Childhood obesity has become a critical health issue in the global community, both in developed and developing nations. Diet, lifestyle, physical inactivity, sedentary lifestyles, and urbanization have also led to the increase in the prevalence of overweight and obesity in children and adolescents.[1] Childhood obesity is linked to unfavorable metabolic results, such as raised blood pressure, dyslipidemia, and insulin resistance, potentially continuing into adulthood and exposing them to the risk of cardiovascular disease.[2]

Overweight in childhood has been linked with a number of negative short- and long-term health effects. Among them, high blood pressure is especially problematic due to its contribution to the emergence of cardiovascular disease at an early stage.[3] Children experience variations in blood pressure depending on age, sex, and growth, and higher levels in childhood have been observed to correlate with higher levels in adulthood. Young people or children who have higher blood pressure are prone to acquiring permanent hypertension in adulthood, which puts them at risk of cardiovascular disease and renal disease. The early detection of abnormal blood pressure patterns in childhood is thus a significant preventive opportunity.[4]

Childhood obesity and high blood pressure are known to have a relationship. Excess fatness can increase blood volume, cardiac output, insulin resistance, and sympathetic nervous system activation, which can lead to elevated systolic and diastolic blood pressure. Moreover, other dietary factors, such as eating a lot of salt, fruits, and vegetables, and having a low

level of physical activity, also contribute to blood pressure levels in children. These risk determinants are often concentrated in the urban setting and increase cardiovascular risk at a young age.[5]

Childhood overweight and obesity epidemiology in the world has shown a great rise in the past 2 decades, which has been linked to high blood pressure and hypertension among children. Nevertheless, these health problems are not uniform in severity, location, or age.[6] Nutritional transition in most low- and middle-income countries has been rapid and uneven, yielding varied patterns of child growth. As an instance, some children develop surplus adiposity, and others remain growing, faltering, and undernourished, as is universal in the same locality.[7] As such, a local body mass index (BMI) distribution and blood pressure trends should be interpreted in the context of grains to make health interventions effective. This dual load of malnutrition is also being experienced by Pakistan.[8] Since undernutrition is a cardinal issue as far as children are concerned, and especially the vulnerable groups, the increase in overweight and obesity of urbanized groups can be traced.[9] Findings of major urban research have reported a rise in overweight and obesity among school-going children, poor dietary practices, and physical inactivity. Paradoxically, in this case, the issue of pediatric hypertension is not recognized in such a way, and the routine blood pressure monitoring is not actively implemented in clinical and educational facilities. Survey-based approaches, evident in schools, offer a well-grounded framework for evaluating growth and cardiovascular risk measures in children. Through such studies, large, reasonably well-characterized cohorts across a wide age range are obtained, making it easy to measure anthropometric indices and blood pressure in a standardized manner. Although cross-sectional studies are inherently weak at establishing causal relationships, they are invaluable for assessing disease prevalence and trends in risk factors when longitudinal baseline data are limited.[10]

The analysis of age- and sex-specific trends in body mass index and blood pressure is a major undertaking towards understanding how cardiovascular risk changes throughout childhood and adolescence. Adolescence, as a period of transition, is characterized by dynamic somatic development and complex physiological changes that can alter vascular tone.[11] As such, the prevalence of both underweight and overweight/obesity has to be outlined in order to have an overall picture of the nutritional environment in which the urban Pakistani children are going through. The dietary status of childhood in low- and middle-income countries such as Pakistan is both complicated in nature and stratified because of socioeconomic disparity.[12]

The issue of under-eating has never been a new development, particularly when it comes to those who are of disadvantaged backgrounds, yet there is a propensity in the urban population towards being overweight. This two-sided malnutrition pressure is overwhelming for government health facilities and requires indirect intervention measures.[13] Despite the fact that historically, hypertension was managed as one of the low-frequency health events among youths, it is currently gaining significance in clinical settings. It has also been reported that high blood pressure in children and adolescents persists into adulthood, therefore exposing them to the risks of cardiovascular diseases in the long run. Adolescence is an important period when physiological development, endocrinological relationships, and lifestyle choices interact to influence blood pressure responses and body composition. Despite the fact that evidence is still accumulating to the association of pediatric obesity with high blood pressure, a clear gap in information regarding the blood pressure trends in various cohorts of body mass index that fall within the category of pediatric standards in the state of Hyderabad, Sindh, the information remains lacking at the population level that occurs in schools.[14] The available Pakistani literature is mostly hospital-based or limited to larger metropolitan regions, with a knowledge gap regarding age- and sex-specific trends in nutrition status and hypertension. It seeks to fill this gap and presents robust, school-based data on body mass index and blood pressure among children aged 5-17 years in Hyderabad, Sindh. The data obtained are likely to guide early detection procedures and the formulation of preventive community health measures specific to this population category.

