Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Sex-specific patterns of thinness, underweight, and obesity among children and adults in seven South Asian countries: a secondary ecological analysis of NCD-RisC 2022 estimates

Dr. Hina Naveed

hinaghufran14@gmail.com

Federal Government Polyclinic Hospital

Dr. MADHIA ABID

National institute of Child Health Karachi Pakistan

Dr Asma Tayyab

PAF Hospital Islamabad

Research Article

Keywords: pediatric obesity, thinness, South Asia, coexisting undernutrition and obesity, sex differences, pediatric endocrinology

Posted Date: November 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11340801/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Background

South Asia continues to experience pediatric thinness alongside rising obesity within the same populations, although these represent different individuals rather than simultaneous weight categories in one person. We performed a secondary ecological analysis of age-standardized 2022 NCD Risk Factor Collaboration (NCD-RisC) estimates for thinness and obesity in girls and boys aged 5–19 years and for underweight and obesity in women and men aged 20 years or older across seven South Asian countries. We derived the summed prevalence of thinness/underweight and obesity, the obesity share of this sum, adult-minus-pediatric obesity-share gradients, adult-to-pediatric obesity ratios, exploratory paired contrasts, and pediatric–adult rank concordance; a 100,000-draw simulation tested sensitivity to rounding of the published whole-percentage source values.

Results

Boys had higher thinness than girls in all seven countries (median 18% versus 14%; median paired difference 3 percentage points; Wilcoxon p = 0.0156), whereas pediatric obesity showed no consistent sex difference (median 5% in boys versus 7% in girls; p = 0.625). Adult obesity was higher in women than men in every country (median 15% versus 7%; median difference 6 percentage points; p = 0.0156). Country rankings for pediatric and adult obesity were concordant (Spearman rho = 0.782 for female strata and rho = 0.901 for male strata). Pakistan combined substantial pediatric thinness with the comparator panel's highest obesity prevalence in boys (10%), women (27%), and men (20%), and had the largest adult-minus-pediatric obesity-share gradient (46.1 points in female strata and 39.6 points in male strata). India retained the highest pediatric thinness (20% in girls and 22% in boys). The rounding-sensitivity analysis preserved the principal directional findings.

Conclusions

The contemporary South Asian nutrition transition is sex-divergent and incomplete: pediatric thinness and obesity are both present in national populations, alongside substantially greater adult obesity, especially among women. Pakistan shows a particularly concerning combination of these population-level patterns in this seven-country comparison. Pediatric endocrine and internal-medicine strategies should combine early obesity and cardiometabolic prevention with continued identification and treatment of thinness, while strengthening transition-focused care from adolescence into adulthood.

Background

The global nutritional landscape in school-aged children and adolescents is changing rapidly. UNICEF reported that, by 2025, obesity among people aged 5–19 years had surpassed underweight globally for the first time, while low- and middle-income countries were carrying most of the growth in pediatric overweight [1]. However, there are significant regional differences within this transnational phenomenon.

In South Asia, thinness remains prevalent while obesity continues to increase. The term "double burden of malnutrition" is not used to imply that a single person simultaneously suffers from thinness (adult underweight) and obesity, but rather to describe the presence of thinness (adult underweight) and obesity among different individuals in the same population.

NCD-RisC has conducted a comprehensive harmonized assessment of this challenge, based on 3,663 population-representative studies and measured height and weight data of 222 million participants. The 2024 analysis estimated low BMI (underweight or thinness) and obesity up to 2022 among adults as well as children and adolescents (5–19 years) and indicated low BMI (underweight or thinness) and obesity as major concerns in South Asian countries such as India and Pakistan [2]. New NCD-RisC analyses based on the latest data project the obesity trend to 2024, and show that many developing regions have continued to experience accelerating trends, while rates have leveled off in several high-income ones [3]. Therefore, thinness/underweight and obesity in 2022 remain clinically relevant in the context of the more recent obesity trajectory.

South Asian pediatric evidence is extensive but fragmented. A recent scoping review listed 296 studies in school-age children and adolescents, and estimates of thinness and obesity were inconsistent, and there were key limitations in nationally representative surveillance [4]. A 2024 meta-analysis agreed that obesity is rising among young populations in South Asia, but mainly concentrated on overweight and obesity, while not examining the overall population trends of being thin and overweight or obese [5]. Secondary analyses of the Global School-Based Student Health Survey identified thinness and overweight in adolescents, and the surveys were conducted back in 2009–2016 and mostly for school-going adolescents (12–15 years) [6]. More recent data from rural Sindh, Pakistan, show underweight and overweight/obesity among adolescents, but represent a subnational sample [7]. It is also evident from national-level data on India that micronutrient deficiencies and metabolic abnormalities can occur at different BMI levels at both individual and national levels [8].

However, a gap still exists in the interface between the nutritional phenotype of children and adults. Pediatric endocrinology has become more aware of the problem of obesity as a chronic condition with long-term implications that will need to be addressed in adult internal medicine, but there is a transition in care at 18 or 19 years of age, or at 20. An ecological comparison of age strata across countries can therefore offer a useful clinical parallel: a snapshot of population patterns, rather than a longitudinal estimate; an evaluation that determines overall whether pediatric obesity is associated with adult obesity, whether the associations between thinness and obesity vary by age group, and whether they vary by sex.

