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Influence of urban and rural living environments on body measures, strength and lifestyle among first-year university students

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Abstract

Primary prevention is particularly relevant for young adults experiencing major life changes that may affect their health. This cross-sectional study aimed to assess the physical condition and lifestyle of first-year university students, with a focus on differences by sex and area of origin (urban or rural). The sample consisted of 315 students (59% female, 41 % male; aged 18-25). Of these, 159 (62% female) were from urban areas, while 156 (57% female) were from rural areas. Anthropometric characteristics, body mass index, waist-to-height ratio and Handgrip Strength (HGS) were measured; Fat Mass (FM%), Fat Free Mass (FFM%) and Muscular Mass (MM%) were estimated through bioelectrical impedance vector analysis. Physical activity and the adherence to the mediterranean diet were also assessed. Males showed significantly higher values than females in all anthropometric traits, body composition, HGS and moderate-to-vigorous physical activity. Rural males reported lower FM% and higher MM% than urban males. Rural groups had a lower prevalence of being overweight. Our findings suggest an association between environmental context and certain body measurements, particularly in males.

Introduction

Primary prevention interventions play a fundamental role in public health, as disease onset and progression are influenced by genetic, environmental and lifestyle factors[1]. Primary prevention is widely implemented among youth population (children and adolescents) addressing a broad range of aspects,[2,3] whereas in the young adults often researchers focused on specific topics such as tobacco, alcohol abuse and drug consumption.[4]

There are currently various projects underway at universities, that aim to encourage students to adopt a healthy lifestyle, which can then spread to their personal and social lives. Examples include the International University Sports Federation (FISU) Healthy Campus Project.[5] In line with this trend, the University of Torino launched the Wellness4Students (W4S) project in 2023. This initiative examined the health, psychophysical and social well-being of first-year students across all bachelor's degree programs. Along with the most common body analysis and lifestyle variables, the project also considered the area in which the students grew up, to explore whether their environment had conditioned their growth. Currently, there is conflicting data on the influence of living environments on anthropometric characteristics, strength expression, eating habits, physical activity, and predisposition to health conditions and diseases.

With regard to physical activity, urban and rural environments provide distinct contexts, in which certain characteristics may influence opportunities for engagement.[6] For example, differences exist in access to facilities such as gyms and sports centers, availability of outdoor spaces (e.g., parks), and the range of sports opportunities offered.[6] It is widely accepted that people living in cities have access to more structural and instrumental resources that facilitate physical activity and active travel.[6] Individuals living in rural communities may have less access to community infrastructure, such as walking routes, streetlights, public transport and indoor places in which to perform physical activity[7] but better opportunities for unstructured outdoor physical activity in natural environments.[6]

The living environment may influence anthropometric characteristics. Higher proportions of overweight and obesity were found among rural children,[8] but another study found opposite results in adolescents, in which rural ones tended to have lower Body Mass Index (BMI) and healthier diets.[9] A link has also been demonstrated between overweight/obesity and pollution, with a higher prevalence of overweight adolescents in urban areas who are more predisposed to diseases in the future.[10]

A physically inactive lifestyle tends to increase during the transition from adolescence to adulthood, and at the start of university.[11] It is already known that low levels of physical activity are a risk factor for developing non-communicable diseases, which may be correlated with environmental and contextual factors.[12] Furthermore, several studies have shown that university students may experience alcohol and drug abuse,[4] as well as a poor diet.[13]

Regarding eating habits, several studies have highlighted the potential health benefits of the Mediterranean Diet (MD) in reducing risk factors for most non-communicable diseases.[14] To prevent these diseases, it is important to monitor weight and lifestyle factors in order to suggest improvements and verify changes in the prevalence of overweight and obesity in young adult populations.

This study aimed to investigate the influence of urban and rural environments on the anthropometric and functional characteristics of a sample of first-year university students. This was achieved by evaluating the anthropometric characteristics, body composition, hand strength and lifestyle data (eating habits and physical activity).