METHODS

Study design and setting: This cross-sectional study was conducted from September 2025 to February 2026 in Hyderabad, Sindh, after approval from the institutional ethics committee letter No. 105, dated 13/08/25. Written consent was obtained from parents/guardians, and confidentiality of the participants' data was maintained throughout the study period. Sample size was calculated using the Epi Online Calculator with 95% confidence and a 5% margin of error. A total of 7980 participants were included through stratified random sampling, ensuring representation across socioeconomic strata. Schools were categorized into low-, middle-, and high-socioeconomic groups, and participants were randomly selected.

A self-structured questionnaire was used to collect data, and standardized procedures were used to attain anthropometric measurements. A stadiometer was used to measure height to within 0.1cm, and weight was measured using a calibrated digital scale with a precision of 0.1kg. Waist and hip circumference were measured using a non-stretchable tape measure, and then the waist-to-hip ratio was calculated. The body mass index was calculated by dividing the weight (kg) by the height (m) squared (kg -m). The indices were classified according to the WHO growth reference standard for children and adolescents. Systolic and diastolic blood pressure measurements were obtained using an automated digital sphygmomanometer fitted with a correctly sized cuff. The test was performed with the child sitting and relaxing for at least 5 minutes to ensure only one composite reading was available and measured, and the composite reading was analyzed statistically. Blood-pressure classification was done according to pediatric age and sex-specific criteria.

Statistical Package for Social Sciences (SPSS) version 23.0 was used for data processing. Continuous variables are provided in the form of mean and standard deviation, and categorical variables are provided in the form of frequencies and percentages. The analysis method was mainly descriptive.

RESULTS

The sample included 7,980 schoolchildren: 3,541 (44.4%) males and 4,439 (55.6%) females, aged 5-17 years. The age distribution was found to be statistically similar between the sexes and therefore provides an equal representation of both childhood and adolescent phases.

Age-related patterns of blood pressure and anthropometry

The average systolic (SBP) and diastolic (DBP) blood pressures increased gradually with age in both sexes. Similar age-specific increases in height and weight were also observed in the canonical growth curves. Body mass index (BMI) showed a temporary minimum in early adolescence, followed by an increase in late adolescence, as anticipated by known developmental patterns.

Table 1: Mean BMI and blood pressure by age group (overall population)

Age Group (years)	Mean BMI (kg/m²)	Mean SBP (mmHg)	Mean DBP (mmHg)
5	21.16 ± 0.23	88 ± 3.3	62 ± 2.1
6–8	19.20 ± 0.31	90 ± 3.1	63 ± 2.2
9–11	17.75 ± 0.33	95 ± 3.3	65 ± 2.6
12–13	15.52 ± 0.24	99 ± 3.3	65 ± 4.2
14–15	17.04 ± 0.23	103 ± 4.3	65 ± 5.2
16–17	17.99 ± 0.35	108 ± 4.2	80 ± 2.5

Note: Age-group sample sizes (n) were not reported in the original dataset; these, together with 95% confidence intervals, should be added by the authors from the underlying data.

Prevalence of hypertension and nutritional status

Children below the age of nine years did not have hypertension. The incidence of high blood pressure increased with age, reaching 4.14% in the 16-17-year-old cohort. At the same time, the number of overweight individuals was rising in the sequential age groups, especially at the adolescent stage. Obesity remained infrequent throughout the whole age range. On the other hand, there was no improvement in weight status between childhood and adolescence, with the highest value in mid-adolescence.

