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ORIGINAL ARTICLE

Young Turkish Adults Show a Continuing Positive Secular Change of Height But an Alarming Increase of Overweight in Males: Pilot Study for the Initiation of Updated Growth Charts

Bayrak Demirel O et al. Secular Height Change and Male Overweight in Turkey

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What is already known on this topic?
Current Turkish growth charts are based on data from 1989 to 2002. Positive secular trends in height are observed globally, and updating growth references every 20 years is recommended. Obesity is a global issue with rising prevalence, and monitoring body mass index is crucial due to its long-term health implications.

What this study adds?
The present study shows that Turkish young adults' height increased by 1.8 cm over two decades, consistent with a continuing positive secular trend. The study demonstrated that females' BMI remained stable, while males showed a significant and alarming increase in BMI, with 58% classified as overweight or obese.

Abstract
Objective: Turkish growth reference charts are based on 1989-2002 data. Globally, positive secular trends in height have been observed, and updating growth charts every 20 years is recommended. Additionally, obesity is a rising health issue worldwide. This study investigates if there has been a further increase in young Turkish adults' mean height and BMI compared to previous national data (TK2002) and Turkish-origin young adults in the Netherlands. It also explores the association between adult height and BMI with socioeconomic status (SES) and geographical region.
Methods: This cross-sectional study (2023-2024) included 217 females and 218 males, aged 18-26, voluntarily recruited from Istanbul University, representing all regions of Turkey. Height, weight, and SES were recorded. The top two SES groups were combined for analysis.
Results: Sample distribution aligned with Turkey's regional population distribution. Mean height was 1.8 cm taller in females (p=0.003) and males (p<0.001) compared to TK2002, and also taller (2.3 and 0.5 cm, respectively, p<0.001 and p=0.03) than in NL2009. BMI was significantly higher in males than in TK2002 and NL2009 (p<0.001).
Conclusion: Final height of Turkish students increased by 1.8 cm in both sexes over two decades. Males' BMI was alarmingly high (58% overweight or obese). A population growth study to generate updated growth charts from birth to young adulthood and prevention programs to reduce obesity are needed.
Keywords: body mass index, final height, growth, secular trend, obesity

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Introduction

Anthropometric measurements play a crucial role in tracking children's growth and development. Growth references are benchmarks for assessing children's health and comparing their growth with peers. A population's height is influenced by environmental factors [particularly nutrition and socioeconomic status (SES) (1), which can lead to a "secular trend". Therefore, up-to-date national references for height assessment are needed (2). Body mass index (BMI) is even more strongly affected by environmental influences, as illustrated by the obesity epidemic in the last five decades (3).
The first growth references in Turkey (1968-1970) were collected in 0-18 year old youngsters of high SES living in Istanbul (4). The subsequent study (TK2002) included 6-18 year old students attending primary and secondary schools located in six districts of Istanbul city in 1989-2002 and showed a mean height increase of 1.4 cm and 2.7 cm in 17-year-old males and females, respectively. Notably, height differences were compared using data from 17-year-olds, as the first study lacked sufficient height data for the 18-year-old group (5). Mean weight increased by 4.5 and 1.5 kg in 18-year-old males and females, respectively.
It has been recommended that growth references should be reassessed every 5-10 or 15-20 years for populations where large (≥1 cm/decade) or little secular change is expected, respectively (6). Before embarking on an expensive nation-wide growth study, we performed a pilot study in young adults to determine whether the positive secular trend of height has continued and to assess current BMI. While a positive secular change of height is generally considered a positive indicator of a population's health status, a BMI increase is associated with negative consequences of overweight and obesity for individuals and society (3). Young adulthood can be considered a suitable life stage to assess final height and BMI, as it reflects the cumulative outcomes of childhood growth and nutrition.

The primary aim of this study was to test our hypothesis that mean height and BMI of young Turkish adults is higher compared with previous national data (TK2002). The secondary aim was to compare current height and BMI of young Turkish adults with those of young adults of Turkish origin living in the Netherlands measured in 2009 (NL2009) (7-9). Thirdly, we aimed to explore the association between final height and BMI with SES and geographical region.

Methods

Study setting

A prior power analysis (95% power) indicated that at least 122 subjects of each sex were needed to detect a 1.8 cm height increase (p=0.05) vs TK2002. Sample size calculation was performed using G-Power 3.1.3 (Faul, University of Kiel, Kiel, Germany). From 65,000 students at Istanbul University, originating from every region of Turkey in 2023-2024, we recruited a sample of 529 volunteer students. Inclusion criteria for the study were: (a) age between 18 and 26 years, (b) being a student at Istanbul University, and (c) volunteering to participate in the study. Exclusion criteria were: (a) diagnosis of a chronic disease, (b) history of surgery that can affect linear growth, (c) diagnosis of growth retardation, (d) history of growth hormone administration, (e) having a parent born outside of Turkey, (f) birth length or weight less than -2 SDS, and (g) current height or BMI less than -3 SDS or greater than +3 SDS. (**Figure 1**). The students' medical history, birthplace, high school graduation province, parental education level and occupation and household income were recorded through a questionnaire.