Materials and Methods

Study design

A cross-sectional study (W4S project) was conducted at the University of Torino. This initiative aimed to assess the physical and psychological well-being of students at the university, with the intention of identifying and developing future university actions and policies. Specifically, students completed an online questionnaire prior to participating in the visits. The questionnaire collected information on students' growth area, their adherence to the MD and the quantity of their physical activity. After this, the students took an appointment to the Center for Preventive and Sports Medicine, University of Torino, where anthropometric and functional data were collected. The students were then provided with feedback based on their results.

All the first-year students were invited to participate via an institutional email from the University. Participation was voluntary and students had to sign an informed consent form.

This is an ongoing project and the results from the first year (October 2023 to October 2024) are reported here. Part of the research described in this manuscript was previously presented at the 97th Congress of the Società Italiana di Biologia Sperimentale (SIBS), held in Palermo, Italy, from April 10 to 13, 2025.

Inclusion and exclusion criteria

Participants had to be first-year students at the University of Torino and have signed the informed consent form. Only data from students who completed the entire protocol were analysed in this study. The analysis excluded people aged over 25 years (n= 39), those who did not report their gender (n= 2), and those who selected "Mixed" in response to the question about the area in which they grew up (n=18).

Urban and rural

The subjects were asked to identify the area in which they grew up (from 0 to 15 years old), choosing from the following five options:[15] "Urban/Suburban Area", "Little Town", "Village", "Countryside" and "Mixed". Subjects were then divided into an urban group ("Urban/Suburban Area") and a rural group (including "Little town", "Village" and "Countryside"). These grouping choices are supported by internal check trough the Analysis of Variance (ANOVA) and the Kruskal-Wallis tests. We excluded the "Mixed" group (those who had moved from an area type to another) from the analysis. Subjects were categorized as follows by area and sex: Urban Females (UF), Rural Females (RF), Urban Males (UM), and Rural Males (RM).

Medi-lite questionnaire

The Medi-Lite score[16] was used to estimate adherence to the MD, through nine questions regarding the consumption of fruits, vegetables, cereals, meat/meat-products, dairy products, legumes, fish, alcohol and olive oil. Depending on the food category, scores ranging from 0 to 2 are assigned according to frequency and/or quantity of intake. Higher scores are attributed to foods typical of the MD (fruit, vegetables, cereals, legumes, and fish), whereas the scoring is reversed for non-typical foods (meat and dairy products), which receive lower scores with higher consumption. Moderate consumption of alcohol (1-2 servings per day) yields the highest score, while high consumption receives no points and intake below one serving per day is assigned 1 point. The final score ranges from 0 to 5 (low adherence), from 6 to 12 (medium adherence) and from 13 to 18 (high adherence).

Global Physical Activity Questionnaire (GPAQ)

The Global Physical Activity Questionnaire (GPAQ)[17] was used to assess physical activity and sedentary behavior. The questionnaire comprises 16 closed questions. Questions 1-6 measure workplace physical activity by assessing the frequency (days/week) and duration (minutes/day) of vigorous and moderate activity. Questions 7-9 assess the duration and frequency of walking or cycling to common destinations. Questions 10-15 evaluate recreational physical activity performed during leisure time, distinguishing between vigorous and moderate activities and recording the number of days and minutes spent on each. Question 16 assesses sedentary behavior by quantifying daily sitting or lying time, excluding sleep. GPAQ data were converted into Metabolic Equivalent (MET)-minutes per week using standard coefficients: 8 METs for vigorous activities, 4 METs for moderate activities and 4 METs for active walking. For the analysis, Moderate-to-Vigorous Physical Activity (MVPA) was used to reflect total physical activity, excluding active transportation to reduce potential misclassification related to activity intensity. Although active transportation may include activities of moderate intensity, it is frequently performed at low intensity (e.g., slow walking for short distances). Including this domain in the MVPA outcome may therefore introduce substantial variability and noise, potentially inflating physical activity estimates without accurately reflecting true moderate or vigorous exertion.

