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ORIGINAL ARTICLE

Determinants of BMI underreporting in adults from families at high risk for type 2 diabetes in Europe: The Feel4Diabetes study

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Abstract

Aim The aim of this study was to investigate the determinants of body mass index (BMI) underreporting in adults from families at high risk for type 2 diabetes in Europe.

Subject and methods In total, 3169 adults (65.3% females) from six European countries were included in this cross-sectional analysis using data from the baseline assessment of the Feel4Diabetes study. Anthropometric, sociodemographic, dietary, and behavioral data were assessed, and underreporting of BMI was calculated.

Results Underreporting of BMI ranged from 20% to 84%. Women were 1.27 times more likely to underreport their BMI than men ($p = 0.01$), while participants from Southeastern Europe were 1.52 times more likely to underreport their BMI than those residing in Central/Northern Europe ($p < 0.001$). Furthermore, participants with BMI > 25 kg/m^2 and those with waist circumference (WC) ≥88 cm for women and ≥102 cm for men were 3.4 and 2.6 times more likely to underreport their BMI, respectively ($p < 0.001$). Regarding the clinical status of the participants, the existence of (pre)diabetes, hypertension (HTN), and metabolic syndrome (MS) was also associated with underreporting of BMI. More specifically, participants with (pre)diabetes, HTN, and MS were 1.4, 1.6, and 1.8 times more likely to be under-reporters ($p = 0.001$, $p = 0.003$, and $p < 0.001$, respectively).

Conclusion Given the increasing global rates of noncommunicable diseases (NCDs), having a more precise estimation of obesity is crucial in order to develop effective public health policies that promote obesity prevention and contribute to the battle against obesity and NCDs.

Keywords Underreporting · BMI · Obesity · NCDs · Weight perception

Introduction

The prevalence of obesity has almost doubled worldwide over the last 30 years, having an important impact on physical, mental, spiritual, and social health and quality of life (Seidell and Halberstadt 2015). Some of the comorbidities related to obesity include noncommunicable diseases (NCDs) (i.e., hypertension, cardiovascular diseases, cancers, and respiratory diseases), as well as cognitive impact and dementia, osteoarthritis, even increased risk of disability. Obesity also has a significant impact on national health expenditures, contributing to psychological impairments and weight-related discrimination (Dai et al. 2020; Lam et al. 2023).

Body mass index (BMI) is one of the commonly used tools to assess and monitor obesity prevalence and population health. It is calculated by dividing weight in kilograms by the square of height in meters. This measurement adds to the estimation of the health status in populations and is a cost-effective way to evaluate obesity. The BMI cutoffs for defining obesity are determined based on well-established risks for cardiometabolic morbidity and premature mortality (Adab et al. 2018). Various types of physical measurements, including BMI, are often self-reported for convenience and due to cost-effectiveness, particularly in large-sample studies or in case where researchers are unable to take participants' measurements (e.g., during home visits or lab consultations). As a result, they are prone to response and recall bias, causing people to sometimes intentionally or unintentionally underreport their body weight, height, or BMI.

Extended author information available on the last page of the article

Many studies in adults have examined the accuracy of self-reported weight and height, concluding that they can be underreported, affecting the estimation of BMI and consequently leading to obesity misclassification (Nyholm et al. 2007; Danubio et al. 2008; Shiely et al. 2010). Furthermore, several studies in the past have investigated the possible determinants mainly for weight and BMI misreporting, with the majority of them indicating age, sex, BMI category, and socioeconomic and/or educational status as predictors (Yannakoulia et al. 2006; Song et al. 2020; Hodge et al. 2020; Freigang et al. 2020). Thus, the aim of this study was to investigate the determinants of BMI underreporting in adults from families at high risk for type 2 diabetes in Europe.

Materials/participants and methods

Study design

This study was a cross-sectional analysis of baseline data of high-risk families participating in the large pan-European population-based Feel4Diabetes Study (Families across Europe following a healthy Lifestyle for Diabetes prevention). Feel4Diabetes was a large school- and community-based intervention among families from vulnerable groups in six European countries, undertaken from 2016 to 2018 (National Clinical Trial number NCT02393872; https://feel4diabetes-study.eu/). The aim of the intervention was to promote a supportive social and physical environment in home and school settings to assist families in adopting a healthy and active lifestyle. In Bulgaria and Hungary (i.e., low- and middle-income countries—LMICs), all families were considered vulnerable and eligible to participate in the study, while in Belgium, Finland, Greece, and Spain (i.e., high-income countries—HICs), families from municipalities with the lowest educational level or the highest unemployment rate (as retrieved from official resources and authorities) were included as vulnerable groups.

