Original Article

Misclassification of Self-Reported Body Mass Index Categories

A Systematic Review and Meta-Analysis

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Summary

Background: Overweight and obesity are an increasingly serious public health problem in Western societies, including Germany. The tendency of overweight and obese people not to classify themselves as such limits the efficacy of information on the health risks of these conditions and lessens the motivation to change behavior accordingly. In this article, we summarize the available study data on the self-perception of weight class. We present and discuss the differences between self-reported body-mass index (BMI) category and the actual category of the BMI when it is calculated from the individual's measured height and weight.

Methods: We systematically searched the Medline, EMBASE, and Cochrane Library databases in August 2017 for pertinent publications. The study protocol was published in the PROSPERO register (CRD42017064230). Meta-analyses were calculable for a number of subgroup analyses.

Results: A total of 50 studies from 25 countries were identified that contained findings on self-estimation of weight in a total of 173 971 study participants. The percentage of correct self-categorizations of BMI category varied from 16% to 83%, with marked heterogeneity of the population groups studied. In Europe, women overestimated their BMI category three times as often as men (RR: 3.22; 95% confidence interval: [2.87; 3.62], I^2 = 0%). Most erroneous classifications were based on underestimates. Study participants of normal weight were more likely than others to categorize their BMI correctly. In European studies, 50.3–75.8% categorized their BMI correctly. Low socioeconomic status was associated with an incorrect perception of BMI.

Conclusion: The self-assignment of BMI categories is often erroneous, with underestimates being more common than overestimates. Physicians should take particular care to provide appropriate information to persons belonging to groups in which underestimating one's BMI is common, such as overweight people and men in general.

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Overweight and obesity are a growing global public health problem (1). Epidemiological analyses have projected that overweight will be one of the top 4 global causes of preventable years of life lost in the future, besides hypertension, diabetes, and smoking (2). Already in 2007, the social costs of overweight amounted to 16 billion Pound Sterling in the United Kingdom (corresponding to 1% of their gross national product), with a strong upward trend. According to guideline recommendations on the prevention of myocardial infarction, stroke, and diabetes, physicians should offer lifestyle interventions to their overweight patients (3, 4). The 13th nutrition report of the German Nutrition Society (DGE, Deutsche Gesellschaft für Ernährung e. V.) highlights the need to stop this obesity epidemic in Germany and calls for urgent action (5).

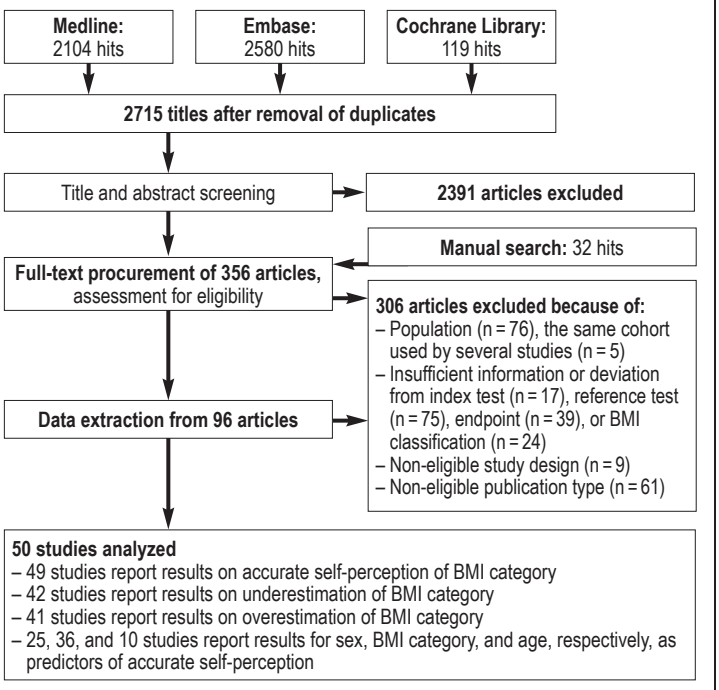
According to the World Health Organization (WHO), in 2016 worldwide 39% of adults were overweight with a body mass index (BMI) of ≥ 25 kg/m^2, while 11% of men and 15% of women were obese with a BMI of ≥ 30 kg/m^2 (6). The prevalence of obesity is high in Germany. Of the adult population, 54% have a BMI of ≥ 25 kg/m^2 and 18% of >30 kg/m^2 (7). In the United States, prevalence rates are even higher, with 36% of the population being obese (8).