Measurements

Height was measured with bare feet using a portable stadiometer (SECA® 213 Leicester, Hamburg, Germany) and documented to the nearest 0.1 cm. Height measurements were repeated twice, and the mean value was calculated. If the difference exceeded 0.3 cm, a third measurement was taken, and the average of the two closest values was used. Individuals were weighed wearing light clothing using a digital scale (SECA® 813, Hamburg, Germany), recorded to the closest 0.1 kg. BMI was calculated as kg/m^2. Two trained technicians performed all measurements.

Classification of socioeconomic status

After collecting all data, the participants were classified into four groups according to socioeconomic status (SES) based on educational level of both parents and father's occupation. The SES classification ranged from SES 1 (highest scoioeconomic group) to SES 4 (lowest). For example, SES 1 included individuals with university-educated parents and professional occupations, while SES 4 included those with limited education and unskilled jobs. **(Supplementary material 1**) (7-9). Compared with the TK2002 questionnaire, the educational level of parents was increased by one level because of the 26% average increase in the duration of education in Turkey between 2002 and 2022 (10). Since height and BMI were not different between the top two SES groups in previous (4,5) nor in the current study (all p>0.2), students from both classes (151 females and 157 males) were combined for this analysis.

Geographical subgroup analysis

Geographical subgroups were defined in two different ways: based on the participant's birthplace and based on the region where they completed high school. Each participant was categorized into one of the seven official geographical regions of Turkey (1: Marmara, 2: Aegean, 3: Mediterranean, 4: Black Sea, 5: Central Anatolia, 6: Eastern Anatolia, 7: Southeastern Anatolia). Analyses were conducted separately for both definitions, and corresponding results were reported in tables and supplementary material.

Comparative Analyses

Height and BMI of the present study population were compared with those of the TK2002 study, in which data for 18-year-olds were collected from measurements of senior high school students in six affluent districts of Istanbul. The technical specifications and measurement methods of the instruments used in this study are identical to those used in TK2002, ensuring comparability and consistency across both studies. Final height was compared with 21-year-olds of Turkish origin living in the Netherlands measured in 2009 (NL2009), while BMI was compared with 18-year-olds from the same cohort (7- 9).

Statistical analyses

Statistical analyses were performed using SPSS 27.0 (IBM Corp., Armonk, NY, USA). Normality was assessed using the Shapiro–Wilk test. Descriptive data are presented as frequencies, percentages, means ± standard deviations, or ranges. Normally distributed data were compared using Student's t-tests, while non-normally distributed data were analysed with the Mann-Whitney U test. To investigate the association between the geographical regions and height and BMI, a Multivariate Analysis of Variance (MANOVA) was performed. Multiple group comparisons were conducted using one-way Analysis of Variance (ANOVA). For significant ANOVA results, Levene's Test for homogeneity of variances and Tukey's HSD test for post hoc comparisons were used.

Age, SES, and geographical region were used to conduct subgroup analyses. Age groups were divided into 18-22 and 23-26 years.

Results

The study included 465 young adults (217 females, 248 males) (**Figure 1**). **Table 1** shows the results of anthropometric measurements for SES groups. In females, mean height tended to decrease with lower SES (p = 0.4) but no such pattern was noted for weight and BMI. In males, mean height of the SES 4 group was shorter (by 4 cm) than that of the other three SES groups (p = 0.002), weight and BMI tended to decrease with lower SES. Data obtained from the SES 1 and 2 groups were used for further analyses.

Supplementary materials 3 and 4 show the percentages of the study sample for region of birth and of high school completion, respectively, in comparison with Turkey's overall population distribution.[11] In general, the regional distribution of our sample is consistent with that of the Turkish population although percentages of individuals born in the Marmara and Mediterranean regions are slightly over-represented and Aegean and Central Anatolia regions slightly under-represented.

Table 2 presents mean height, weight and BMI in the high SES group by region. In females, birthplace was not associated with height and BMI (MANOVA, Wilks' Lambda, F (12, 298) = 1.572, p = 0.099), in contrast to the region of high school completion (Wilks' Lambda, F (12, 288) = 2.130, p = 0.016). Further analysis (ANOVA) revealed an effect of the region of high school completion on height (F (6, 150) = 2.91, p = 0.005) but not on BMI (F (6, 150) = 0.97, p = 0.412). Post hoc Tukey's HSD test showed differences in height between regions Marmara and Central Anatolia (p = 0.011) and between Region Central Anatolia and Eastern Anatolia (p = 0.04). In males, the MANOVA results indicated no association between birthplace or of high school completion and height and BMI (Wilks' Lambda, F (12, 298) = 1.572, p = 0.099 and Wilks' Lambda, F (12, 298) = 0.933, p = 0.514).