This study aimed to understand sex-specific trends and patterns of thinness/underweight and obesity among children, adolescents, and adults in the seven South Asian countries covered in the NCD-RisC 2022 country comparator. We also sought to quantify the proportion of the sum of low-BMI and obesity prevalence attributable to obesity; to explore and quantify the adult-to-pediatric obesity-share gradient, country-level agreement between pediatric and adult obesity prevalence, and describe the obesity profile

of Pakistan in comparison with neighboring countries. In a targeted literature search updated through 4 October 2026, we did not identify a prior South Asian study combining these four elements in one sex-stratified pediatric–adult ecological framework; this is therefore presented as a focused gap rather than a claim of absolute global novelty.

Methods

Study design and data source

We performed a secondary ecological analysis based on publicly available, age-standardized prevalence estimates that were produced by NCD-RisC for 2022. Thinness in girls and boys aged 5–19 years and underweight in women and men aged 20 years or older were copied from the NCD-RisC India country fact sheet, which shows a South Asia comparator panel for Afghanistan, Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka [9]. The estimates are based on the Bayesian hierarchical modeling framework used in the main Lancet analysis [2]. The NCD-RisC archive provides links to the 2024 country data releases by age group, and the collaboration's code and data are available through Zenodo [10, 11].

The analysis deliberately applied the seven countries shown in the NCD-RisC South Asia country-comparison panel as opposed to using another geopolitical definition. Maldives was not shown in that comparator panel, and was therefore not added from a separate source. Findings should, accordingly, be understood to be relevant to these seven countries and not necessarily to other countries which may be encompassed within other definitions of South Asia.

Outcome definitions

Thinness for girls and boys aged 5–19 years, according to NCD-RisC, was defined as BMI-for-age < − 2SD of the WHO growth reference and obesity as BMI-for-age > + 2SD of the WHO growth reference. Underweight was defined as BMI < 18.5 kg/m² and obesity was defined as BMI ≥ 30 kg/m² [2] for females and males aged ≥ 20 years. Prevalence estimates in the fact sheets were age-standardized to the WHO standard population [9]. The combined prevalence of thinness and obesity, as well as underweight and obesity, has been calculated for pediatric and adult strata respectively, as thinness and obesity are mutually exclusive in each sex-age group. This amount is an estimate of the proportion of people that may be affected by either BMI extreme; this does not suggest that both extremes may exist in the same person.

We calculated the obesity share of combined prevalence by calculating the prevalence of obesity divided by the sum of thinness/underweight and obesity prevalence and multiplying by 100. This measure reflects relative thinness/underweight prevalence versus obesity prevalence of these two different BMI categories without setting any arbitrary categorization level. Adult-minus-pediatric obesity-share gradient was computed as adult obesity share – pediatric obesity share and in percentage points for each sex stratum. Also, the ratio of adult obesity prevalence to children's obesity prevalence for both sexes was

calculated. These are ecological indices and should not be taken as individual life-course transition probabilities.

Statistical analysis

Each country was treated as an analytical unit. Since the study consisted of the full seven-country comparator and not a random sample of people, the main analysis was descriptive - i.e., medians and interquartile ranges were used to describe the range of country prevalences and derive indicators, with country rankings reported directly. No population weighting was used, as the aim was the comparison of phenotypes across countries, and we did not aim to estimate a pooled South Asian population prevalence.

Within-country differences among boys versus girls, women versus men, and pediatric versus adult obesity strata were explored via paired Wilcoxon signed-rank tests. Concordance between obesity rankings in childhood/adolescence and adulthood (separately in the female and male strata) was evaluated using Spearman rank correlations. The $p < 0.05$ values were descriptive signals and not used for confirmatory causal inferences; no multiplicity adjustment was planned. Analyses were performed in Python 3.13.5 using NumPy 2.3.5, pandas 2.2.3, and SciPy 1.17.0. The manuscript is supplemented with reproducibility code and the extracted dataset.

NCD-RisC comparator values from the public fact sheet are rounded to the nearest whole percentage. We conducted a prespecified rounding-sensitivity analysis with 100,000 Monte Carlo draws to consider how rounding might affect the key results. Each observed prevalence was sampled within a range of 1 percentage point above and below the published prevalence. All key indices and country rankings were recomputed. This procedure assesses rounding sensitivity only and does not replace the posterior uncertainty intervals of the underlying NCD-RisC model.

Results

Country-level pediatric thinness and obesity

Across the seven countries, median thinness prevalence was 14.0% (IQR 7.5–15.0) in girls and 18.0% (IQR 11.0–19.0) in boys. Thinness prevalence were higher for boys than for girls in each country (median within-country difference 3 percentage points, range 2–5, Wilcoxon $W = 0$, $p = 0.0156$). The highest figures for pediatric thinness occurred in India (20% in girls and 22% in boys), followed by high values in Sri Lanka, Pakistan and Bangladesh. Overall, pediatric obesity was lower and showed greater heterogeneity by sex than that of adults: median 7.0% (IQR 3.0-7.5%) and 5.0% (IQR 3.0-7.5%), respectively, with no consistent paired sex difference ($W = 8$, $p = 0.625$). Obesity prevalence was highest among girls in Afghanistan (9%) and boys in Pakistan (10%) (Table 1; Fig. 1).