During the first-stage screening, primary schools in each country located in the selected "vulnerable" areas were used as the entry point to the community. Children attending the first three grades of compulsory education as well as their parents and grandparents (wherever feasible) were recruited to the study. Of these recruited families ("all families"), the "high-risk families" were identified based on type 2 diabetes (T2D) risk estimation, using the Finnish Diabetes Risk Score (FINDRISC) questionnaire. A family was regarded as "high-risk" if at least one parent fulfilled the country-specific cut-off point for FINDRISC that indicated increased T2D risk (for the majority of countries, considering the young age of the participants, that was set as a FINDRISC score ≥ 9). Self-administrated FINDRISC questionnaires were collected from 11,396 families, and then all the parents and/or grandparents of the "high-risk families," irrespectively of their individually calculated FINDRISC, were invited to undergo a more detailed assessment (second screening) delivered in local community centers or during home visits (in Belgium). From the identified "high-risk families," 3148 parents from 2535 families underwent the second screening. Regarding the "all families" component of the intervention, a sample of 600 "all families" per treatment arm was required to achieve statistical power greater than 80% (at a two-sided 5% significance level) for reducing screen time by 0–2 h/day in children within 8 months. Regarding the "high-risk families" component of the intervention, a minimum sample of 150 "high-risk families" per treatment arm was required to achieve statistical power greater than 80% (at a two-sided 5% significance level) for reducing BMI by 0–7 kg/m^2 in adults within a year. Therefore, a minimum sample of 1200 "all families" and of these 300 "high-risk families" per country, resulting in a total sample of 7200 "all families" and 1440 "high-risk families," was initially targeted. However, to account for an estimated dropout rate of about 20%, a total number of about 9000 "all families" and 2160 "high-risk families" were initially aimed to be recruited in the six participating countries. The randomization to the intervention and control group was conducted at a municipality level (1:1 ratio) after the completion of baseline measurements. Therefore, the schools and the families (i.e., "all families" and "high-risk families") within each municipality were automatically allocated to the intervention or control group. A detailed description of methods has been published previously (Manios et al. 2018, 2020).

Bioethics

The Feel4Diabetes study adhered to the Declaration of Helsinki and the conventions of the Council of Europe on human rights and biomedicine (Manios et al. 2018). All participating countries obtained ethical clearance from the relevant ethical committees and local authorities. More specifically, in Belgium the study was approved by the Medical Ethics Committee of the Ghent University Hospital (ethical approval code: B670201524437); in Bulgaria, by the Ethics Committee of the Medical University of Varna (ethical approval code: 52/10-3-2016r) and the Municipalities of Sofia and Varna, as well as the Ministry of Education and Science local representatives; in Finland, by the hospital district of Southwest Finland ethical committee (ethical approval code: 174/1801/2015); in Greece, by the Bioethics Committee of Harokopio University (ethical approval code: 46/3-4-2015) and the Greek Ministry of Education; in Hungary, by the National Committee for Scientific Research in Medicine (ethical approval code: 20095/2016/EKU); and in Spain, by the Clinical Research Ethics Committee and the Department of Consumer Health of the Government of

Aragón (ethical approval code: CP03/2016). All participants gave their written informed consent prior to their enrollment in the study.

Study population

The sample of the present study consisted of 3169 adults from the "high-risk families," having full data for the variables used in the present analysis regarding the baseline measurements of the study.

Anthropometry

Self-reported weight, height, and BMI were recorded through the self-administered FINDRISC questionnaire, which includes these questions and was provided to the participants during the screening procedure. Afterwards, for the weight measurement, the participants had to wear light clothing and remove their shoes, while for the height measurement, they had to stand in an erect position without shoes, shoulders relaxed, arms by the side, and head aligned in the Frankfort plane. Weight was recorded to the nearest 0.1 kg using a calibrated SECA digital scale (SECA 813, Hamburg Germany), and height was recorded to the nearest tenth of a centimeter (i.e., 0.1 cm) using a telescopic stadiometer (SECA 213). All volunteers were categorized by the BMI cutoff points. BMI was calculated by the formula [weight/height^2]. Waist circumference (WC) was measured midway between the lowest rib margin and the iliac crest to the nearest 0.1 cm using a nonelastic measuring tape (SECA 201). BMI and WC were classified based on the World Health Organization (WHO) criteria (Ulijaszek 2003).