Supplementary material 4 shows mean ± SD of anthropometric measurements in the high SES group according to two age groups (18-22 years versus 19-26 years). No notable differences were observed, but BMI in males showed a trend of increasing with age (p=0.12).

Table 3 and **Figures 2a and b** show 3-10-25-50-75-90-97th percentiles of TK2024, TK2002 and NL2009 for height in both sexes. Mean height was 1.8 cm taller in females (p=0.003) and males (p<0.001) compared to TK2002.

Table 4 and **Figures 2c and d** show these percentiles for BMI versus earlier growth studies. In females, BMI was similar to TK2002 and lower than NL2009 (p<0.001). BMI was higher in males than in TK2002 and NL2009 (p<0.001).

Discussion

Our study shows a notable increase of mean height of young adult males and females by 1.8 cm over two decades, showing a continuing positive secular trend in both sexes. Compared to previous national growth studies, secular growth change continues at a similar rate (4, 5). Notably, males show a concerning increase in BMI, with 58% classified as overweight or obese, while females' BMI has remained stable. Compared to the 2003 Turkey Demographic Health Survey (TDHS), the weight-for-height ratio of 0-5-year-olds increased in the 2018 TDHS, suggestive for an increasing BMI in childhood (18, 19). Regional variations in height were present among females but not males. We speculate that the ongoing secular trend of height is associated with improved living and nutritional conditions, even in the best-off segments of the population, and improved child health and immunization programs.

Istanbul (population >15 millions) has the highest number of migrants from all regions of Turkey, predominantly young individuals aged 20 to 24 moving for educational purposes (12). Previous national growth reference studies used data from children in affluent neighbourhoods of Istanbul (4,5,13). Istanbul University, with a student body of 63,790 from across Turkey, accurately reflects the country's demographic composition (14). The alignment between our sample distribution and Turkey's regional demographics ensures the generalizability of our findings. The only regional height variation was observed among females when classified by the region where they completed high school (shorter heights in Central Anatolia compared with Marmara and Eastern Anatolia), consistent with a 2007-2008 study in Kayseri, Central Anatolia (15).

The main factors that influence the assessment of secular change of final height are the SES, geography and age of the male study sample. While SES and geography of TK2002 and TK2024 were comparable, the age of measurement of males was 18 and 18-26 years, respectively. Since in the NL2009 study mean male height increased by 0.5 cm between 18 and 21 years (9), we cannot exclude that the unbiased secular trend in males is 1.3 cm. Current mean height of Turkish young adult males is also taller than that of offspring of Turkish immigrants living in the Netherlands 15 years earlier (NL2009) (8), probably mainly associated with the time interval.

In developing countries, it is advised to exclude malnourished children of low socioeconomic backgrounds from population growth studies, as they may not accurately represent the overall population's growth potential. We therefore included students with higher SES into the study, in line with the previous national growth references (TK2002) and WHO growth standards (5, 21). This "prescriptive" or "normative" approach aims to create references that can be utilized to identify inappropriate growth rather than to define the current population averages (6). In our study, the mean height of males in the lowest SES group was lower than that of the other SES groups. Additionally, a trend of a height decrease from high to low SES was observed in females. We realize that this approach has also disadvantages, e.g. that it obscures disparities within the country, overestimates the “real” mean final height and secular trend (if mean height in the highest SES cohort would increase more than in lower SES groups) or underestimates it if the opposite phenomenon would occur. Furthermore, it causes a bias when the height of the Turkish population is compared with that of other countries.

A very concerning result of our study is the increase in males’ BMI (58% overweight or obese). Males’ BMI increased compared to TK2002 and NL2009 data (7,13), indicating that the Turkish population is at risk of a severe obesity epidemic that starts at least in young adulthood, but likely already before. Factors such as sedentary lifestyles and unhealthy dietary patterns may contribute to this increase. The two TDHSs (2013 and 2018) in 0-5 year-olds (19,22) reported overweight prevalences of 11 and 8%, respectively, while the prevalence peaked at 6-36 months and 12-17 months of age, respectively. For future BMI reference charts, it is important to present normative data derived from growth studies performed before the overweight epidemic, as done in the current USA, WHO and Dutch charts (6, 23-26).

Interestingly, while males showed a marked increase in BMI, the BMI of females remained relatively stable over the same period. This sex-specific difference may be influenced by societal pressure regarding body image and stronger motivation for weight control among females, as reported in previous studies (27). Additionally, females often show healthier dietary preferences than males (28). These behavioral differences might partly explain the stable BMI trend observed in females in our study.

When the sample was divided into age groups (18-22 years and 23-26 years), no differences were found in height. This suggests that the chosen age range of young adults for assessing final height was appropriate and did not introduce bias related to age within the specified range. However, it is noteworthy that BMI in males tended to increase with age ($p = 0.12$), which may require further investigation in future studies with larger sample sizes.