Table 2. Overall Prevalence of Hypertension and Nutritional Status (N = 7,980)

Outcome	Prevalence (%)	n
Hypertension	1.44	115
Overweight	2.56	205
Obesity	0.85	68
Underweight	9.53	761

Note: N = 7,980 (3,541 boys; 4,439 girls). Frequencies and percentages have been recalculated to match the sex-specific values reported in Table 3. 95% confidence intervals and p-values should be reported by the authors.

Sex-specific prevalence patterns

Sex-specific analysis found that there was an upward trend in the prevalence of hypertension and overweight in both male and female cohorts with age. Obesity was not as prevalent in both genders, but underweight was more prevalent than obesity in all age groups. Table 3 provides detailed sex-specific prevalence patterns.

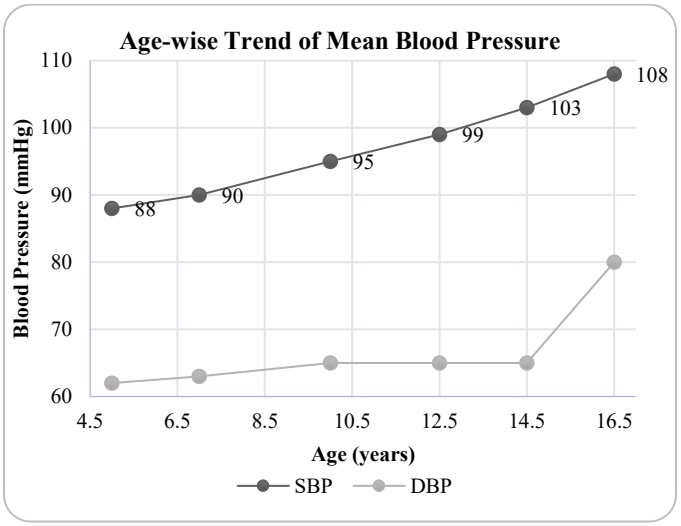
Table 3. Sex-specific prevalence of hypertension and nutritional status

Sex	Hypertension (%)	Overweight (%)	Obesity (%)	Underweight (%)
Boys	1.55	2.44	0.83	10.42
Girls	1.14	4.61	1.10	8.87

Note: Boys, n = 3,541; Girls, n = 4,439. p-values for sex comparisons should be reported by the authors.

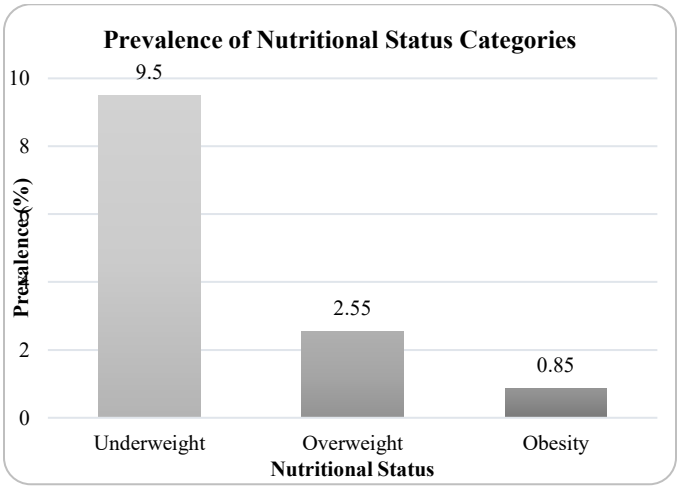
A line graph that shows a gradual rise in systolic and diastolic blood pressure (SBP and DBP) between ages five and seventeen years. The average SBP and DBP levels increase with age, and the increase is especially significant during adolescence (Figure 1).

Figure 1: Age-wise trend of mean systolic & diastolic blood pressure



A bar chart showing the overall prevalence (%) of hypertension, overweight, obesity, and underweight in the total sample (N = 7,980). The chart is not stacked and does not break down results by age group; underweight has the highest overall prevalence, followed by overweight, hypertension, and obesity. (Figure 2)

Figure 2: Overall prevalence of hypertension & nutritional status categories



DISCUSSION

This cross-sectional study provides a comprehensive description of growth patterns, blood pressure levels, and nutritional status among school-going children in Hyderabad, Sindh. The findings demonstrate age-related increases in systolic and diastolic blood pressure, a rising prevalence of overweight during adolescence, persistently low levels of obesity, and a substantial burden of undernutrition. Together, these results reflect the evolving nutritional and cardiovascular health profile of children living in an urban Pakistani setting.