Blood indices

Blood tests were performed on the same day as the anthropometric measurements by professional staff on all participants in the morning (8:30–10:30) after 12-h overnight fasting. Measurements of fasting plasma glucose (FPG) were acquired. Blood samples directed for glucose measurement were collected in tubes with sodium fluoride (10.0 mg) and potassium oxalate (8.0 mg) for the inhibition of glycolysis. Participants were classified according to the American Diabetes Association (ADA) criteria in the following categories: normoglycemic (FPG $<$ 100 mg/dl; 5.6 mmol/l), categorized as prediabetes (FPG 100–125 mg/dl; 5.6–6.9 mmol/l), and having T2D (FPG $>$ 126 mg/dl; 7.0 mmol/l) (American Diabetes Association 2017). Measurements of serum total and high-density lipoprotein (HDL) cholesterol and triglyceride (TG) levels were also acquired. Low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula (Friedewald et al. 1972).

Blood pressure measurement

Blood pressure was measured on the right arm with the participant in a sitting position using electronic sphygmomanometers (OMRON M6 or OMRON M6 AC) after 5 minutes of rest, with three readings taken at 1-minute intervals. The measurements were conducted in a private, quite place with proper temperature. The existence of hypertension (HTN) was based on elevated systolic blood pressure (SBP), diastolic blood pressure (DBP), or both according to the latest European guidelines (Williams et al. 2018).

Metabolic syndrome

The diagnostic criteria for metabolic syndrome used in the present study were those outlined by a consensus between the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) and International Diabetes Federation (IDF) (Alberti et al. 2009). A diagnosis was posed when three or more of the following criteria listed were met:

- Increased waist circumference: $\geq$ 102 cm (men) and $\geq$ 88 cm (women)
- Elevated triglyceride: $\geq$ 150 mg/dl (1.7 mmol/L)
- Reduced high-density lipoprotein C: $<$ 40 mg/dl (men); $<$ 50 mg/dl (women)
- Elevated blood pressure: systolic $\geq$ 130 and/or diastolic $\geq$ 85 mmHg
- Elevated fasting glucose: $\geq$ 100 mg/dl

Dietary assessment

Dietary information was obtained from adults using a questionnaire measuring the frequency of meals and snacks, the frequency and quality of consumption of certain types of food at breakfast, the reasons for skipping breakfast, and the quantity, quality, and frequency of consumption of particular types of food and beverages over the past month (Anastasiou et al. 2020; Androutsos et al. 2020).

Demographic and behavioral characteristics

Standardized self-reported questionnaires (translated–back-translated into each local language) were used for all study participants to gather information on basic sociodemographic characteristics (age, ethnicity, education level, marital status, occupation) along with information concerning smoking, physical activity, sedentary behaviors (i.e., sitting hours, screen time), and sleep duration as well as their determinants.

Statistical analysis

Continuous variables were checked for normality using the Kolmogorov–Smirnov test. Those that were normally distributed are presented as mean ± SD while those that were not normally distributed are presented as median and interquartile range [IQR, 25th–75th percentile]. Categorical variables are presented as frequencies. The Kruskal–Wallis test for independent samples was used to evaluate differences in the continuous variables due to non-normality of the data, and one-way analysis of variance (ANOVA) was used to evaluate the means of the normally distributed variables. Associations between categorical variables were tested using the chi-squared test.

Mean values of body weight and height and underreporting of BMI were calculated as the difference between self-reported and measured data within individuals. Self-reported weight or height was deemed acceptably accurate if within ±2.0 kg or ±2.0 cm of measured weight or height, respectively. These cutoff points were determined to allow for various factors that might explain differences between self-reported and measured height and weight that can occur even in the absence of any intentional or unintentional underreporting. One factor is the technical error of measurement of weight (negligible) and height (0.5 cm), and another is temporal variation in weight and height depending on food/liquid consumption and fluid balance. In addition, height and weight in an individual can vary with age, and subjects may have meticulously reported their weight and height based on a measurement that was taken months ago.