Our study has notable strengths, such as using a clearly defined sample from Istanbul University, which includes participants from all regions of Turkey. Thus, we believe that our findings can be generalized to the Turkish population. Moreover, using standardized anthropometric measurements and detailed statistical analyses ensures the reliability and accuracy of the data. Furthermore, the SES questionnaire used in this study was based on scales from previous national studies, ensuring comparability and relevance for the analysis. This methodological consistency allows for reliable comparisons with previous research, strengthening the validity of our findings. The study's design meets the criteria recommended by Waterlow and recognized by the World Health Organization (WHO). These criteria necessitate that the reference population be adequately nourished, the sampling procedure be clearly defined and reproducible, the sample size be sufficient, the measurements be relevant and high quality, and the data be appropriately processed (21,29).

Study Limitations

A potential limitation of our study is that the sample consists only of university students. Although we acknowledge that this does not fully represent all young adults in Turkey, the large and diverse student body of Istanbul University from all regions of Turkey significantly reduces this concern. Furthermore, the current national growth curves are based on measurements taken from students in schools in well-off Istanbul districts with high socioeconomic status.[13] Since the sample that best reflects the growth potential of the society should be selected when constructing growth references, we believe that the study sample is appropriate for our purpose and that the results can be generalized to the Turkish population.

Another potential limitation is the age range of 18-26 years in our study. The previous national study (TK2002) with which we compared our results includes data only up to 18 years old. Despite these limitations, the study provides valuable insights into the anthropometric measurements of Turkish young adults.

Conclusion

Our study has demonstrated that the average height of Turkish young adults has increased by 1.8 cm over the past two decades. Accordingly, we suggest that this increase be considered when interpreting target height, to reflect current trends in growth evaluation. Future research is needed to assess the age period in which this height increase has mainly occurred. Furthermore, while the BMI of young female adults did not change, males have reached alarmingly high BMI levels, with 58% being classified as overweight or obese, highlighting a rising public health issue. This indicates the importance of enhancing prevention programs to promote healthier habits and lower obesity rates.

Declarations

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of Istanbul University, Istanbul Faculty of Medicine (2023/1455).

Data Availability
Data supporting the findings of this study are included within the manuscript and the supplementary information files. However, some data are not openly available due to sensitivity concerns. These data can be obtained from the corresponding author upon reasonable request.

Author Contributions
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ozge Bayrak Demirel, Cansu Koc, Nur Mine Sukur, and Firdevs Bas. The first draft of the manuscript was written by Ozge Bayrak Demirel and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Conflict of interest
The authors have no relevant financial or non-financial interests to disclose.

Consent to participate
Informed consent was obtained from all individual participants included in the study.

Trial registration number (ClinicalTrials.gov Identifier): NCT06514924. Date of registration: 09.07.2024, Retrospectively registered.