Anthropometric measurements and body composition analyses

Subjects were dressed in light clothes and barefoot. Participants' height, weight, waist circumferences were measured using respectively a stadiometer, a medical scale and medical metric tape.[18] Body composition was evaluated with the Bioelectrical Impedance Vector Analysis (BIVA) performed with a phase sensitive device (BIA 101 BIVA PRO AKERN Srl, Pisa, Italy) using an electric current at a frequency of 50 kHz. The specific electrodes (BIATRODES Akern Srl; Florence, Italy) were applied on the skin of the right foot and right hand below the fingers with a distance of minimum 5 cm.[19] Measurements were made using tetrapolar configuration as described by Lukaski *et al*.[20] The components estimation and graphical representation were processed by the Bodygram™ Dashboard. In this study, the following estimated body composition parameters were considered: Fat-Free Mass percentage (FFM%), Fat Mass percentage (FM%) and Muscle Mass percentage (MM%).

Body Mass Index (BMI) was calculated as kg/m^2 and participants were categorized according to the WHO cut-off[21] in: underweight (BMI < 18.50 kg/m^2), normal weight (18.50-24.99 kg/m^2), overweight (≥ 25.00 kg/m^2) and obese (≥ 30.00 kg/m^2). Additionally, we determined the cardiometabolic risk with the Waist-to-Height Ratio (WHtR) using the cut-off of 0.5:[22] lower metabolic risk (WHtR ≤ 0.5), higher metabolic risk (WHtR > 0.5).

Handgrip Strength Test (HGS)

The Handgrip Strength test (HGS) was assessed using a G200 Dynamometer with a standard Jamar configuration (Biometrics Ltd, Newport UK). Participants were instructed to stand firmly on both feet, with the arm completely extended along the body with the elbow and the wrist extended. They were also told to keep their shoulders slightly abducted and their forearms in a neutral position. The handle width was adjusted to fit the size of the hand. Participants had to squeeze the dynamometer with their dominant hand, with maximum isometric effort for about 2-3 seconds.[23] The same test was then repeated using the non-dominant hand.[24] Only one attempt was administered, as a single trial is considered adequate to elicit the maximal value.[25] We indicated the value of the HGS test performed with the dominant hand as "DHGS", while we used "NDHGS" for the value of the non-dominant hand.

Statistical analyses

Data analysis was conducted using IBM SPSS Statistics (version 29). The Kolmogorov-Smirnov test was used to assess the normality of the data. Mann–Whitney U tests were performed to examine the differences between the following pairs: UF and RF, UM and RM, UF and UM, RF and RM. Spearman's correlation coefficient (r) was used to assess the strength of the relationship between the variables. To account for multiple comparisons, a Bonferroni-adjusted significance threshold of $p < 0.0125$ (0.05/4) was applied to the Mann-Whitney U tests. For all other analyses, statistical significance was set at $p < 0.05$.

Results

Descriptive results

The sample consisted of 315 students (59% female, 41% male), aged between 18 and 25 years old (mean age: 19.6 ± 1.2 years). According to where they grew up, 159 students were from urban areas (62% female) and 156 were from rural areas (57% female). The descriptive analyses are presented in Table 1**,** which reports socio-demographic data, anthropometric variables and related indices, estimates of body composition, Medi-Lite score, HGS and MVPA.

Differences between groups stratified by environment and sex

In Table 1, any differences between the subsamples that reached statistical significance (e.g. UF *vs*. RF, UM *vs*. RM, UF *vs*. UM, RF *vs*. RM) are shown in bold.