The progressive increase in blood pressure with advancing age observed in both boys and girls is consistent with normal physiological maturation and has been widely reported in pediatric populations worldwide.[15,16] Growth-related increases in cardiac output, vascular resistance, and hormonal changes during puberty contribute to rising blood pressure levels during adolescence.[16] The absence of hypertension in younger children and its emergence during adolescence in the present study further supports the notion that adolescence is a critical period for the early identification of elevated blood pressure.[17]

Although the overall prevalence of hypertension was relatively low, the clear age-related rise, particularly in adolescents aged 16–17 years, is clinically important. Even modest elevations in blood pressure during adolescence have been shown to track into adulthood and are associated with increased cardiovascular risk later in life.[18,19] Similar age-related trends in pediatric hypertension have been reported in South Asian populations, where urbanization and lifestyle changes are contributing to increased cardiometabolic risk among adolescents.[20]

The nutritional profile observed in this study highlights an important dual burden of malnutrition. While overweight prevalence increased steadily with age, obesity remained uncommon across all age groups. In contrast, underweight affected a considerable proportion of children, particularly during mid-adolescence. This pattern differs from that observed in many high-income countries, where childhood obesity predominates, but aligns with findings from several low- and middle-income countries in South Asia where undernutrition and overnutrition coexist.[21, 22]

The comparatively low rates of obesity may be due to variations in eating habits, physical activity, and socioeconomic inequalities within the population. Nevertheless, the growing trend of overweight adolescence suggests a premature shift in lifestyle, such as increased intake of energy-dense foods and decreased physical activity, especially in urban settings.[23, 24] The condition of overweight adolescents is a proven risk factor of obesity and cardiometabolic disease in adulthood, which shows that the current trends can determine the rise in obesity-associated health issues unless preventive strategies are adopted.[25, 26]

Underweight was more common than overweight or obesity in most age categories, which indicated a phenomenon of persistent nutritional deficiencies. Adolescence is a period of high nutritional needs, and poor intake at this stage can negatively affect growth, pubertal progression, and future health outcomes.[27, 28] The coexistence of undernutrition and the rise in overweight highlights the importance of a balanced approach to public health promotion to address nutritional deficiencies and the increase in excess weight, rather than focusing solely on obesity prevention.

Sex-specific analyses showed that there are generally similar age-specific patterns in blood pressure and nutritional status in boys and girls; however, there were differences in the prevalence of overweight and underweight. These differences may be due to sex-specific differences in developmental patterns, the timing of puberty, physical activity, and sociocultural factors that affect dietary habits.[28,29]

CONCLUSION

This study has shown that school-going children in Hyderabad have an age-related rise in blood pressure and prevalence of overweight, coupled with chronic undernutrition. To resolve this twin burden, a combination of school-based and community-level measures to promote healthy growth, balanced nutrition, and cardiovascular health will be required from the early childhood period through adolescence.

LIMITATIONS

This cross-sectional design precludes causal inference regarding the relationships among obesity, nutritional status, and blood pressure. Blood pressure was measured only once per participant, which is a significant methodological limitation; current pediatric guidelines (AAP 2017; AHA 2022) require confirmation of elevated readings on at least two separate occasions before a diagnosis of hypertension can be established. Consequently, the reported hypertension prevalence of 1.44% should be interpreted as a screening estimate and may represent an overestimation. The analysis was primarily descriptive; the absence of inferential statistical testing (e.g., Chi-square, ANOVA, or regression analyses) limits the ability to draw firm conclusions from sex- and age-group comparisons. Pubertal status, dietary intake, and physical activity levels were not assessed, despite their known influence on BMI and blood pressure patterns. The study was conducted exclusively in urban schools, limiting generalizability to rural populations and other regions of Pakistan. Additionally, school-based sampling excludes out-of-school children, who may represent more nutritionally vulnerable groups.