References

1. Grasgruber P, Cacek J, Kalina T, Sebera M. The role of nutrition and genetics as key determinants of the positive height trend. *Econ Hum Biol.* 2014;15:81-100.
2. Wit JM, Kamp GA, Oostdijk W, on behalf of the Dutch Working Group on Triage and Diagnosis of Growth Disorders in Children. Towards a rational and efficient diagnostic approach in children referred for growth failure to the general paediatrician. *Horm Res Paediatr.* 2019;91:223-240.
3. Jebeile H, Kelly AS, O'Malley G, Baur LA (2022) Obesity in children and adolescents: epidemiology, causes, assessment, and management. *Lancet Diabetes Endocrinol.* 2022;10:351-365.
4. Neyzi O, Binyıldız P, Alp H. Türk çocuklarında büyüme gelişme normları 1. *İstanbul Tıp Fak Mecm.* 1978;41:3-22
5. Neyzi O, Furman A, Bundak R, Gunoz H, Darendeliler F, Bas F. Growth references for Turkish children aged 6 to 18 years. *Acta Paediatr.* 2006;95:1635-1641.
6. Karlberg J, Cheung Y, Luo Z. An update on the update of growth charts. *Acta Paediatr.* 1999;88:797-802.
7. Van Dommelen P, Schönbeck Y, HiraSing RA, Van Buuren S. Call for early prevention: prevalence rates of overweight among Turkish and Moroccan children in The Netherlands. *Eur J Public Health* 2015;25:828-83.
8. Schönbeck Y, Van Dommelen P, HiraSing RA, Van Buuren S. Trend in height of Turkish and Moroccan children living in the Netherlands. *PLoS One.* 2015;10(5):e0124686.
9. Talma H, Schönbeck Y, Bakker B, HiraSing RA, van Buuren S. Groeidiagrammen. *TNO 2010.* ISBN: 978-90-5986-347-7, 2010.
10. Turkish Statistical Institute (2022) National Education Statistics, 2022. https://data.tuik.gov.tr/Bulten/Index?p=National-Education-Statistics-2022-49756. (27 September 2024, date last accessed).
11. T.R. Ministry of Interior. Population Map of Turkey. 2021.https://www.nvicisleri.gov.tr/turkiyenin-nufus-haritasi-10072021.
12. Turkish Statistical Institute. Internal Migration Statistics, 2021. https://data.tuik.gov.tr/Bulten/Index?p=Ic-Goc-Istatistikleri-2021-45869 (27 September 2024, date last accessed).
13. Neyzi O, Bundak R, Gökçay G et al. Reference values for weight, height, head circumference, and body mass index in Turkish children. *J Clin Res Pediatr Endocrinol.* 2015;7:280-293.
14. Istanbul University. Demographic information about the student population. 2024. https://sayilarla.istanbul.edu.tr/#/siu/illere-gore-ogrenci-dagilimi-haritasi-3000490068006F004B003...006E00300065...006B003100 (27 September 2024, date last accessed).
15. 15. Zararsız G, Çiçek B, Kondolot M, Mazıoğlu MM, Öztürk A, Kurtoğlu S. Comparison of updated weight and height percentiles with previous references in 6-17-year-old children in Kayseri, Turkey. *J Clin Res Pediatr Endocrinol.* 2017;9(1):39.
16. Fredriks AM, Van Buuren S, Burgmeijer J et al. Continuing positive secular growth change in The Netherlands 1955–1997. *Pediatr Res.* 2000;47:316-323.
17. Schönbeck Y, Talma H, van Dommelen P, Bakker B, Buitendijk SE, HiraSing RA, van Buuren S. The world's tallest nation has stopped growing taller: the height of Dutch children from 1955 to 2009. *Pediatr Res.* 2013;73:371-377.
18. Hacettepe University Institute of Population Studies. Turkey Demographic and Health Survey. Ministry of Health General Directorate of Mother and Child Health and Family Planning, State Planning Organization and European Union, 2003. https://www.dhsprogram.com/pubs/pdf/FR160/FR160.pdf (27 September 2024, date last accessed).
19. Hacettepe University Institute of Population Studies. 2018 Turkey Demographic and Health Survey. T.R. Presidency of Turkey Directorate of Strategy and Budget and TÜBİTAK, 2019. https://www.dhsprogram.com/publications/publication-fr372-dhs-final-reports.cfm?cssearch=70131_1 (27 September 2024, date last accessed).
20. Wit JM, Clayton PE, Rogol AD, Savage MO, Saenger PH, Cohen P. Idiopathic short stature: definition, epidemiology, and diagnostic evaluation. *Growth Horm IGF Res.* 2008;18:89-110
21. WHO Multicentre Growth Reference Study Group, de Onis M. WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatr.* 2006;95:76-85.
22. Hacettepe University Institute of Population Studies. 2013 Turkey Demographic and Health Survey. T.R. Ministry of Development and The Scientific and Technological Research Council of Turkey (TÜBİTAK), 2014. https://nhps.hacettepe.edu.tr/en/2013_turkey_demographic_and_health_survey-265 (27 September 2024, date last accessed).
23. Ogden CL, Kuczmarski RJ, Flegal KM et al. Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version. *Pediatrics.* 2002;109:45-60.
24. Schönbeck Y, Talma H, van Dommelen P et al. Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PLoS One.* 2011;6(11): e27608.
25. Cole TJ and Roede MJ. Centiles of body mass index for Dutch children aged 0–20 years in 1980—a baseline to assess recent trends in obesity. *Ann Hum Biol.* 1999; 26(4): 303-308.
26. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ.* 2000;320 (7244): 1240-3.
27. Jacob JS, Panwar N. Effect of age and gender on dietary patterns, mindful eating, body image and confidence. BMC Psychol. 2023 Sep 5;11(1):264. doi: 10.1186/s40359-023-01290-4. PMID: 37670398; PMCID: PMC10478183.

28. Lombardo M, Feraco A, Armani A, Camajani E, Gorini S, Strollo R, Padua E, Caprio M, Bellia A. Gender differences in body composition, dietary patterns, and physical activity: insights from a cross-sectional study. Front Nutr. 2024 Jul 11;11:1414217. doi: 10.3389/fnut.2024.1414217. PMID: 39055386; PMCID: PMC11271261.
29. Waterlow JC, Buzina R, Keller W, Lane J, Nichaman M, Tanner J. The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of 10 years. *Bull World Health Organ.* 1977;55:489-498.