Furthermore, multiple logistic regression analysis was applied to evaluate the explanatory ability of various characteristics of the participants in relation to BMI underreporting (dependent variable). The analysis accounted for the potential confounding effect of the following characteristics: age, sex, country of residence, education (measured in years) as a proxy for social status, and smoking status (never smoked/former smoker/current smoker). The results are presented as odds ratios (OR) and their corresponding 95% confidence intervals (95% CI). All reported *p*-values were based on two-sided tests. Statistical calculations were carried out using SPSS 25 software (IBM Corp., Armonk, NY, USA).

Table 1 Distribution of study participants' characteristics for the total sample and by country category

	Total ($n=3\ 169$)	High-income countries (Belgium, Finland) ($n=885$)	High-income countries under austerity measures (Greece, Spain) ($n=1\ 394$)	Low- and middle-income countries (Bulgaria, Hungary) ($n=890$)
	Median [IQR, 25th–75th percentile] or mean ± SD or (%)	Median [IQR, 25th–75th percentile] or mean ± SD or (%)	Median [IQR, 25th–75th percentile] or mean ± SD or (%)	Median [IQR, 25th–75th percentile] or mean ± SD or (%)
Age (years)	41 [37–45]	39 [36–44]	43 [39–46]	39 [36–44]
Sex				
Male (%)	34.7	35	39.8	27.3
Female (%)	65.3	65	60.2	72.7
Education				
≤ 12 years (%)	27	18.1	28.4	32.7
> 12 years (%)	73	81.9	71.6	67.3
Smoking				
Never smokers (%)	46.6	56	43.8	42.5
Former smokers (%)	27.5	31.1	28.7	22.4
Current smokers (%)	25.9	12.8	27.5	35.2
Body mass index (kg/m^2)	28.7 ± 6	28.5 ± 5	29.3 ± 6	27.8 ± 6
Waist circumference (cm)	95 [85–105]	95 [85–104]	97 [87–106]	91 [78–103]
Existence of (pre)diabetes	26.7	30.7	28.9	17.6
Existence of hypertension	11.2	15.8	7.9	11.6
Existence of metabolic syndrome	23.4	27.2	20.6	24.3
Sitting hours (hours/day)	5 [2.5–8]	5 [3–8]	4 [2–8]	4 [2–7]

Results

Table 1 presents the basic characteristics of the 3169 participants stratified by country category. The median age of the participants was 41 years (IQR: 37–45), and most of them were women (65.3%). Almost one quarter of participants had less than 12 years of education (27%) and were current smokers (25.9%), with these percentages being statistically significantly lower in high-income countries than in other country categories ($p < 0.001$). Regarding anthropometric characteristics, participants were overweight ($p < 0.001$), while the median for the WC was 95 cm (IQR: 85–105). As for the clinical characteristics of the participants, the prevalence of (pre)diabetes, HTN, and MS was 26.7%, 11.2%, and 23.4%, respectively, with these percentages being statistically significantly higher in high-income countries than in low- and middle-income countries ($p < 0.001$, $p < 0.001$, and $p = 0.002$, respectively). Finally, participants were more likely to spend at least 5 hours per day sitting (Table 1).

Table 2 presents the percentages of participants per weight status category underreporting BMI according to their country of residence and sex. Underreporting BMI ranged from 20% to 84%, with the percentages being higher for women than for men ($p = 0.01$) and for the countries of Southeastern Europe compared to countries of Central/Northern Europe ($p < 0.001$). Moreover, higher percentages of underreporting of BMI were observed for obese and overweight participants compared to normal-weight participants ($p < 0.001$).

Mean values of weight being underreported ranged from 1.9 to 9.7 kg, with the differences being significant for women compared to men ($p = 0.02$) and for the countries of Southeastern Europe compared to countries of Central/Northern Europe ($p < 0.001$). Moreover, higher mean values of weight being underreported were observed for obese and overweight participants than for normal-weight participants ($p = 0.004$) (Table 3). Mean values of height being underreported ranged from 0.6 to 11.4 cm, with the differences being significant for women compared to men ($p = 0.02$) and for the countries of Southeastern Europe compared to countries of Central/Northern Europe ($p < 0.001$). No significant differences were observed for the mean values of height being underreported with regard to the different categories of body weight ($p = 0.32$) (Table 3).