For weight-loss interventions to be successful, people need to be aware of the fact that they are overweight; without this awareness, a behavioral change is unlikely to happen (9–11). The agreement between self-perception and measured weight status has already been evaluated in numerous studies on a variety of populations; however, an aggregation of these data for the general adult population is missing.

The aim of this review is to organize the available data from studies on weight perception in adults, to identify areas that need to be addressed in future research, and to provide summarized answers to the following questions:

- How often is the self-perceived BMI categorization accurate?
- Is misclassification based on overestimation or underestimation?
- What groups of persons show good weight self-perception and what groups do not?

FIGURE



Literature search flow diagram

To this end, differences between self-reported BMI categories and those calculated from height and weight measurements were compared.

Methods

Search strategy

This systematic review is based on a study protocol (Prospero registration number: CRD42017064230). A search strategy was developed on the basis of the inclusion criteria *(Box)*. Three electronic databases (Medline, Embase, and the Cochrane Library) as well as the references of all systematic reviews were systematically searched in August 2017. Detailed information about the search strategy is provided in the *eMethods*.

Study selection, data extraction and quality assessment

Two authors (RF, AKG) independently screened all retrieved titles and abstracts as well as the full-text articles of all potentially useful papers and extracted the information specified in the study protocol from them. Study quality was assessed using the QUADAS-2 criteria (12) which were adapted to the aim of our study *(eBox)*. After pilot testing and further modification of the quality criteria, which are based on 4 domains, the quality of each study was assessed. Any unclear decisions were discussed with a third researcher (SU).

Statistical analysis

The frequencies of accurate self-perception, underestimation, and overestimation were described using prevalence rates and their 95% confidence intervals [95% CI]. Given non-substantial heterogeneity, these were summarized using a random effects model (Review Manager, version 5.3) and only interpreted in a descriptive manner. Heterogeneity assessment relied on statistical criteria (I^2 and p values of the Q test); non-substantial heterogeneity was defined as $I^2<80\%$. The causes of heterogeneity were explored using calculated relative risks (RR) or odds ratios (OR), comparing the numbers of accurate self-classification by female and male, normal-weight and over-weight, younger and older participants, and participants with lower and higher socioeconomic status (SES). RR/OR >1 describes a higher prevalence in women, normal-weight and younger participants, and participants with lower socioeconomic status. Age comparisons are based on data of the youngest and oldest reported age cohorts and ORs describing the increased likelihood of occurrence in the presence of an age difference of 10 years. Confounder-adjusted results were given preference in the heterogeneity analyses for age and socioeconomic status and reported as ORs. Subgroup analyses are reported for intercontinental differences, with a significance level of $p<0.05$. Funnel plots were used to assess the risk of publication bias for at least 10 of the studies included in the meta-analysis.

Results

Altogether, 2747 articles were screened based on title and abstracts; 356 potentially relevant articles were assessed in full text. The 50 studies that met the inclusion criteria *(Figure)* are described in this systematic review.

Description of the included studies

The studies included in this review are based on surveys conducted in 25 countries. Most studies were carried out in North and South America (16 studies), followed by Africa (12 studies), Europe (9 studies), Asia (8 studies), and Australia plus Polynesia (5 studies).

In the included studies, self-perceived BMI category and measured BMI category were compared for altogether 173 971 participants. Of these, 54% were female; 8 studies included only women and 2 studies only men. The mean age ranged between 21 and 64 years. Only 11 studies were based on representative cross-sectional surveys of the general population of a country or region. The included studies typically targeted groups with a particularly high or low risk of overweight, such as specific age groups or professional groups (for example, dancers, firefighters, patients). A detailed description of other study characteristics is provided in *eTable 1*.