SUGGESTIONS / RECOMMENDATIONS

School-based blood pressure screening programs should be integrated into routine health checkups, particularly targeting adolescents aged 12–17 years, given the observed age-related rise in hypertension prevalence. Nutritional interventions should address the dual burden of undernutrition and overweight simultaneously, rather than focusing solely on obesity prevention. Health education initiatives promoting balanced dietary habits and physical activity should be introduced at the school level from early childhood. Future studies should adopt longitudinal designs and assess pubertal status, dietary intake, and physical activity to better understand the determinants of observed patterns. Research should be extended to rural areas and other provinces of Pakistan to enable broader generalizability of findings. Policymakers should

consider integrating pediatric cardiovascular risk monitoring into national school health programs to enable early identification and timely intervention.

CONFLICT OF INTEREST / DISCLOSURE

The authors thank the administrations, teachers, and staff of the participating schools in Hyderabad, Sindh, for their cooperation during data collection. We are grateful to the children and their parents or guardians for their willingness to participate in this study. The field data collection team is acknowledged for its adherence to standardized measurement protocols. The authors also thank the institutional ethics committee for their review and approval of the study protocol. No external funding was received, and the authors declare no conflicts of interest.

ACKNOWLEDGEMENTS

All authors declare no conflict of interest.

FUNDING

No funding.