Table 1
Pediatric thinness, obesity, and combined prevalence in 2022

Country	Girls thinness (%)	Girls obesity (%)	Boys thinness (%)	Boys obesity (%)	Girls combined burden (%)	Boys combined burden (%)
Afghanistan	6	9	10	8	15	18
Bangladesh	14	2	19	2	16	21
Bhutan	4	7	6	5	11	11
India	20	3	22	4	23	26
Nepal	9	3	12	1	12	13
Pakistan	14	7	19	10	21	29
Sri Lanka	16	8	18	7	24	25

Note: Combined burden = prevalence of thinness or obesity (sum of mutually exclusive categories); source values are rounded age-standardized prevalences from the NCD-RisC 2022 country comparator.[9]

The median combined prevalence of pediatric thinness and obesity was 16.0% (IQR 13.5–22.0) in girls and 21.0% (IQR 15.5–25.5) in boys. The highest combined burden in boys occurred in Pakistan (29%), followed by India (26%) and Sri Lanka (25%). Among girls, Sri Lanka (24%), India (23%), and Pakistan (21%) had the highest values. These patterns show that a country can have a high combined burden for different reasons: India's burden was predominantly thinness, whereas Afghanistan and Bhutan had a substantially greater contribution from obesity among girls.

Adult underweight–obesity profile

Adult patterns differed sharply from pediatric patterns. Median obesity prevalence was 15.0% (IQR 9.5–20.0) in women and 7.0% (IQR 5.0–12.5) in men. Women had a higher obesity prevalence than men in every country, with a median within-country difference of 6 percentage points (range 4–9; $W = 0$, $p = 0.0156$). In contrast, adult underweight did not show a consistent sex difference (median 10% in women and 9% in men; $W = 6$, $p = 0.750$). Pakistan had the highest adult obesity prevalence in both sexes (27% in women; 20% in men) and the highest combined adult burden (34% in women; 27% in men) (Table 2).

Table 2
Adult underweight, obesity, and combined prevalence in 2022

Country	Women underweight (%)	Women obesity (%)	Men underweight (%)	Men obesity (%)	Women combined burden (%)	Men combined burden (%)
Afghanistan	6	24	5	15	30	20
Bangladesh	11	8	14	3	19	17
Bhutan	3	16	3	10	19	13
India	14	10	12	5	24	17
Nepal	10	9	9	5	19	14
Pakistan	7	27	7	20	34	27
Sri Lanka	10	15	14	7	25	21

Note: Combined burden = prevalence of underweight or obesity (sum of mutually exclusive categories). Women and men are aged ≥ 20 years; values are rounded age-standardized prevalences from NCD-RisC. [9]

Pediatric–adult obesity-share gradient

The share of the summed low-BMI and obesity prevalence represented by obesity increased from the pediatric to the adult stratum in every country for both sexes (Table 3; Fig. 2). The median obesity share was 33.3% in girls and 28.0% in boys, compared with 60.0% in women and 35.7% in men. The median adult-minus-pediatric obesity-share gradient was 26.7 percentage points for female strata and 28.0 points for male strata. Pakistan had the largest gradient for both sexes: 46.1 points for female strata and 39.6 points for male strata. This indicates that thinness contributed more than obesity to the combined pediatric prevalence in Pakistan, whereas obesity contributed more in adult strata.

Table 3
Obesity share and pediatric–adult gradients by country

Country	Girls obesity share (%)	Boys obesity share (%)	Women obesity share (%)	Men obesity share (%)	Female gradient (pp)	Male gradient (pp)
Afghanistan	60.0	44.4	80.0	75.0	20.0	30.6
Bangladesh	12.5	9.5	42.1	17.6	29.6	8.1
Bhutan	63.6	45.5	84.2	76.9	20.6	31.5
India	13.0	15.4	41.7	29.4	28.6	14.0
Nepal	25.0	7.7	47.4	35.7	22.4	28.0
Pakistan	33.3	34.5	79.4	74.1	46.1	39.6
Sri Lanka	33.3	28.0	60.0	33.3	26.7	5.3

Note: Obesity share = obesity/(thinness or underweight + obesity) × 100; categories are mutually exclusive. Gradient = adult obesity share − pediatric obesity share. pp, percentage points.

Cross-age concordance and sensitivity analyses

Adult obesity prevalence exceeded the corresponding pediatric obesity prevalence in all seven female-stratum comparisons (median adult-to-pediatric ratio 3.00; IQR 2.48–3.60; W = 0, p = 0.0156). For male strata, it was higher in six countries and equal at the displayed precision in Sri Lanka (median ratio 1.88; IQR 1.38–2.00; W = 0, p = 0.0313). Countries with higher pediatric obesity also tended to rank higher for adult obesity: Spearman rho = 0.782 (p = 0.0378) for girls versus women and rho = 0.901 (p = 0.0056) for boys versus men (Fig. 3). These correlations are ecological and do not demonstrate individual tracking.

Table 4
Exploratory paired comparisons and rank correlations

Analysis	Median A	Median B	Median difference	Statistic	p value
Boys vs girls thinness	18.0	14.0	3.0 pp	W = 0	0.0156
Boys vs girls obesity	5.0	7.0	−1.0 pp	W = 8	0.6250
Women vs men obesity	15.0	7.0	6.0 pp	W = 0	0.0156
Women vs girls obesity	15.0	7.0	7.0 pp	W = 0	0.0156
Men vs boys obesity	7.0	5.0	4.0 pp	W = 0	0.0313
Women vs men underweight	10.0	9.0	0.0 pp	W = 6	0.7500
Girls vs women obesity rank				rho = 0.782	0.0378
Boys vs men obesity rank				rho = 0.901	0.0056

Note: Wilcoxon signed-rank tests and Spearman correlations are exploratory country-level analyses based on rounded public prevalences; pp, percentage points.