Index test and reference test

In the index test, study participants were asked in interviews and questionnaires to self-classify their weight based on at least 3 response options. In the reference

test, the BMI of participants was obtained by weighing and measuring them at the survey site; these BMI data were then classified as underweight, normal weight, overweight, or obesity.

Quality assessment

The greatest limitations to study quality are related to applicability when the study sample is not representative of the general population *(Table 1)*. Other limitations result from lack of information about how the index test and/or the reference test were performed; in this situation, only inadequate quality assessment could be performed. Due to the use of more narrow criteria, the quality of the studies is rather underestimated than overestimated.

Study results

Accurate self-classification of BMI category

The proportion of participants with accurate self-perception varies between 16% and 83% *(Table 2)*. Because of this substantial heterogeneity ($I^2 = 100\%$, $p<0.00001$), no meta-analysis was performed.

High rates of misclassification were associated with:

- African American descent
- a non-western lifestyle
- some of the studied professional groups, such as firefighters and healthcare professionals, as well as
- older patients with cardiovascular disease, diabetes, or overweight.

Younger participants, by contrast, were usually able to classify their weight with a high level of accuracy, irrespective of their health status and cultural background.

In all 9 European studies, the prevalence rates of accurate BMI categorization were above 50% and in 4 studies at about 75%. Accurate self-perception of weight status was far less common in American (prevalence <50% in 9 of 15 studies) and African studies (prevalence <50% in 6 of 12 studies); in 2 studies representative of the US population and Mexican population, respectively, less than 50% of the participants were able to accurately classify their weight (13, 14).

Overestimation and underestimation of BMI category

Inaccurate weight self-perception can show either as an underestimation or overestimation of the BMI category *(Table 2)*. Given the substantial heterogeneity of the studies, here again it was not reasonable to perform a meta-analysis (each $I^2 = 100\%$).

Globally, the underestimation prevalence varies between 8% and 84%. Overestimation, by contrast, was markedly less common and, apart from 2 studies (15, e1), only observed in less than 20% of the participants. In Europe, the prevalence of underestimation was mostly less than 25%, while overestimation was observed in less than 10% of participants. The substantial heterogeneity was not reduced by a subgroup analysis of the representative studies.

BOX

Inclusion criteria

- Population: Adults (≥ 18 years) without eating disorder (e.g. anorexia nervosa, binge-eating disorder, or bulimia nervosa).
- Index test: Self-perception of participants as underweight, normal weight, overweight, or obese.
- Reference test: Objective measurement of weight and height; calculation of BMI and classification of categories according to WHO criteria: underweight (BMI <18.5 kg/m²), normal weight (BMI: 18.5 to ≤ 25 kg/m²), overweight (BMI: 25 to ≤ 30 kg/m²), obesity (BMI ≥ 30 kg/m²).
- Endpoint: Prevalence rates of accurate self-perception, underestimation or overestimation of BMI category based on data from comparisons of index and reference tests.
- Types of study design eligible for inclusion: Observational studies (cohort, case–control, and cross-sectional studies) and randomized controlled trials.
- Types of publication eligible for inclusion: Full-text article in English or German.

Predictors of accurate self-classification of BMI category

The impact of sex (25 studies)

In 17 studies, including all 5 studies conducted in Europe, weight self-perception of women was more likely to be accurate compared to that of men *(eFigure 1)*. Given the substantial heterogeneity, summarizing the results of the studies was not suitable, neither for accurate BMI categorization nor for underestimation. In 15 of 22 studies, men underestimated their BMI category more frequently than women *(eFigure 2)*. In 18 of 21 studies, women overestimated their weight more frequently than men; here, large intercultural differences were noted. European women overestimated their BMI categories three times more frequently than men (RR: 3.22; [2.87; 3.62], $I^2 = 0\%$). Australian, Asian, and American studies reported similar results, with substantial heterogeneity of the results in the American and Australian studies. In Africa, by contrast, weight overestimation was significantly less common in women than in men (RR: 0.69; [0.48; 0.99], $I^2 = 0\%$) *(eFigure 3)*.