The male sample, both urban and rural, showed significantly higher values than their female counterparts regarding anthropometric variables such as height, weight, waist circumference, body composition estimates (FFM%, FM%, MM%), HGS and MVPA. Regarding differences related to the environment, significantly better body composition was observed in RM than in UM, which presented a significantly smaller amount of FM% (-2.9 ± 0.8, Cohen's D = 0.5, $p = 0.004$) and a higher amount of MM% (+2.9 ± 0.4, Cohen's D = 0.6, $p > 0.001$). Instead, no differences were detected among females when distinguishing by area. No statistically significant differences in BMI and WHtR indices were found between subgroups, either by sex or by area.

All four samples reported a medium level adherence to the MD as the average score in the subsamples never exceeded 9.2. The majority of the sample (88.9%) showed medium adherence, while only 5.4% reported low adherence and 5.7% high adherence.

Weight status according to BMI and WHtR indexes

In the analysis of BMI (Figure 1), even if there were no significant differences between the four groups, a tendency of higher prevalence of overweight and obesity has been highlighted in urban samples, especially for males (24.6%), but also for females (18.4%), compared to the rural counterpart. The highest percentage of underweight has been found among UF (10.2%).

The analysis of the risk categories according to the WHtR (Figure 2), although not having achieved statistically significant differences among groups, indicated a trend of greater risk in the urban samples (UF = 11.2%; UM = 13.1%) compared to the rural ones, even if less evident compared to the critical issues emerged for the BMI. It should be highlighted, in particular, how rural males showed the lowest percentage of cases at risk of incurring cardiovascular metabolic diseases (RM = 1.5%).

Correlations among variables

The details of the relationships identified in the four subgroups are reported below.

In all four samples, BMI negatively correlated with MM% (UF: $r = -0.592$, $p < 0.001$; RF: $r = -0.498$, $p < 0.001$; UM: $r = -0.431$, $p < 0.001$; RM: $r = -0.309$, $p = 0.011$) and positively correlated with FM% (UF: $r = 0.808$, $p < 0.001$; RF: $r = 0.735$,$p < 0.001$; UM: $r = 0.735$, $p < 0.001$; RM: $r = 0.563$, $p < 0.001$).

WHtR showed the same trend in correlation with MM% (UF: $r = -0.530$, $p < 0.001$; RF: $r = -0.446$, $p < 0.001$; UM: $r = -0.502$, $p < 0.001$; RM: $r = -0.342$, $p = 0.005$) and FM% (UF: $r = 0.722$, $p < 0.001$; RF: $r = 0.663$, $p < 0.001$; UM: $r = 0.769$, $p < 0.001$; RM: $r = 0.566$, $p < 0.001$).

In all four samples, BMI was significantly correlated with DHGS (UF: $r = 0.298$, $p = 0.003$; RF: $r = 0.240$, $p = 0.023$; UM: $r = 0.437$, $p < 0.001$; RM: $r = 0.466$, $p < 0.001$) and NDHGS, mostly in males (UF: $r = 0.213$, $p = 0.035$; RF: $r = 0.286$, $p = 0.007$; UM: $r = 0.316$, $p = 0.013$; RM: $r = 0.493$, $p < 0.001$).

With regard to physical activity outcome, moderate correlations were identified between MVPA and MM% in both males ($r = 0.261$, $p = 0.003$) and females ($r = 0.185$, $p = 0.012$). Furthermore, only the female sample showed correlations between MVPA and NDHGS ($r = 0.166$, $p = 0.024$).

Discussion

This cross-sectional study examined the anthropometric characteristics, functional parameters, and lifestyle habits of a sample of first-year students at the University of Torino. The primary goal was to ascertain whether there were any differences in these variables between students who grew up in urban or rural environments.