The rounding-sensitivity analysis supported the stability of the main findings. Across all 100,000 draws, boys remained thinner than girls in every country; women remained more obese than men in every country; female adult obesity remained higher than female pediatric obesity in every country; and Pakistan retained the highest obesity prevalence among women, men, and boys. Pakistan retained the largest female obesity-share gradient in 100% of simulations and the largest male gradient in 99.94%. The 2.5th–97.5th percentile range of simulated Spearman coefficients was 0.714–0.821 for female strata and 0.857–0.929 for male strata. These ranges reflect rounding sensitivity, not model-based confidence intervals.

Discussion

Principal findings

Across seven countries in South Asia, there is a sex-divergent nutrition transition visible in the pediatric–adult age group. First, pediatric thinness remains substantial and is consistently higher in boys than girls. Second, children are already obese, and the sex trend of obesity differs across countries. Thirdly, the presence of adult obesity becomes evident and is significantly higher in women compared to men across all countries. Fourth, pediatric and adult obesity rankings show strong between-country concordance. Lastly, Pakistan is in a particularly worrying situation, having the highest obesity prevalence in boys and adults and having a high prevalence of thinness in children, thus generating the highest 'obesity-share shift' between the two strata.

This should not be interpreted as proof that thin children turn into obese adults. The design is ecological and cross-sectional. Instead, the findings describe population-level coexistence of low BMI and obesity among different individuals: the challenge is for the same national-level health systems to tackle chronic childhood nutritional deficiencies and prevent excessive fat accumulation and metabolic diseases. This is in line with the NCD-RisC global analysis, which identified that obesity is a growing component of the combined prevalence of low BMI and obesity in spite of thinness being dominant [2]. In addition, the 2026 obesity analysis reveals that the obesity trend in many developing contexts is continuing to increase [3].

Comparison with regional evidence

Our pediatric findings extend earlier South Asian evidence while highlighting important differences. These findings highlight the large variation in data across the region, and the lack of comparable national-level data across the school-age population [4]. Although Bansal et al. performed a meta-analysis that uncovered an increasing burden of obesity in the young, they did not associate obesity with thinness and adult levels [5]. Analysis of the Global School-Based Student Health Survey showed that adolescents are both thin and overweight, with country-specific sex differences, but used older school-based surveys [6]. A 2026 rural Pakistani study reported an underweight prevalence of 18.3% and an overweight/obesity prevalence of 4.2% for young people and adolescents in rural areas, illustrating the heterogeneity of undernutrition and excess weight among the different groups of adolescents living in the same environment [7]. We incorporated a harmonized 2022 national-model perspective, and compared the pediatric patterns to those of adult obesity in the same countries.

The Indian CNHS analysis reveals that micronutrient deficiencies and/or the presence of abnormal metabolic markers may exist with either undernutrition or obesity [8]. Our index, in contrast, counts only the two mutually exclusive BMI extremes and is a deliberately narrow, reproducible indicator rather than a complete measure of nutritional or endocrine health. Its power is its capacity to reveal patterns of nutrition transition with standardized definitions of what happens across countries, highlighting cross-country patterns and sex differences.

Pediatric endocrine and internal-medicine implications

This is important clinically as it suggests that South Asian youth may be at risk for cardiometabolic disease at lower BMI and earlier ages than other ancestral groups [12]. There are also differences in body composition, with greater adiposity and metabolic risk at any BMI for many South Asian children [13]. Therefore, the comparatively low obesity rates reported in children in some countries do not necessarily indicate low metabolic risk. Dyslipidemia, hypertension, fatty liver disease, and other metabolic complications can begin in childhood before the onset of obesity, and may coexist with insulin resistance [14].

Contemporary obesity guidelines treat pediatric obesity as a chronic disease that warrants active assessment and treatment rather than watchful waiting [15]. However, an obesity-only response would not go far enough in South Asia. The consistently high thinness in boys and the combined thinness-and-

obesity prevalence in India, Pakistan, Bangladesh, and Sri Lanka argue for dual-track services: growth-faltering and nutritional deficiency pathways must remain active while pediatric endocrine services build capacity for obesity, hypertension, dyslipidemia, metabolic dysfunction-associated steatotic liver disease, and type 2 diabetes prevention. This approach is particularly relevant to Pakistan, where the source data show that boys' obesity ranks first in the seven-country comparator while adult obesity is also the highest in both sexes.

In addition, pediatric–adult concordance allows for improved prevention with a transition focus. Evidence suggests that BMI pathways from childhood to adulthood contribute to future cardiovascular and metabolic outcomes [16], and systematic reviews provide evidence associating childhood body size with future cardiometabolic NCD risk [17]. Recent synthesis indicates that apparently metabolically healthy childhood obesity may have adult cardiometabolic repercussions, which may differ by phenotype [18]. Therefore, regional pediatric endocrine programs should create definite transition programs from pediatric obesity/metabolic risk to the adult world of medicine rather than ending preventive care at age 18 or 19.