The impact of BMI category (36 studies):

Study participants with normal weight more frequently classified their BMI status accurately compared to overweight or obese participants, but there was substantial heterogeneity among included studies *(eFigure 4)*.

Impact of age (10 studies):

Worldwide, younger participants classify their weight more accurately than older participants *(eFigure 5)*. However, the results of the only German study were strikingly different (16). In the subgroup of

TABLE 1

Results of the quality assessment of included studies

Study	Risk of bias				Applicability		
	Representative-ness	Index test	Reference test	Timing	Representative-ness	Index test	Reference test
Agrawal (2014)	🟢	🔴	🟢	🔴	🔴	🔴	🟢
Akgöz (2017)	🔴	🔴	🟢	🟢	🔴	🟢	🟢
Akindele (2017)	🟢	🟢	🟡	🔴	🔴	🟢	🟡
Akinpelu (2015)	🟢	🔴	🟢	🟢	🟢	🟢	🟢
Barichella (2011)	🔴	🟡	🟢	🔴	🔴	🟡	🟡
Barzuca (2013)	🟡	🟢	🟡	🔴	🔴	🔴	🟢
Baur (2012)	🟡	🟢	🟢	🟢	🔴	🟢	🟢
Blokstra (1999)	🔴	🟢	🟡	🔴	🟢	🔴	🟢
Caleyachetty (2016)	🟢	🟢	🔴	🔴	🟢	🟢	🟢
Colchero (2014)	🟢	🟢	🟢	🟢	🟢	🟢	🟢
DeVille-Almond (2011)	🟢	🟢	🟡	🟡	🔴	🟢	🔴
Dorosty (2014)	🟢	🟢	🟢	🔴	🔴	🟢	🟢
Drumond (2012)	🟡	🟡	🟢	🟢	🔴	🟢	🟢
Duncan (2014)	🔴	🟢	🟢	🔴	🔴	🔴	🟢
El-Kassas (2016)	🔴	🟡	🟢	🔴	🔴	🟢	🟢
Faber (2005)	🔴	🔴	🟢	🔴	🔴	🔴	🟢
Gao (2017)	🟢	🟡	🟢	🔴	🔴	🟢	🟢
Griger (2015)	🟢	🟢	🟢	🔴	🟢	🟢	🟢
Harris (2016)	🔴	🟢	🔴	🔴	🔴	🟢	🟢
Hendley (2011)	🟢	🟢	🟢	🔴	🟡	🟢	🟢
Herbert (2017)	🟢	🟢	🟢	🔴	🟢	🔴	🟢
Howard (2008)	🟢	🟡	🟢	🟢	🟢	🟢	🟢
Irani (2007)	🟢	🟢	🟡	🟢	🔴	🟢	🟢
Jeffs (2016)	🟢	🔴	🟢	🟢	🔴	🟢	🟢
Johnston (2014)	🟢	🟡	🟡	🔴	🔴	🔴	🟢
Kim (2018)	🟢	🟢	🟢	🟢	🟢	🟢	🟢
Kirk (2008)	🟢	🟢	🟡	🟢	🔴	🟢	🟡
Jáuregui (2016)	🟢	🟢	🟢	🔴	🔴	🟢	🟡
Loret de Mola (2012)	🟢	🟢	🟢	🟢	🔴	🟢	🟢
Maruf (2012)	🟢	🟡	🟡	🟡	🔴	🟢	🟢
Minsky (2013)	🟢	🟡	🟡	🔴	🔴	🟢	🟢
Mogre (2014)	🟢	🟢	🟢	🔴	🔴	🟢	🟢
Mogre (2015)	🟢	🟢	🟢	🔴	🔴	🟢	🟢
Monteagudo (2015)	🟢	🔴	🟢	🔴	🔴	🟢	🟢
Moore (2010)	🔴	🟢	🟡	🟢	🔴	🟢	🟢
Mueller (2014)	🟢	🟢	🟢	🔴	🔴	🟢	🟢
Muhihi (2012)	🟢	🟢	🟢	🔴	🔴	🟢	🟢
Murillo (2016)	🟢	🟢	🟡	🔴	🔴	🔴	🔴