Analysis of body composition revealed that rural males exhibited higher MM% and lower FM%. In addition to statistical significance, the observed differences showed a medium effect size, suggesting that the association between living environment and estimated body composition in males is not only statistically detectable but also meaningful in magnitude. However, the observed differences in the male samples cannot be explained by the amount of MVPA or diet, as no significant differences were found between the two groups in relation to these variables. On the other hand, the female sample did not show any differences in body composition. This finding may be attributed to the fact that women generally report higher levels of body dissatisfaction compared to men, which could lead them to monitor their weight and body shape more closely, regardless of other sociocultural influences.[26]

Comparing the handgrip strength of the four subgroups with European reference values,[27] HGS values for both female samples fell between the 40th and 50th percentiles, while for the male samples the values ranged between the 30th and 40th percentiles, even after normalizing HGS for height. Handgrip strength is a predictor of overall musculoskeletal strength capacity across all age groups,[28] and correlations with height, weight, and BMI[29] have been reported in the literature. However, in this study HGS correlated in all four samples only with BMI. Literature reports that adherence to MD is slightly higher in rural environments.[30] In this study, no significant differences were found between the urban and rural subsamples; however, the RF and RM samples had slightly higher mean values than the UF and UM samples.

The majority of the sample in this study showed a medium level of adherence to the MD, and only 5.4% showed low adherence. Another study[31] conducted on an Italian population of young adults found a 23.5% prevalence of low adherence to the MD. The high adherence rates reported in this study may also be attributable to the participants' increased sensitivity to the subject matter, resulting from their decision to join a wider health program, and to the generally healthy body weight status of the participants. A review[32] showed that university students with an unhealthy diet and low MD adherence were more likely to be overweight and to be living away from family home. Furthermore, significant gender differences in MVPA were observed, with higher values in males. No significant differences emerged between participants from rural and urban areas. These findings support the gender hypothesis, which posits that men generally engage in more physical activity than women, in both urban and rural contexts.[33] A study in a university population identified selfefficacy, peer support, and activity-related motivation as key factors influencing physical activity among female students.[34] Notably, peer support appears to be more limited in rural than urban contexts.

Overall, the BMI indicated that the total sample had lower rates of being overweight or obese than the general Italian population aged 18 to 34,[35] which reports prevalence rates of 21.5% and 5.5%, respectively. In contrast, the present study observed rates of 12.7% for overweight and 3.8% for obesity. Comparing the data with other Eurostat reference values,[36] which use a more comparable age range (16-24 years, 15.4% overweight), the overall sample still displayed a healthier weight status. Furthermore, when comparing the prevalence of underweight in this study with that reported by the National Institute of Statistics (ISTAT) for young adults aged 18-24 years,[37] it was observed that females in the present study had lower rates than the national average (9.1% *vs*. 15%), while males showed slightly higher rates than the national average (6.3% *vs*. 4.8%).

Although no significant differences in BMI were observed among the four groups, urban males showed a higher prevalence of overweight and obesity, more closely aligned with reference values. This is consistent with a global study of 112 million adults, which reported that in Central Europe there are no differences in BMI between rural and urban environments.[38]

Nevertheless, BMI has significant limitations in distinguishing between fat and muscle mass.[39] Metabolic risk should be diagnosed with different indices other than just BMI, such as the WHtR.[22] In this study. The analysis of WHtR showed that the percentages of individuals at risk for metabolic and cardiovascular diseases are lower than those observed using BMI. However, as with BMI, the subgroups reporting the highest risk were the two urban samples (UF and UM). Interestingly, the RM sample showed a very low proportion of individuals at risk, despite 16.4% being classified as overweight by BMI. This suggests that the higher BMI in this subgroup may be due to greater muscle mass rather than excess fat. In the male samples, the correlation between MM% and BMI was lower than that between MM% and WHtR. Additionally, FM% was more strongly associated with WHtR than with BMI, but this pattern was observed only in the two male samples.