Table 1: Anthropometric measurement results according to SES groups

	SES1	SES2	SES3	SES4	SES1&2	All
FEMALES (n,%)	49 (23%)	102 (47%)	42 (19%)	24 (11%)	151 (69%)	**217**
Age (years)	22 ± 1.5	21.8 ± 1.6	22.1 ± 1.4	21.2 ± 1.5	21.8 ± 1.6	21.8 ± 1.[illegible]
Height (cm)	164.9 ± 5.9	164.3 ± 5.5	164.1 ± 6.5	163.3 ± 6.7	164.5 ± 5.6	164.3 ± 5.[illegible]
Weight (kg)	59 ± 9.7	60.1 ± 8.4	60 ± 9.4	60 ± 7.4	59.7 ± 8.8	[illegible]
BMI (kg/m²)	21.6 ± 2.8	22.2 ± 2.8	22.4 ± 3.2	22.5 ± 2.4	22.1 ± 2.8	22.1 ± 2.8
MALES (n,%)	54 (22%)	103 (41%)	62 (25%)	29 (12%)	157 (63%)	**248**
Age (years)	21.8 ± 1.9	21.5 ± 1.9	21.6 ± 1.7	21.1 ± 1.7	21.6 ± 1.9	[illegible]1.5 ± 1.8
Height (cm)	178.3 ± 6.2	178.8 ± 6.3	178.2 ± 7	174.6 ± 6	178.6 ± [illegible].3	[illegible] ± [illegible].5
Weight (kg)	83.5 ± 12.3	81.5 ± 12.4	79.8 ± 11.8	77.8 ± 15.5	82.2 ± 12.3	81.1 ± 12.6
BMI (kg/m²)	26.2 ± 3.3	25.5 ± 3.5	25.1 ± 3.3	25.5 ± 4.8	25.7 ± [illegible]	25.6 ± 3.6

Table 2: Anthropometric measurements of participants by regions (high SES)*

Females					Males			
n	**Height** (cm)	**Weight** (kg)	**BMI** (kg/m²)	**Region**	**n**	**Height** ([illegible])	**Weight** (kg)	**BMI** (kg/m²)
52 (66)	165.9 ± 6 (165.9 ± 5,7)	60.6 ± 9.7 (61.2 ± 10.2)	22 ± 2.9 (22.2 ± 3)	1	[illegible] ([illegible])	178.[illegible] ± 6.5 (178.[illegible] ± 6.3)	83.7 ± 11.8 (84.1 ± 11.9)	26.2 ± 3.3 (26.3 ± 3.2)
14 (12)	164.2 ± 6.1 (164.6 ± 5.4)	58.6 ± 9.2 (57.2 ± 7.3)	21.6 ± 2.6 (21.1 ± 2.4)	2	5 (5)	179 [illegible] ± 5.3 ([illegible] ± 3)	70.7 ± 9 (74.3 ± 13.4)	22 ± 3.1 (22.7 ± 22.7)
22 (24)	164.2 ± 4.4 (163.9 ± 5.2)	59.2 ± 6.7 (61.3 ± 6.9)	21.9 ± 2.2 (22.8 ± 2.7)	3	31 (33)	179.9 ± 5.5 (179 ± 6)	81.5 ± 12 (81.6 ± 14.4)	25.2 ± 3.6 (25.4 ± 4.3)
17 (16)	164.9 ± 6.4 (163.7 ± 6.2)	62.9 ± 11.4 (60.3 ± 9)	23 ± 3.4 (22.4 ± 2.9)	[illegible]	1[illegible] ([illegible]13)	175.7 ± 6.5 (176.3 ± 6.9)	78.6 ± 14 (78.8 ± 11.8)	25.3 ± 3.4 (25.3 ± 3.1)
16 (11)	161.1 ± 4.3 (160 ± 4.3)	56.2 ± 6.8. (55.9 ± 7)	21.7 ± 2.5 (21.9 ± 2.4)	5	12 (8)	179.6 ± 5 (178.9 ± 5.1)	87.1 ± 10.6 (84 ± 7.9)	26.9 ± 2.6 (26.2 ± 2.5)
14 (8)	166.8 ± 4.2 (167.4 ± 2.9)	61.5 ± 8.1 (58.7 ± 9)	22.2 ± [illegible].5 (21 ± 3.6)	6	10 (11)	177.2 ± 6 (178.8 ± 6.9)	76.4 ± 12.1 (77.7 ± 10.3)	24.3 ± 3.3 (24.3 ± 2.9)
16 (14)	161.5 ± 4.6 (161.7 ± 4.8)	59.7 ± 6.3. (55.4 ± 4.1)	[illegible] ± 2.6 (22.1 ± 1.7)	[illegible]	17 (15)	178 ± 7.2 (178.4 ± 7.5)	84.5 ± 13.2 (82.7 ± 12.1)	26.6 ± 3.6 (25.7 ± 2.6)

*Data are presented as mean ± standard deviatio[illegible]. The f[illegible]st values are the results of the groups categorized by birthplace, and the values in brackets are the results of the groups formed accor[illegible] to the re[illegible]ion of high school completion. Regions: 1: Marmara, 2: Aegean, 3: Mediterranean, 4: Black Sea, 5: Central A[illegible], 6: E[illegible]tern [illegible]natolia, 7: Southeastern Anatolia

Table 3: Height data of young adults [illegible] TK20[illegible] [illegible]pared with TK2002 and NL2009[5, 8, 9]