Study	Risk of bias				Applicability		
	Representative-ness	Index test	Reference test	Timing	Representative-ness	Index test	Reference test
Peltzer (2012)	🟢	🟢	🟢	🔴	🔴	🟢	🔴
Phetla (2017)	🟢	🟡	🟡	🟢	🔴	🟢	🟢
Prinsloo (2014)	🟢	🟢	🟢	🔴	🔴	🔴	🟢
Rahman (2010)	🟡	🟢	🟡	🔴	🔴	🟢	🔴
Rouiller (2016)	🔴	🔴	🟢	🔴	🟢	🔴	🟢
Shin (2015)	🟢	🔴	🟢	🔴	🟢	🔴	🔴
Sinhababu (2007)	🟢	🟢	🔴	🔴	🔴	🔴	🟢
Strassnig (2005)	🟢	🟢	🟡	🔴	🔴	🟢	🔴
Van Minnen (2011)	🟢	🟡	🟢	🔴	🔴	🔴	🟡
Veggi (2004)	🔴	🟢	🟢	🔴	🔴	🟢	🔴
Ver Ploeg (2008)	🟢	🟢	🟢	🔴	🟢	🔴	🔴
Wang (2017)	🟢	🟢	🟡	🔴	🔴	🟢	🟢

🟢 Low risk of bias/high applicability
🟡 Rated as unclear
🔴 High risk of bias/low applicability

normal-weight participants, the youngest surveyed age cohort, the 18- to 29-year-olds, less frequently classified their BMI category correctly compared to the age cohort of the 70- to 79-year-olds (OR 0.23; [0.16; 0.33]). The funnel plot *(eFigure 6)* showed no sign of publication bias.

The impact of socioeconomic status (15 studies): Participants with lower SES, lower educational attainment, or lower income were less likely to classify their BMI status accurately compared to participants with higher SES; again, substantial heterogeneity was observed among the studies *(eTable 2)*.

Discussion

Our review shows that worldwide people find it difficult to accurately categorize their BMI status, with underestimations being far more common than overestimations. Most at risk of underestimating their BMI category were older, male, and overweight participants as well as participants with low socioeconomic status.

A variety of factors has been discussed as possible causes of inaccurate self-perceived BMI categorization. Besides lack of information, key factors include social group effects which make it appear "normal" to be overweight, because other people living in the same social environment are also overweight—the so-called "peer effect" (3, 13, 17). Such environments can be professional groups, age groups, migrant background, urban/rural settings, cultural groups, or traditions (18). In Germany, overweight is a common and relevant problem: 54% of the adult population has a BMI ≥ 25 kg/m^2 and 18% a BMI above 30 kg/m^2 (7). A comparison of studies from the United States (19–21) and Europe (16, 22, 23) suggests that with the increase in prevalence of overweight the likelihood of inaccurate self-perception also increases. Against the backdrop of high obesity rates in Germany (7), raising awareness in a timely manner could help to thwart this effect.

In African cultures, overweight is often seen as a sign of wealth and health, and being underweight as a sign of a potential HIV infection or AIDS (24–26). At the same time, in some of the included African studies, e.g. the study by Phetla et al. (24), the percentage of overweight participants was very high.

Underestimation of the BMI category was markedly more common than overestimation in almost all studies, a finding that confirms the relevance of raising awareness of overweight/obesity in the general population.

Due to the high variability of the results of the individual studies, no significant differences between men and women could be demonstrated. However, in more than two-thirds of the studies allowing direct comparison, women were ahead in terms of accurate self-perception. In addition, marked differences in the type of misclassification of BMI category were found. While women rather overestimated their BMI category in most cultures, the primary concern in men was underestimation of the BMI category. This is in line with the results of the representative German Health Interview and Examination Survey for Adults (16) which found that, while the rates of accurate