Regarding the results on physical activity, the GPAQ-derived MVPA showed moderate correlations in both the male and female samples with MM%, suggesting that increased MVPA is associated with greater MM%. Moreover, these associations were stronger among female students, where MVPA was positively correlated with NDHGS. This suggests that MVPA may contribute to increased muscle mass, particularly in women, which may consequently enhance hand strength. Across the entire student sample, greater engagement in MVPA appeared to be associated with better body composition. Similar associations have been reported among university students and young adults, including overweight or obese individuals.[40]

In this study significant differences were identified between groups defined by their developmental environment. However, the results must be interpreted in light of certain limitations. First of all, given the cross-sectional design of the study, causal relationships cannot be inferred, and the observed findings should be interpreted as associations rather than evidence of cause-and-effect mechanisms. The sample size was small, which may limit the generalizability of the findings, and participation was voluntary, potentially leading to selection bias, as individuals with higher health awareness may have been more likely to participate. Despite the use of standardized and validated methods, participants may still have been subject to recall bias and social desirability bias during questionnaire completion, potentially leading to an overestimation of healthy dietary and physical activity behaviours. Furthermore, the lifestyle assessment focused solely on current physical activity and MD adherence, failing to consider past habits or behavioural trajectories. In addition, other sociocultural factors known to influence physical development, such as family income, parental education level and access to recreational facilities, were not considered. Although the sample selected for this study consists entirely of university students, representing an already restricted group that generally comes from a similar and more advantaged socioeconomic backgrounds, future studies could integrate more social, cultural, geographical and economic variables in the analyses. Moreover, the distinction between urban and rural groups is based on a self-reported attribution and is not supported by an objective analysis of density of population. This could have generated confusion among the participants in differentiating between smaller metropolitan areas and large provincial towns.

Future studies should validate these findings using larger sample sizes and include students from subsequent academic years to investigate whether environmental differences change as individuals adopt a more urban lifestyle.

Conclusions

This study found significant differences in body composition between male first-year students who had grown up in urban and rural environments. Overall, the rural environment was associated with more favorable indicators of physical development, particularly in males, within the context of a Western, economically developed society. Regarding the prevalence of being overweight or obese, the values observed in this study were less concerning than European and Italian reference data for both sexes. In contrast, the prevalence of being underweight among males was slightly above the average. Almost the entire sample showed moderate adherence to the Mediterranean Diet, with only a very small proportion exhibiting high adherence. These findings highlight the need to strengthen primary prevention strategies by paying closer attention to the environment in which children grow up, as this has been shown to have a significant influence. It is therefore essential to promote educational, awareness, nutritional and physical activity programs within schools.

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Table 1. Analysis of the anthropometric measurements, HGS, Medi-Lite score, and MVPA in the groups defined by sex and living environment.

	UF (n=98)	**RF (n=89)**	**UM (n=61)**	**RM (n=67)**
Age (years)	19.6 ± 1.1	19.4 ± 1.1	19.8 ± 1.2	19.6 ± 1.3
Height (cm)	**162.4 ± 5.7***	**163.6 ± 5.3***	**175.1 ± 6.3**	**175.5 ± 6.4**
Weight (Kg)	**59.8 ± 10.6***	**58.8 ± 8.4***	**71.0 ± 12.7**	**68.9 ± 9.4**
Waist Circumference (cm)	**71.8 ± 8.2***	**70.7 ± 6.9***	**78.7 ± 9**	**76.6 ± 5.3**
BMI (Kg/m^2)	22.7 ± 4.1	21.9 ± 3.1	23.1 ± 3.9	22.4 ± 2.7
WHtR	0.443 ± 0.056	0.432 ± 0.044	0.45 ± 0.051	0.437 ± 0.032
FM%	**25.4 ± 7.4***	**24.4 ± 6.4***	**15.2 ± 5.9†**	**12.3 ± 5.1**
FFM%	**74.6 ± 7.4***	**75.6 ± 6.4***	**84.8 ± 5.9†**	**87.7 ± 5.1**
MM%	**49.4 ± 5.1***	**49.7 ± 4.8***	**59.8 ± 4.7†**	**62.7 ± 4.3**
DHGS (Kg)	**27.9 ± 5.4***	**27.8 ± 4.6***	**43.2 ± 8.9**	**43.9 ± 9.6**
NDHGS (Kg)	**25.9 ± 5***	**26.1 ± 4.7***	**40.7 ± 8.1**	**41.5 ± 9.6**
Medi-Lite score	9.0 ± 2.2	9.2 ± 2.4	8.7 ± 2	9.2 ± 2.2
MVPA. (MET-min/week)	**1695 ± 2673***	**1103 ±1632***	**3129 ± 6689**	**3219 ±4443**