Percentiles		3	[illegible]	25	50	75	90	97
Females (cm)	**TK2024**	[illegible]52.[illegible]	[illegible].5	160.0	164.9	168.0	171.9	174.2
	T[illegible]2002	[illegible]2.0	155.6	159.1	163.1	167.1	170.7	174.2
	NL2009	151.3	154.9	158.6	162.6	166.6	170.3	173.9
M[illegible]les (cm)	**[illegible]K2024**	166.7	170.9	174.4	178.0	182.3	187.5	192.7
	TK2002	164.5	168.2	172.0	176.2	180.4	184.2	187.9
	NL2009	164.7	168.8	172.9	177.5	182.1	186.2	190.3

Table 4: BMI data of young adults in TK2024 compared with TK2002 and NL2009[7, 13]

Percentiles		5	15	25	50	75	85	95
Females	**TK2024**	18.4	19.2	19.7	21.6	23.8	25.1	27.6
	TK2002	19.0	19.9	20.5	21.8	23.3	24.3	26.1
	NL2009	17.9	19.6	20.7	23.1	26.0	27.9	31.5
Males	**TK2024**	20.3	22.7	23.7	25.5	27.7	29.3	31.4
	TK2002	19.2	20.5	21.3	23.1	25.2	26.6	28.4
	NL2009	18.2	19.7	20.7	22.9	25.5	28.9	30.6

Figure 1: Flow chart of the study participants

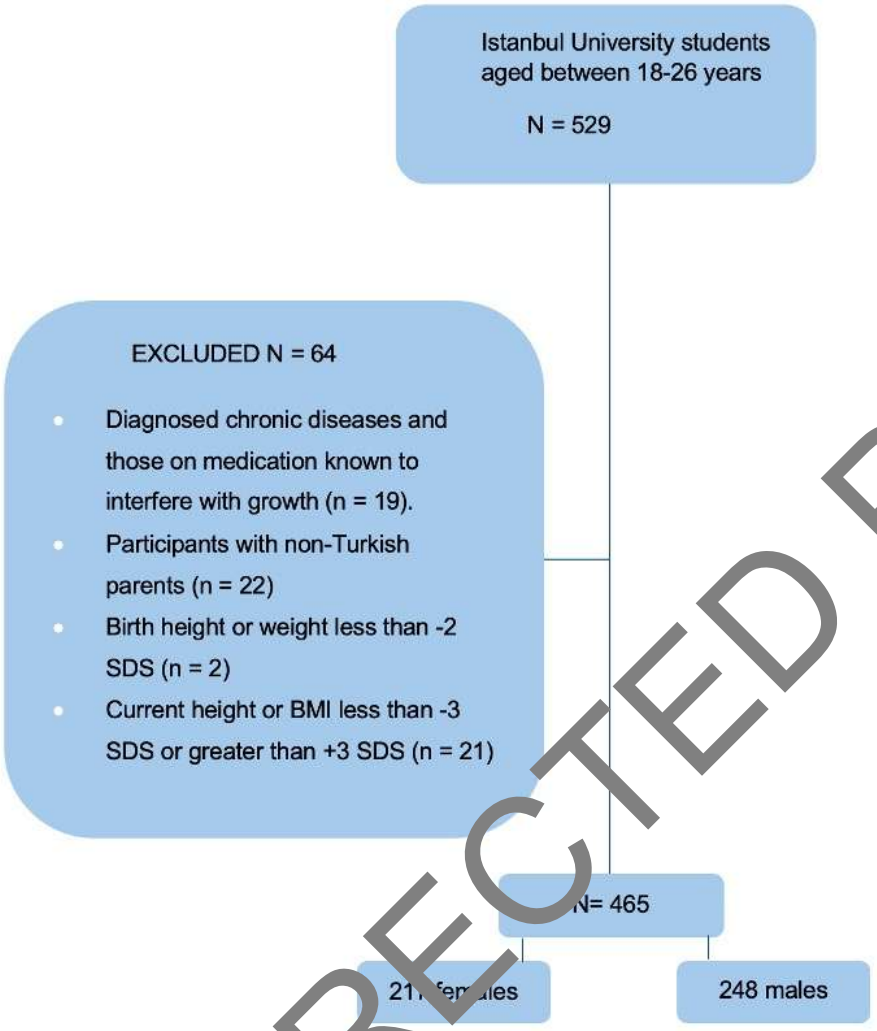
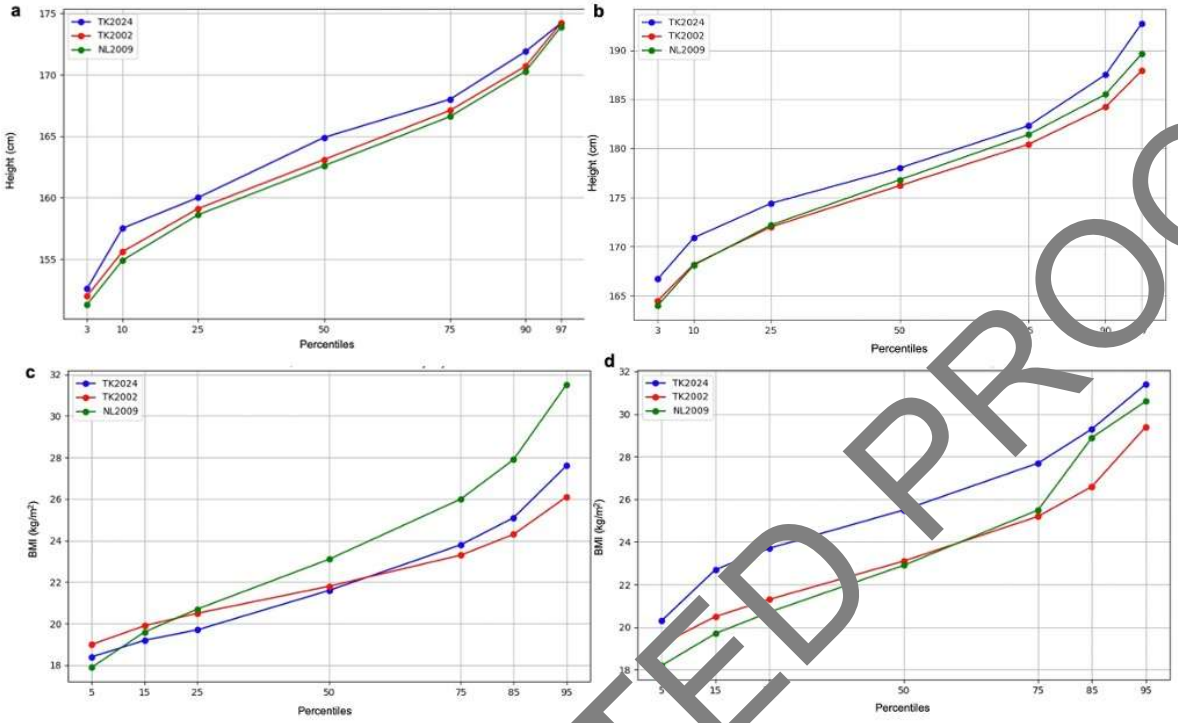