REFERENCES

1. Akhtar S, Khan S, Aziz N, Imran M, Samad Z, Iqbal R, et al. Obesity and Risk of Hypertension in Preadolescent Urban School Children: Insights From Pakistan. J Health Popul Nutr. 2024 Jun;43(1):89.
2. Chung ST, Krenek A, Magge SN. Childhood Obesity and Cardiovascular Disease Risk. Curr Atheroscler Rep. 2023 Jul;25(7):405-415.
3. Jańczewska I, Wierzba J, Jańczewska A, Szczurek-Gierczak M, Domżalska-Popadiuk I. Prematurity and Low Birth Weight and Their Impact on Childhood Growth Patterns and the Risk of Long-Term Cardiovascular Sequelae. Children (Basel). 2023 Oct;10(10):1599.
4. Flynn JT, Urbina EM, Brady TM, Baker-Smith C, Daniels SR, Hayman LL, et al. Ambulatory Blood Pressure Monitoring in Children and Adolescents: 2022 Update: A Scientific Statement From the American Heart Association. Hypertension. 2022 Jul;79(7):e114-e124.
5. Huang Z, Li X, Liu X, Xu Y, Feng H, Ren L. Exercise Blood Pressure, Cardiorespiratory Fitness, Fatness and Cardiovascular Risk in Children and Adolescents. Front Public Health. 2024 Jun;12:1298612.
6. Muyulema SL, Carpio-Arias TV, Verdezoto N, Lara VEG, Manzano AS, Pulgar H, et al. Worldwide Trends in Childhood Overweight and Obesity Over the Last 20 Years. Clin Nutr ESPEN. 2025 Feb;65:453-460.
7. Zhang Y, Hu J. Nutrition Challenges in Less Developed Regions: Innovative Solutions. In: Healthy Food for Children. Springer; 2025. p. 189-223.
8. Menghwar B, Laghari ZA, Memon SF, Warsi J, Shaikh SA, Baig NM. Prevalence of Malnutrition in Children Under Five Years' Age in District Tharparkar Sindh, Pakistan. J Pak Med Assoc. 2022 Jan;72(1):33-36.
9. Basu B, Das K, Palodhi M. Impact of Malnutrition on Public Health: A Community-Driven Approach. In: Dietary Supplements and Nutraceuticals. Springer; 2025. p. 727-793.
10. Sharma N, Sanjeevi RR, Balasubramanian K, Chahal A, Sharma A, Sidiq M. A Systematic Review on Prevalence of Overweight and Obesity Among School Children and Adolescents in Indian Population. Indian J Endocrinol Metab. 2024 Mar-Apr;28(2):104-116.
11. Di Bonito P, Di Sessa A, Licenziati MR, Corica D, Wasniewska M, Del Giudice EM, et al. Sex-Related Differences in Cardiovascular Risk in Adolescents With Overweight or Obesity. Rev Cardiovasc Med. 2024 Apr;25(4):141.
12. Tanveer M, Hohmann A, Roy N, Zeba A, Tanveer U, Siener M. The Current Prevalence of Underweight, Overweight, and Obesity Associated With Demographic Factors Among Pakistan School-Aged Children and Adolescents—An Empirical Cross-Sectional Study. Int J Environ Res Public Health. 2022 Sep;19(18):11619.
13. Kretschmer A. Exploring the Role of Weight Stigma in the Development of Eating Disorders Among Food-Insecure People [dissertation]. Columbus: The Ohio State University; 2022.
14. Ding N, Li S, Zhou H, Tang Z, Gao T, Tian M, et al. Exploring the Complex Dynamics of BMI, Age, and Physiological Indicators in Early Adolescents. BMC Pediatr. 2024 Apr;24(1):222.
15. Yang Y, Li Y, Yuan H, Tang Z, Chen M, Cai S, et al. Hypertension-Related Status and Influencing Factors Among Chinese Children and Adolescents Aged 6-17 Years: Data From China Nutrition and Health Surveillance (2015-2017). Nutrients. 2024 Aug;16(16):2685.
16. Wójcik M, Starzyk JB, Drożdż M, Drożdż D. Effects of Puberty on Blood Pressure Trajectories—Underlying Processes. Curr Hypertens Rep. 2023 Jul;25(7):117-125.
17. Chu C, Liao Y-Y, He M-J, Ma Q, Zheng W-L, Yan Y, et al. Blood Pressure Trajectories From Childhood to Youth and Arterial Stiffness in Adulthood: A 30-Year Longitudinal Follow-Up Study. Front Cardiovasc Med. 2022 Jun;9:894426.
18. Alvarez-Pitti J, Herceg-Čavrak V, Wójcik M, Radovanović D, Brzeziński M, Grabitz C, et al. Blood Pressure Response to Exercise in Children and Adolescents. Front Cardiovasc Med. 2022 Sep;9:1004508.
19. Wang J, Zhang J, Gui Y, Huo Y, Xu D, Bai F, et al. Sex-Specific Associations Between Body Mass Index Trajectories and Risk of Hypertension. BMC Pediatr. 2024 Oct;24(1):668.
20. Islam B, Ibrahim TI, Tingting W, Wu M, Jiabi Q. Current Status of Elevated Blood Pressure and Hypertension Among Adolescents in Asia: A Systematic Review. J Glob Health. 2025 Mar;15:04115.
21. Kansra AR, Lakkunarajah S, Jay MS. Childhood and Adolescent Obesity: A Review. Front Pediatr. 2021 Jan;8:581461.
22. Mahumud RA, Sahle BW, Owusu-Addo E, Chen W, Morton RL, Renzaho AM. Association of Dietary Intake, Physical Activity, and Sedentary Behaviours With Overweight and Obesity Among 282,213 Adolescents in 89 Low- and Middle-Income to High-Income Countries. Int J Obes (Lond). 2021 Nov;45(11):2404-2418.
23. Lee KX, Quek KF, Ramadas A. Dietary and Lifestyle Risk Factors of Obesity Among Young Adults: A Scoping Review of Observational Studies. Curr Nutr Rep. 2023 Dec;12(4):733-743.
24. Qureshi S, Iqbal M, Rafiq A, Ahmed H, Malik T, Kalam MN, et al. Dietary Habits and Physical Activity Patterns in Relation to Nutritional Status Among School-Aged Children in Pakistan: A Cross-Sectional Study. AIMS Public Health. 2023;10(3):553.
25. Marketou ME, Buechler NS, Fragkiadakis K, Plevritaki A, Zervakis S, Maragkoudakis S, et al. Visceral Fat and Cardiometabolic Future in Children and Adolescents: A Critical Update. Pediatr Res. 2023 Nov;94(5):1639-1647.
26. Bosy-Westphal A, Müller MJ. Diagnosis of Obesity Based on Body Composition-Associated Health Risks—Time for a Change in Paradigm. Obes Rev. 2021 Mar;22(Suppl 2):e13190.
27. Norris SA, Frongillo EA, Black MM, Dong Y, Fall C, Lampl M, et al. Nutrition in Adolescent Growth and Development. Lancet. 2022 Jan;399(10320):172-184.
28. Shalitin S, Gat-Yablonski G. Associations of Obesity With Linear Growth and Puberty. Horm Res Paediatr. 2022 Jun;95(2):120-136.
29. Alsaker FD, Flammer A. Pubertal Maturation. In: Handbook of Adolescent Development. Psychology Press; 2020. p. 30-50.