*p value < 0.0125 when compared to the male sex; †p value < 0.0125 when compared to the rural counterpart, same sex. Data are reported as the mean ± standard deviation. UF, urban females; RF, rural females; UM, urban males; RM, rural males; BMI, Body Mass Index; WHtR, Waist-to-Height Ratio; FM%, Fat Mass %; FFM, Free Fat mass %; MM%, Muscular Mass %; HGS, Handgrip

Strength; DHGS, HGS test of the dominant hand; NDHGS, HGS test of the non-dominant hand; MVPA, Moderate-to-Vigorous Physical Activity; MET, Metabolic Equivalent.

Figure 1. Percentage frequencies of weight status according to BMI cut-offs. UF, urban females; RF, rural females; UM, urban males; RM, rural males; BMI, Body Mass Index.

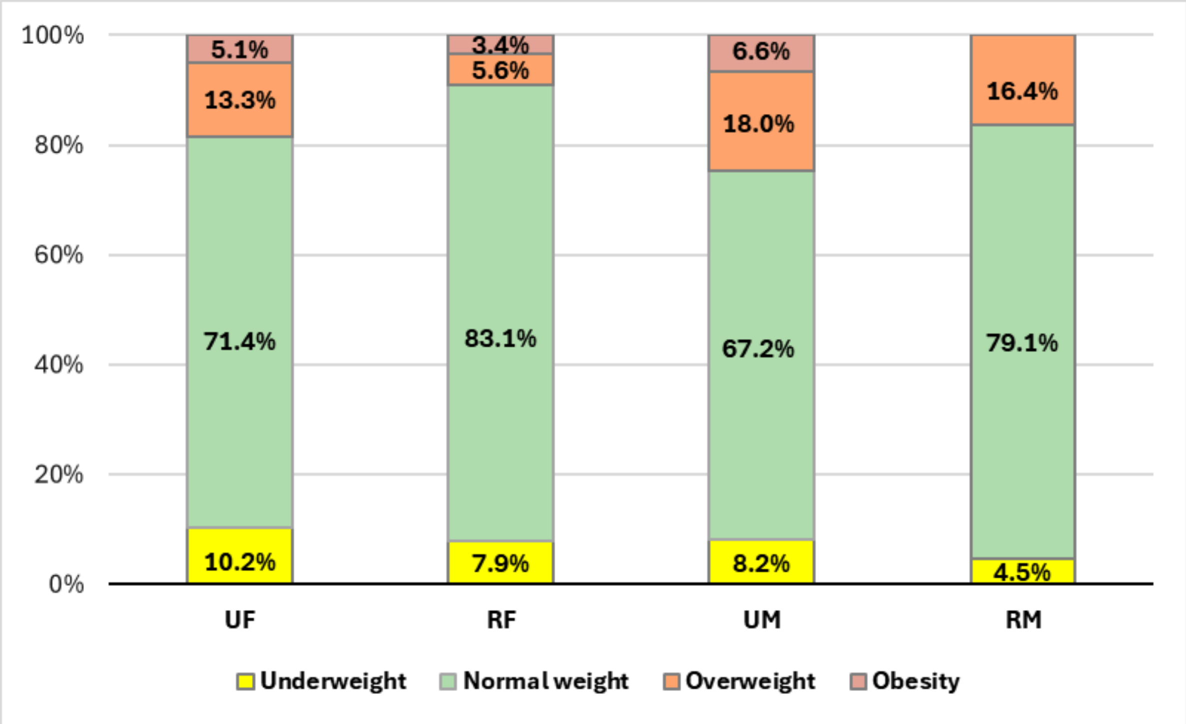
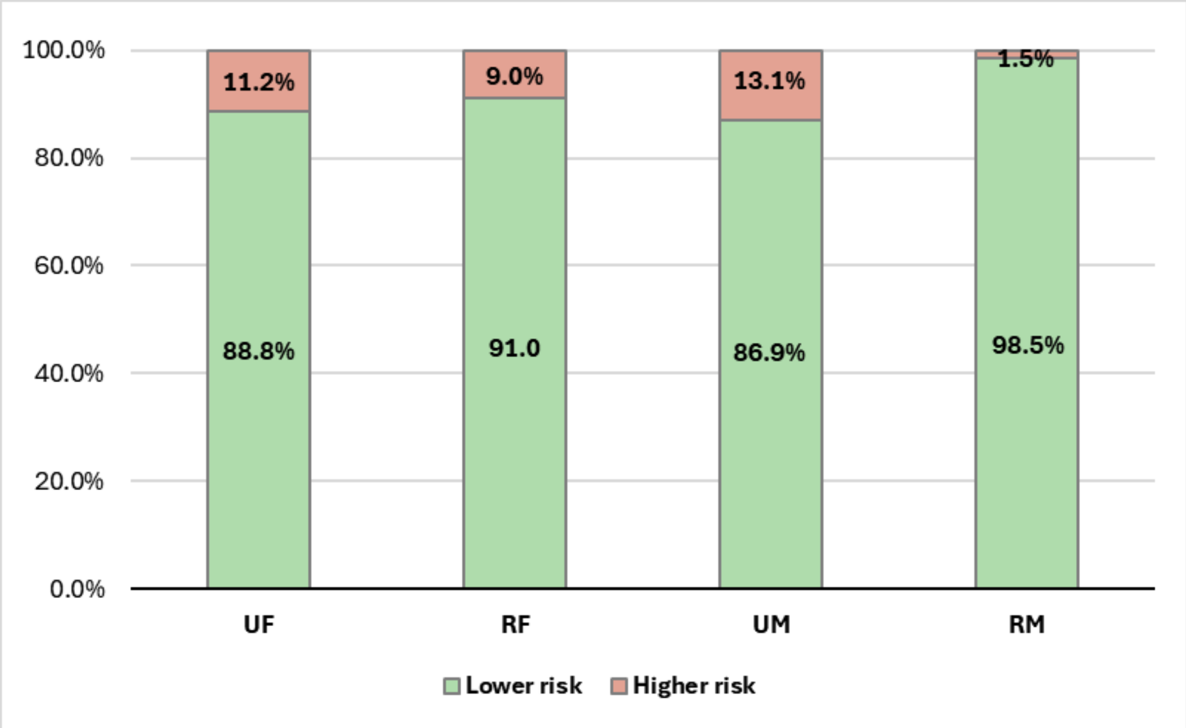


Figure 2. Percentage of individuals at risk of metabolic and cardiovascular diseases based on Waist-to-Height Ratio (WHtR) (cut-off, 0.5). UF, urban females; RF, rural females; UM, urban males; RM, rural males; WHtR, Waist-to-Height Ratio.



Contributions: Margherita Micheletti Cremasco, Anna Mulasso were significant contributors to the conception of the study and the literature search for related studies. Francesco Sguaizer, Bianca Ferreri and Francesco Tufo were significant contributors to the acquisition, analysis, and interpretation of data for the work, and were involved in the literature review and manuscript drafting. Margherita Micheletti Cremasco and Anna Mulasso were involved in literature review, manuscript review and editing and final approval of the manuscript. All authors approved the final version of the manuscript.

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