Sex divergence

Careful attention is given to the sex difference observed. Boys were thinner than girls in all countries, while obesity was higher in women than men across all seven countries. The mechanism is not identifiable based on the overall data but may include several factors, including reproductive, biological, social, life-course, and physical activity, as well as dietary factors. The equal sex distribution of pediatric obesity is not necessarily the baseline pattern that would result in the female preponderance of adult obesity. Future research should thus focus on individual-level longitudinal measures of puberty, weight changes due to pregnancy, socio-economic changes, physical activity, dietary exposure, and sex-based access to health care.

Strengths and limitations

The principal strength is comparability. The estimates share the NCD-RisC framework, use measured anthropometry from population-based studies, and are age-standardized with harmonized definitions across sex and age strata [2]. The analysis is clearly described and reproducible, and data, derived data, statistical summary, sensitivity analysis and the code are provided as supplementary files. This obesity-share measure also does not designate an arbitrary disease threshold, but rather quantifies the makeup of the current, widely used aggregated anthropometric burden measure.

Several limitations are material. First, the source country comparator reports whole-number percentages; derived values and exploratory p-values therefore inherit rounding uncertainty. This 100,000-draw analysis assesses robustness to rounding; it does not mimic the posterior uncertainty in NCD-RisC. Second, it is ecological and cross-sectional, and adult-to-pediatric ratios and gradients must not be interpreted as evidence of individual tracking or causality. Third, the use of broad age groups (5–19 years and ≥ 20 years) masks puberty, adolescence, young adulthood, and the heterogeneity of the oldest adults. Fourth, BMI cutoffs are different for the pediatric and adult strata, showing appropriate variation,

and age comparison is to prevalence patterns only, not based on the same biological cutoffs. Fifth, the NCD-RisC comparator displayed seven South Asian countries; Maldives was not included, and we did not merge estimates from a different source. Sixth, individual-level data on the variables residence, income, diet, physical activity, pubertal stage, pregnancy, and metabolic biomarkers were not available. Lastly, no population weights were assigned, and each country gets the same weight for cross-country comparisons; the results do not represent population-weighted averages for South Asia.

Conclusions

In seven South Asian countries, trends in low BMI and overweight/obesity are not uniform, and do not demonstrate a 'substitution' from low BMI to high BMI. Pediatric thinness is still important, particularly among boys, and adult obesity becomes significantly more important, especially among women, and pediatric obesity is present in selected countries. At the population level, Pakistan also has a significant level of pediatric and adult obesity with pediatric thinness, and has the largest pediatric–adult obesity-share gradient in this comparison. On the clinical side, this combination of results lends itself to integration of a regional strategy involving preservation of capacity to diagnose and treat thinness, scaling up of clinically effective pediatric obesity and metabolic-risk care, and development of a structured pathway of transition into adult internal medicine. Future studies should test the validity of the ecological patterns found here using unrounded country estimates and posterior intervals alongside individual-level longitudinal data in order to see whether the ecological patterns found here are measurable life-course risk trajectories.

Abbreviations

BMI , body-mass index

IQR , interquartile range

NCD-RisC , NCD Risk Factor Collaboration

pp , percentage points

WHO , World Health Organization

Declarations

Author Contribution

HN conceived and designed the study, developed the research methodology, contributed to secondary data extraction and statistical analysis, and prepared the initial manuscript draft. MA contributed to data interpretation, evaluation of the pediatric and endocrine implications, and critical revision of the manuscript for important intellectual content. AT contributed to secondary data extraction, data

verification, interpretation of findings, and critical review of the manuscript. All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

Data Availability

Availability of data and materials This study used publicly available, aggregate-level secondary data from the NCD Risk Factor Collaboration (NCD-RisC) 2022 country estimates. The original data are accessible through the NCD-RisC website (https://www.ncdrisc.org/) and the associated publicly available data repository (https://doi.org/10.5281/zenodo.10534961). The extracted dataset, derived analytical variables, statistical summaries, rounding-sensitivity analysis, and reproducibility code are provided as supplementary materials accompanying this manuscript. No individual-level or personally identifiable data were collected or analyzed.

References

1. UNICEF (2025) Feeding Profit: How food environments are failing children. Child Nutrition Report 2025. United Nations Children's Fund, New York. https://data.unicef.org/resources/feeding-profit-2025-child-nutrition-report/. Accessed 4 October 2026.
2. NCD Risk Factor Collaboration (NCD-RisC) (2024) Worldwide trends in underweight and obesity from 1990 to 2022: a pooled analysis of 3663 population-representative studies with 222 million children, adolescents, and adults. Lancet 403(10431):1027–1050. https://doi.org/10.1016/S0140-6736(23)02750-2
3. NCD Risk Factor Collaboration (NCD-RisC) (2026) Obesity rise plateaus in developed nations and accelerates in developing nations. Nature 653:510–518. https://doi.org/10.1038/s41586-026-10383-0
4. Choedon T, Brennan E, Joe W, Lelijveld N, Huse O, Zorbas C, Backholer K, Murira Z, Wrottesley SV, Sethi V (2024) Nutritional status of school-age children (5–19 years) in South Asia: a scoping review. Matern Child Nutr 20(2):e13607. https://doi.org/10.1111/mcn.13607
5. Bansal D, Safeer VS, Devi N, Boya C, Babu KD, et al (2024) Trends estimation of obesity prevalence among South Asian young population: a systematic review and meta-analysis. Sci Rep 14:596. https://doi.org/10.1038/s41598-023-50973-w
6. Estecha Querol S, Iqbal R, Kudrna L, Al-Khudairy L, Gill P (2021) The double burden of malnutrition and associated factors among South Asian adolescents: findings from the Global School-Based Student Health Survey. Nutrients 13(8):2867. https://doi.org/10.3390/nu13082867
7. Hashmi M, Rehman N, Rizvi A, Padhani ZA, Kumari B, Mirani M, et al (2026) Double burden of malnutrition and its associated factors among adolescents aged 10–19 years in a rural district of Pakistan. PLOS Glob Public Health 6(6):e0006457. https://doi.org/10.1371/journal.pgph.0006457
8. Ji N, Kumar A, Joe W, Kuriyan R, Sethi V, Finkelstein JL, Mehta S (2024) Prevalence and correlates of double and triple burden of malnutrition among children and adolescents in India: the