Table 4 presents the results of the logistic regression analysis that was applied to evaluate the association between various characteristics of the participants and BMI underreporting. Women were 1.27 times more likely to underreport their BMI than men ($p = 0.01$), while participants from Southeastern Europe were 1.52 times more likely to underreport their BMI than those residing in Central/Northern Europe ($p < 0.001$). Furthermore, participants with BMI > 25 kg/m^2 and those with WC ≥ 88 cm for women and ≥ 102 cm for men were 3.4 and 2.6 times more likely to underreport their BMI, respectively ($p < 0.001$). Regarding the clinical status of the participants, the existence of (pre)diabetes, HTN, and MS was also associated with underreporting of BMI. More specifically, participants with (pre)diabetes, HTN, and MS were 1.4, 1.6, and 1.8 times more likely to be under-reporters, respectively ($p = 0.001$, $p = 0.003$, and $p < 0.001$, respectively).

Discussion

In this work, we examined the association of various sociodemographic, anthropometric, and clinical characteristics with BMI underreporting in 3169 adults from families at risk of T2D in Europe. The analysis revealed that women, participants residing in Southeastern Europe, those who were overweight and obese, and those with increased WC were more likely to underreport their BMI. Moreover, the existence of (pre)diabetes, HTN, and MS was positively associated with BMI underreporting.

In line with previous studies (Yannakoulia et al. 2006; Song et al. 2020), it was found that women were more prone to underreport obesity status than men and may have a distorted perception of their body weight. Physical, interpersonal, emotional, cultural, and socioeconomic factors including mass media such as magazines, TV, and social media can impact weight, height, and how women perceive their body image. The societal standard of an "ideal body" often depicted in popular culture and mass media is a tall and slender physique, which may not align

Table 2 Percentage of participants per weight status category underreporting BMI according to country of residence and sex

	Belgium		Finland		Greece		Hungary		Bulgaria		Spain	
BMI categories	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Normal weight	29.7%	34.1%	0%	37.3%	25%	58.1%	–	42.9%	25%	41.3%	20%	44.2%
Overweight	33.3%	53.7%	50.8%	59.5%	50%	70.1%	50%	50%	48.1%	60%	57.7%	64%
Obese	52%	63.5%	69.6%	70.2%	75.8%	82.5%	60%	81%	55.8%	83.9%	74.5%	82.5%

Table 3 Mean values (± SD) of weight (kg) and height (cm) being underreported per weight status category according to country of residence and sex

BMI categories	Belgium				Finland				Greece				Hungary				Bulgaria				Spain			
	Male		Female		Male		Female		Male		Female		Male		Female		Male		Female		Male		Female	
	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)
Normal weight	2.3 ± 1.4	2.6± 1.3	2.2 ± 1.5	1.5± 1.1	2.3	1.9 ± 1.8	2 ± 1.2	1.3 ± 0.8	2.4 ± 1.6	2.3 ± 1	1.9± 1.5	2.8 ± 1.8	–	–	2.4	3.5 ± 1.3	6.6 ± 9	1.7 ± 0.3	3 ± 2.8	2.5 ± 1.5	2.3± 1.6	2.8 ± 2.7	2 ± 2.2	2 ± 1.1
Over-weight	2.9 ± 2	1.8 ± 1.3	3 ± 2	2 ± 1.3	2.6 ± 1.6	1.5± 0.8	2.4 ± 1.4	1.2 ± 0.7	2 ± 1.3	2.8 ± 1.6	3.5 ± 2.7	2.9 ± 1.9	2.5 ± 0.9	0.6	4.3 ± 4	7 ± 7.3	3.7 ± 4	1.9 ± 1.1	3.9 ± 2.8	3.7 ± 3.5	2.5 ± 2.5	2.4± 1.4	2.7 ± 2	3.4± 3.2
Obese	5.8 ± 8	2.8 ± 1.7	4.8 ± 5.4	2.3± 2.5	4 ± 3	1.6 ± 0.9	3.7 ± 3.2	1.8± 1.1	4.8 ± 4	2.8 ± 1.7	5.4 ± 4.3	3.5 ± 1.7	3 ± 0.1	11.4 ± 12.3	9.3 ± 11	5.5 ± 5	5.7 ± 6	3.6± 3.5	9.7 ± 8.8	3.4 ± 2.1	4.4 ± 3.5	2.5± 1.4	4.4 ± 3.6	2.7± 1.5

with the diverse body types of many women in the general population (Shiely et al. 2010; Bibiloni et al. 2017). In modern society, there is a strong emphasis on achieving the perfect body shape and weight, driven not by health considerations but by the societal values associated with diet culture, meaning attractiveness, acceptance, and success. Height is also a valued characteristic in most societies, with its satisfaction being an aspect of body image and various aspects of development and health. Men in particular have an elevated need to achieve socially desirable masculine physical characteristics, being frequently prone to distorting this aspect of their body size. These factors can lead to harsh self-criticism, increased dissatisfaction, and unnecessary concerns about weight and/or height among people, which may be the reason for the inaccuracies in their self-reported BMI.