Figure 2: Height data of females (a) and males (b) and BMI data of females (c) and males (d) in TK2024 compared with TK2002 and NL2009



Supplementary material 1.

Supplementary material 1: Criteria used in grouping the subjects into socioeconomic status (SES)

SES components	1	2	3	4
Component 1: Maternal education	≥11 years	8-10 years	6-7 years	≤5 years
Component 2: Paternal education	≥15 years	11-14 years	8-10 years	≤7 years
Component 3: Paternal occupation	Professional (lawyer, doctor, engineer, etc.) businessman, big business owner, high official	Teacher, military officer, business owner, white-collar worker	Technician, small business owner, white-collar worker	Labourer, driver, other unskilled occupations

SES 1 was attributed to an individual who complied with the highest score for the three components. SES 2 was attributed if none of the three components was <2, and at least 1 component was 2. SES 3 was attributed if none of the three components was <3 and at least one component was 3. SES 4 was attributed if at least one component was 4.

Supplementary material 2.

Supplementary material 2: The distribution of samples by place of birth*

*The numbers inside the blue circles represent the geographical regions:1: Marmara, 2: Aegean, 3: Mediterranean, 4: Black Sea, 5: Central Anatolia, 6: Eastern Anatolia, 7: Southeastern Anatolia. F: Female, M: Male. The first ratio shows the percentage of the overall sample, and the ratio in brackets shows the percentage of high SES included in the analysis. **The ratio of the population living in the region to Türkiye's population.

Supplementary material 3.

Supplementary material 3: The distribution of samples by region of high school completion*

*The numbers inside the blue circles represent the geographical regions:1: Marmara, 2: Aegean, 3: Mediterranean, 4: Black Sea, 5: Central Anatolia, 6: Eastern Anatolia, 7: Southeastern Anatolia. F: Female, M: Male. The first ratio shows the percentage of the overall sample, and the ratio in brackets shows the percentage of high SES included in the analysis. **The ratio of the population living in the region to Türkiye's population.

Supplementary material 4.

Supplementary material 4: Comparison of anthropometric measurement results according to age groups in high SES group

	Age groups	n	Height (cm)	p (height)	Weight (kg)	p (weight)	BMI (kg/m^2)	(BMI)
Females	**18 - 22**	94	164.9 ± 5.6	0.24	59.9 ± 8.8	0.7	22 ± 2.8	
	23 - 26	57	163.8 ± 5.6		59.4 ± 8.9		2.1 ± 2.8	
Males	**18 - 22**	104	178.6 ± 5.9	0.97	81.1 ± 12.2	0.12	25. 3.4	0.8
	23 - 26	53	178.6 ± 6.9		84.4 ± 12.4		26.4 ± 3.	

*n indicates the number of participants in each age group. Mean values are presented with their corresponding standard deviations (SD). p-values indicate statistical comparisons within each gender group between the age categories.