Comprehensive National Nutrition Survey. J Nutr 154(10):2932–2947. https://doi.org/10.1016/j.tjnut.2024.08.021

9. NCD Risk Factor Collaboration (NCD-RisC) (2024) Underweight and obesity in India, 2022: country fact sheet with South Asia comparator estimates. https://www.ncdrisc.org/downloads/country-pdf/double-burden/NCD-RisC%20country%20factsheet%20India.pdf. Accessed 4 October 2026.
10. NCD Risk Factor Collaboration (NCD-RisC) Archives of outdated estimates by NCD Risk Factor Collaboration (NCD-RisC). https://www.ncdrisc.org/archives.html. Accessed 4 October 2026.
11. NCD Risk Factor Collaboration (NCD-RisC) (2024) Code and data sharing for worldwide trends in underweight and obesity from 1990 to 2022. Zenodo, version 1.0. https://doi.org/10.5281/zenodo.10534961
12. Wolf RM, Nagpal M, Magge SN (2021) Diabetes and cardiometabolic risk in South Asian youth: a review. Pediatr Diabetes 22(1):52–66. https://doi.org/10.1111/pedi.13078
13. Sivasubramanian R, Malhotra S, Fitch AK, Singhal V (2021) Obesity and metabolic care of children of South Asian ethnicity in Western society. Children (Basel) 8(6):447. https://doi.org/10.3390/children8060447
14. Luo Y, Luo D, Li M, Tang B (2024) Insulin resistance in pediatric obesity: from mechanisms to treatment strategies. Pediatr Diabetes 2024:2298306. https://doi.org/10.1155/2024/2298306
15. Hampl SE, Hassink SG, Skinner AC, Armstrong SC, Barlow SE, Bolling CF, et al (2023) Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity. Pediatrics 151(2):e2022060640. https://doi.org/10.1542/peds.2022-060640
16. Kibret KT, Strugnell C, Backholer K, Peeters A, Tegegne TK, Nichols M (2024) Life-course trajectories of body mass index and cardiovascular disease risks and health outcomes in adulthood: systematic review and meta-analysis. Obes Rev 25(4):e13695. https://doi.org/10.1111/obr.13695
17. Bander A, Murphy-Alford AJ, Owino VO, Loechl CU, Wells JCK, Gluning I, Kerac M (2023) Childhood BMI and other measures of body composition as a predictor of cardiometabolic non-communicable diseases in adulthood: a systematic review. Public Health Nutr 26(2):323–350. https://doi.org/10.1017/S136898002200235X
18. Huang J-S, Zhang X-Y, Ramakrishnan R, Chu J-Q, Lu M-S, Shao D-T, Qiu X, He J-R (2026) Association of childhood obesity phenotypes with cardiometabolic outcomes in adulthood: a systematic review and meta-analysis. Obes Rev 27(1):1–10. https://doi.org/10.1111/obr.70006