TABLE 2

Summary of the BMI categorization results

Study	Continent	n	Prevalence (%) [95% CI]		
			Accurate classification	Underestimation	Overestimation
Harris (2016)	America	118	16.1 [9; 23]	83.9 [77; 91]	0
Kirk (2008)*2	Australia*1	102	26.5 [18; 35]	–	–
Baur (2012)	America	768	32.0 [29; 35]	68.0 [65; 71]	0
Phetla (2017)	Africa	210	33.3 [27; 40]	60.5 [56; 65]	6.2 [4; 9]
Duncan (2014)	Africa	466	34.1 [30; 38]	63.3 [60; 66]	2.6 [2; 4]
Irani (2007)	America	356	34.4 [29; 39]	56.8 [53; 60]	8.8 [7; 11]
Moore (2010)	America	323	35.6 [30; 41]	61.6 [58; 62]	2.8 [2; 4]
Akgoz (2017)	Asia	300	36.3 [31; 42]	57 [51; 63]	6.7 [4; 10]
Faber (2005)	Africa	187	36.9 [30; 44]	63.1 [56; 70]	0
Colchero (2014)	America	32 052	38.0 [38; 39]	57.8 [57; 58]	4.2 [4.0; 4.3]
Mogre (2014)	Africa	200	42 (35; 49]	45 [40; 50]	13 [10; 16]
Minsky (2013)	America	586	42.8 [39; 47]	51.2 [48; 54]	6.0 [5; 7]
Loret de Mola (2012)	America	983	43 [40; 46]	53.8 [52; 56]	3.2 [2; 4]
Gao (2017)	Asia	10 177	43.4 [42; 44]	53.8 [53; 54]	2.8 [2.6; 3.0]
Muhihi (2012)	Africa	209	46.4 [40; 53]	49.3 [43; 56]	4.3 [2; 6]
Akindele (2017)	Africa	567	46.4 [43; 51]	53.6 [32; 76]	0
Ver Ploeg (2008)	America	623	49.4 [48; 51]	45.0 [44; 46]	5.6 [5; 6]
Mueller (2014)*2	America	507	49.5 [45; 54]	–	–
Monteagudo (2015)	Europe	1282	50.3 [48; 53]	48 [46; 50]	1.7 [1.2; 2.2]
Barzuca (2013)*2	Europe	110	55.5 [46; 65]	–	–
Howard (2008)	Australia*1	2382	55.5 [54; 57]	36.9 [35; 38]	7.6 [6.9; 8.4]
DeVille-Almond (2011)	Europe	263	55.9 [50; 62]	40.3 [34; 46]	3.8 [1; 6]
Akinpelu (2015)	Africa	567	56.8 [50; 64]	35 [30; 40]	8.2 [5; 11]
Jauregui (2016)	Europe	71	57.8 [46; 69]	8.5 [3; 14]	33.8 [26; 42]
Kim (2018)	Asia	16 559	59.9 [59; 61]	23.5 [23; 24]	16.8 [16.4; 17.2]
Wang (2017)	America	623	59.9 [56; 64]	24.2 [12; 36]	15.9 [14; 18]
Sinhababu (2007)*2	Asia	176	61.4 [53; 68]	–	–
Barichella (2011)*2	Europe	914	61.5 [58; 65]	–	–
Drumond (2012)	America	3622	63.1 [62; 64]	31.6 [31; 33]	5.3 [4.7; 5.8]
Shin (2015)	Asia	33 704	63.8 [63; 64]	19.6 [19; 20]	16.6 [16.3; 16.9]
Peltzer (2012)	Africa	289	65.1 [59; 71]	20.4 [17; 14]	14.5 [12; 17]
Jeffs (2016)	Australia*1	638	66.5 [63; 70]	31.0 [27; 35]	2.5 [1; 4]
El-Kassas (2016)*2	Asia	369	66.9 [62; 72]	–	–
Caleyachetty (2016)*2	Africa	5736	67.2 [66; 68]	–	–
Prinsloo (2011)	Africa	301	68.4 [63; 74]	23.6 [19; 28]	8.0 [5; 11]
Veggi (2004)	America	3498	68.6 [67; 70]	16.0 [15; 17]	15.4 [14.8; 16.1]
Murillo (2016)	America	7992	70.1 [69; 71]	–	–
Dorosty (2014)	Asia	542	70.1 [66; 74]	7.8 [5; 10]	22.1 [20; 25]
Herbert (2017)	Australia*1	7947	70.7 [70; 72]	25.5 [25; 26]	3.8 [3.5; 4.1]
Van Minnen (2011)	Australia*1	1272	72.2 [70; 75]	25.7 [24; 27]	2.1 [1.6; 2.7]
Blokstra (1998)	Europe	4601	74.1 [73; 75]	16.1 [15; 17]	9.8 [9.6; 10.0]
Rouiller (2016)	Europe	4786	74.2 [73; 75]	19.1 [18; 20]	6.8 [6.3; 7.3]
Johnston (2014)	Europe	9089	75 [74; 76]	25 [24; 26]	0