Consistent with the findings of other investigators (Hodge et al. 2020; Connor Gorber et al. 2007; Maukonen et al. 2018), participants with overweight and obesity were more likely to underreport BMI than normal-weight participants. Similar results were found regarding WC, which is also a measure specifically for abdominal obesity. This fact should be considered by the scientific community, given the high prevalence of obesity and its comorbidities.

Participants with (pre)diabetes, HTN, and MS were more likely than healthy individuals to underreport their obesity status, a finding that is particularly interesting. Individuals facing the comorbidities of obesity may underreport their BMI as a defense mechanism. Weight and BMI misperception have been linked to unhealthy lifestyles (Althumiri et al. 2021), which could play an important role in the progression of chronic diseases like (pre)diabetes, HTN, and MS.

Accurate diagnosis of obesity is important at the population and policy levels, since inaccurate measurements could mislead the interpretation of its epidemiology. It is worth pointing out that despite the use of BMI as a public health screening tool, it has limitations regarding the distinguishment between fat and lean body mass as well as with respect to different groups of the population (e.g., older adults and Asian populations) (Adab et al. 2018; Sommer et al. 2020). Moreover, the bias observed when it is self-reported should be considered by researchers as well as by health specialists in daily clinical practice.

The large pan-European study sample, the standardized protocols and procedures followed across all centers, and the objectively collected data (i.e., blood and anthropometric indices) ensure the objectivity and reliability of the assessment. However, our study should be viewed in light of some limitations. Because the present study has a cross-sectional design, the determination of cause-and-effect relationships is impossible, and extrapolation of the results should be done with caution. Additionally, some of the collected data were self-reported and thus are prone to recall and social desirability bias.

Table 4 The association of various characteristics of the participants with BMI underreporting (results are presented as odds ratios and 95% CI)

	OR, 95% CI	*p*-value
Age (years)	1.17 (0.99–1.38)	0.07
Sex (female vs. male)	**1.27 (1.06–1.51)**	**0.01**
Country of residence (Southeastern Europe vs. Central/Northern Europe)	**1.52 (1.26–1.83)**	**< 0.001**
Education (> 12 years vs. ≤ 12 years)	0.94 (0.77–1.14)	0.53
Occupation (employed vs. unemployed)	0.94 (0.77–1.16)	0.58
BMI (> 25 kg/m^2 vs. < 25 kg/m^2)	**3.4 (2.79–4.14)**	**< 0.001**
WC (≥88 cm F, ≥ 102 cm M vs. < 88 cm F, < 102 cm M)	**2.55 (2.15–3.02)**	**< 0.001**
Existence of (pre)diabetes (yes vs. no)	**1.41 (1.15–1.73)**	**0.001**
Existence of hypertension (yes vs. no)	**1.57 (1.17–2.12)**	**0.003**
Existence of metabolic syndrome (yes vs. no)	**1.76 (1.42–2.2)**	**< 0.001**

All odds ratios and their corresponding 95% confidence intervals were calculated by performing logistic regression

Analyses were adjusted (except when used as independent variable) for age, sex, country of residence, education, and smoking status

Note: Bold indicates statistical significance (p_{trend} < 0.05)

Abbreviations: CI, confidence interval

Conclusions

In conclusion, women, participants residing in Southeastern Europe, those who were overweight and obese, and those with increased WC were more likely to underreport their BMI. Moreover, the existence of (pre)diabetes, HTN, and MS was positively associated with BMI underreporting. Participants with overweight and obesity and those with other existing NCDs are a high-risk group. Given the increasing global rates of these diseases, having data on the prevalence of overweight and obesity that are as precise as possible is crucial in order to determine whether global goals for NCD prevention and reduced obesity rates will be met. Therefore, measured versus self-reported anthropometric data may offer a more reliable estimate of obesity prevalence, increasing validity and reinforcing public health policies in tackling obesity and NCDs.

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Code availability Not applicable

Declarations

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