Figures

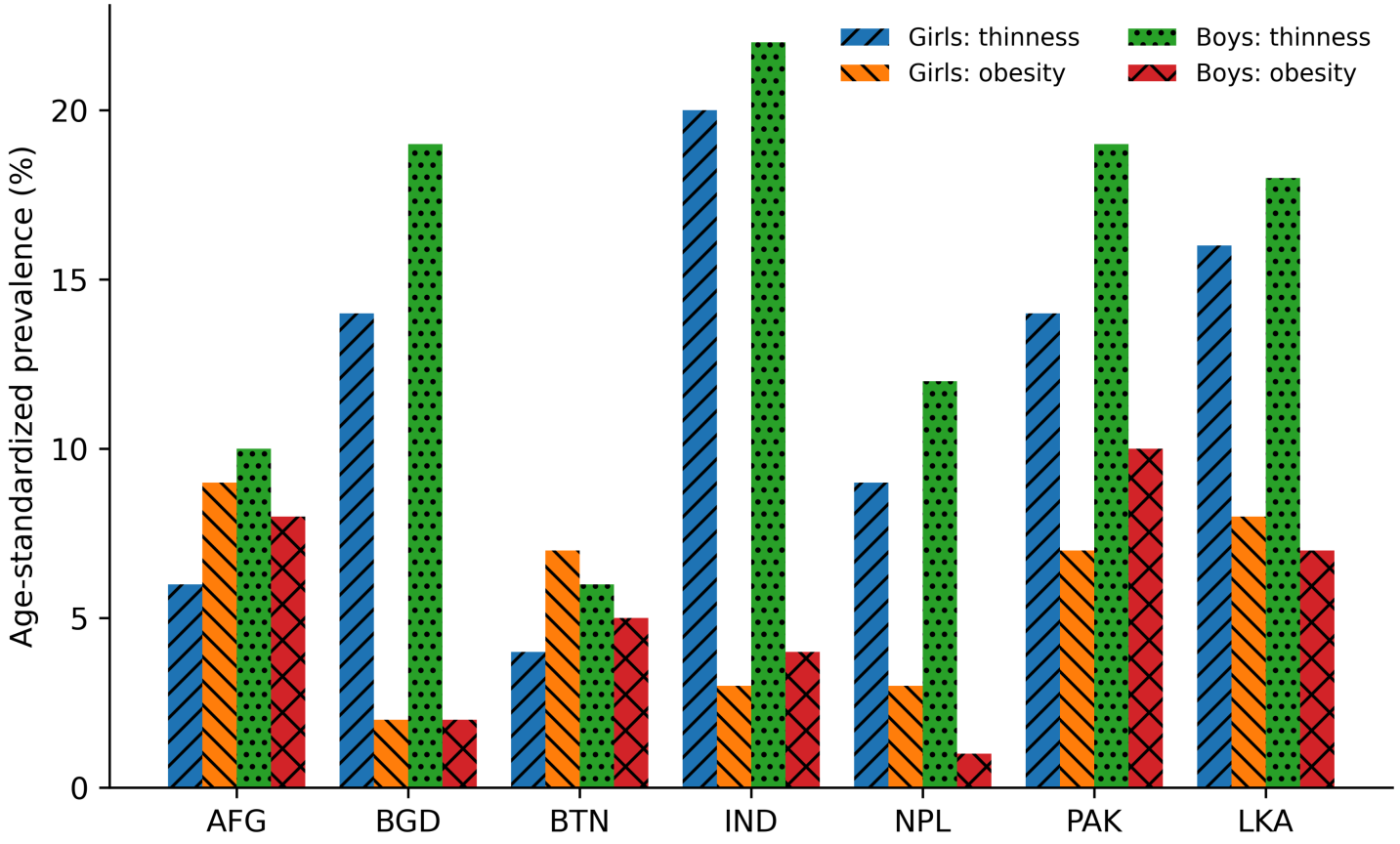


Figure 1

Pediatric thinness and obesity across seven South Asian countries. Bars show 2022 age-standardized prevalence. AFG Afghanistan, BGD Bangladesh, BTN Bhutan, IND India, NPL Nepal, PAK Pakistan, LKA Sri Lanka.

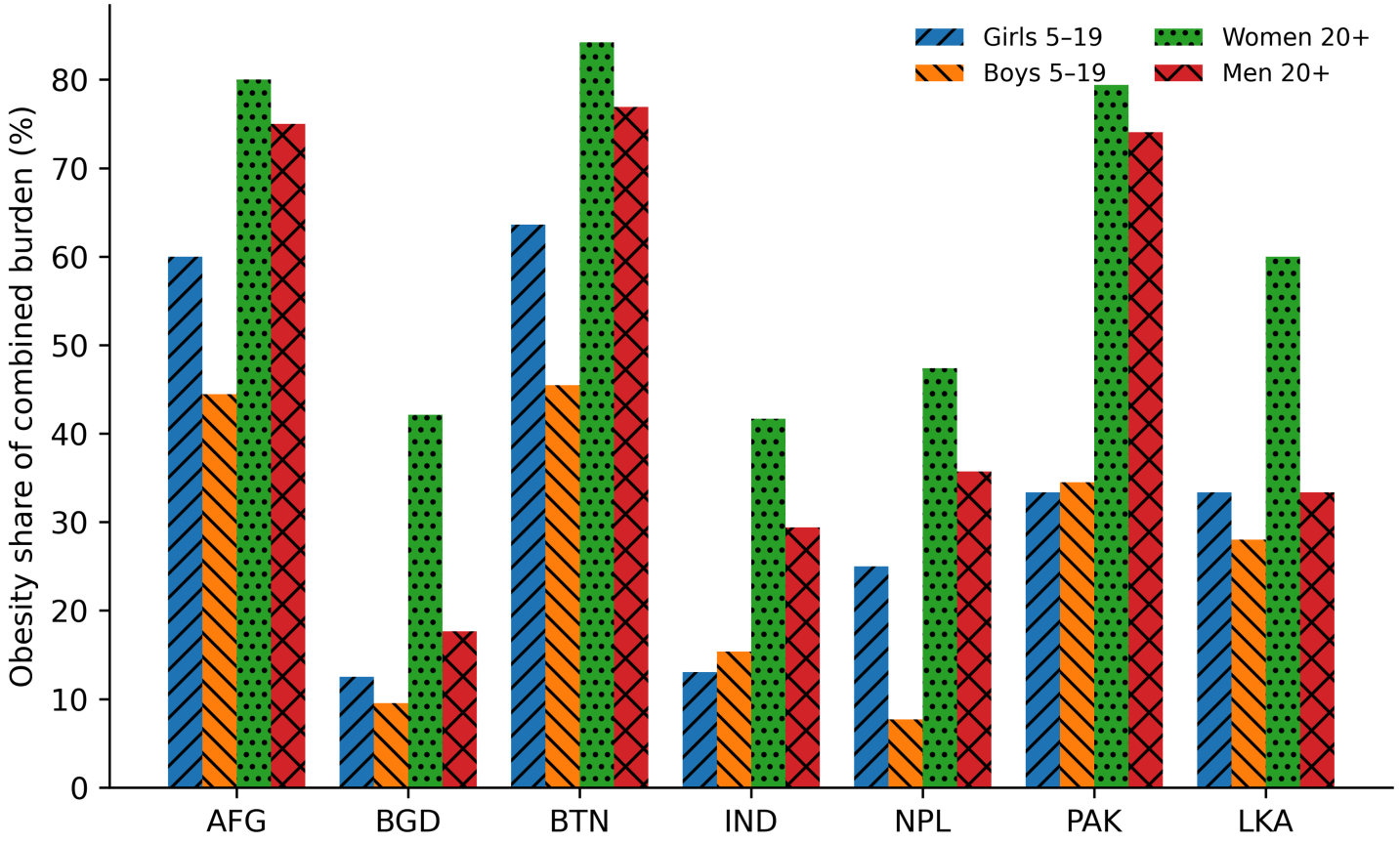


Figure 2

Obesity share of the combined low-BMI and obesity prevalence by age-sex stratum. The obesity share is obesity divided by the combined thinness/underweight-plus-obesity burden. Country abbreviations are defined in Figure 1

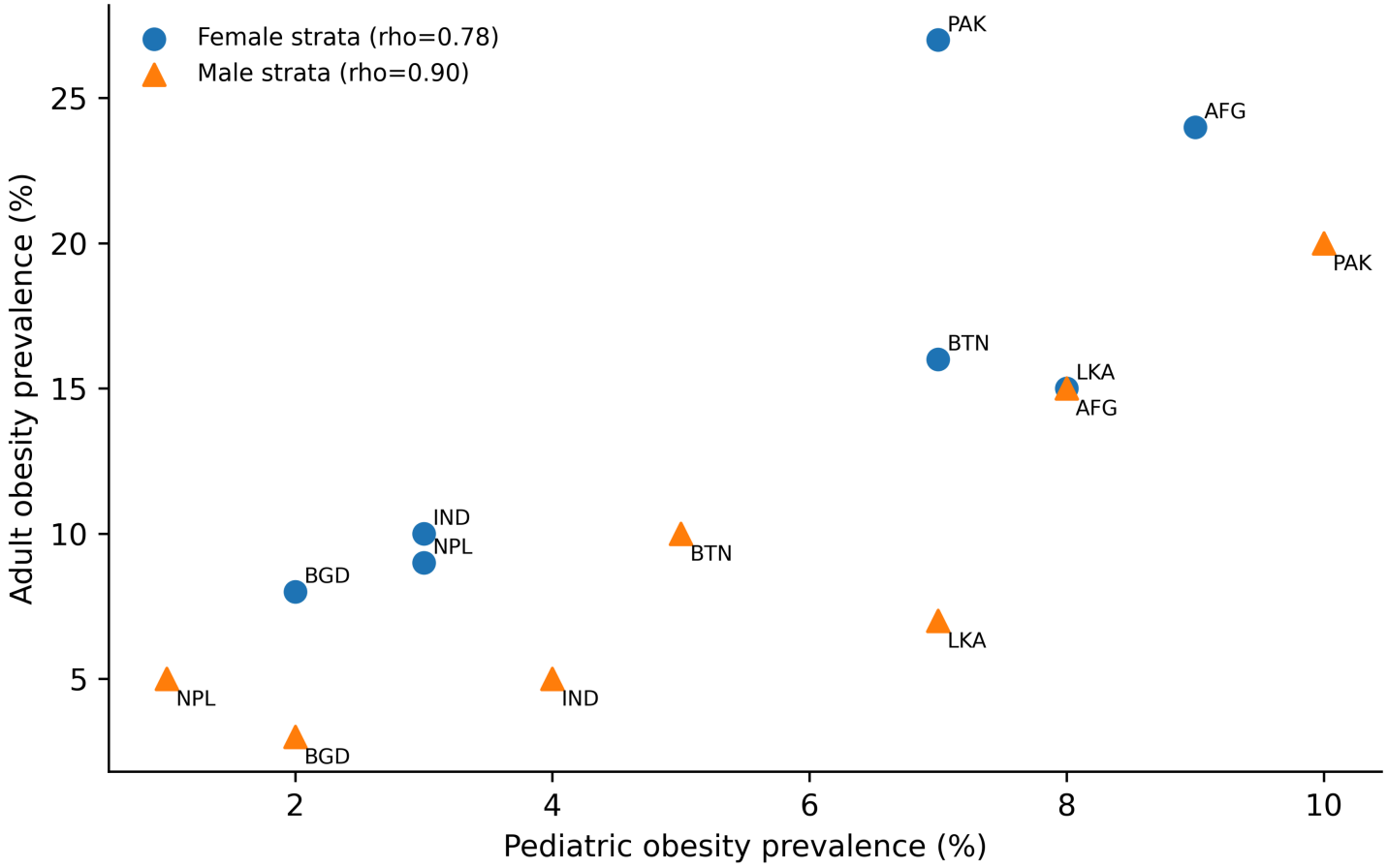


Figure 3

Country-level concordance between pediatric and adult obesity prevalence. Each point is a country. Female strata compare girls aged 5–19 years with women aged ≥20 years; male strata compare boys with men. rho denotes the Spearman rank correlation coefficient.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile1analysisdata.csv
- Additionalfile3roundingsensitivity.csv
- Additionalfile2statisticalsummary.csv
- Additionalfile4reproducibilitycode.py
- Additionalfile5analysisworkbook.xlsx