Study	Continent	n	Prevalence (%) [95% CI]		
			Accurate classification	Underestimation	Overestimation
Griger (2015)	Europe	6886	75.8 [75; 77]	12.9 [12; 13]	11.3 [10.7; 11.8]
Mogre (2015)	Africa	368	79.4 [75; 83]	16.3 [14; 19]	4.3 [3; 6]
Rahman (2010)	America	2224	80.4 [79; 82]	12 [11; 13]	7.6 [7; 9]
Maruf (2012)	Africa	120	80.8 [74; 88]	16.7 [12; 21]	2.5 [1; 4]
Agrawal (2014)	Asia	322	82.6 [78; 87]	11.8 [8; 15]	5.6 [3; 8]
Strassnig (2005)	America	143	83.2 [77; 89]	14 [10; 18]	2.8 [2.2; 3.4]
Hendley (2011)	America	429	–	48.8 [15; 82]	–

*1 Australia and Polynesia
*2 no differentiated information about over- and underestimation provided
CI, confidence interval; n, number of participants

self-perceived BMI categorization were similar for the two sexes, inaccurately classifying men showed a trend to underestimate their weight, while their female counterparts were prone to overestimating their weight. The authors attributed this to greater social pressure associated with the prevailing thin ideal among women, while men follow another, more muscular body ideal (16).

A higher risk of inaccurate self-perception was confirmed for older participants. A representative European study on persons aged 60 years and older found that older participants in this cohort too were more prone to inaccurate self-perception, especially underestimation. As possible explanations, the authors suggested the peer effect and decreasing susceptibility to body image ideals (15). This result is confirmed by the finding of the German study that the proportion of normal-weight persons perceiving themselves as "too fat" declined with age (16).

Medical advice should take into account that overweight and obese individuals and persons with low social status frequently underestimate their BMI category. Information about overweight/obesity and associated health risks falls on deaf ears if patients do not identify themselves as belonging to the risk group (11, 27). A nationally representative US study showed that overweight and obese adults who underestimated their BMI category were less likely to have an interest in weight loss or to have made attempts at weight loss in the preceeding year (28).

Consequently, establishing patient awareness and readiness for change should precede any lifestyle intervention for weight loss (9); if any misperceptions are identified, these should be corrected (11). Long-term primary care appears to be ideal for interventions requiring gradual development of problem awareness, repeated raising of the issue, and cultural sensitivity. Knowing about the prevalence of BMI misperceptions is valuable to primary care physicians as it prevents them from coming straight to the point without adequate preparation (3). In modern practice teams, the task of giving advice to these patients can be delegated to non-medical healthcare professionals who are highly efficient in providing this service and relieve the burden on the physician (29). It appears to be backed by solid evidence that it is worth the effort for the patient, practice team, and society (30).

Limitations

The limitations of our review result from the diversity of research questions addressed in the various studies included. Not only are the study populations very different from each other, but the studies also vary widely in terms of aim or focus (e.g. physical activity [e2], diet [e3, e4], or co-morbidities [e5, e6]). This results in a very heterogeneous presentation of the endpoints selected by us, some of which were not the primary outcomes of the studies. Some of the included studies compared data of different groups of participants, e.g. laymen versus hospital staff (e7), high versus low social status (e8), or untrained individuals versus athletes (e9). We pooled the data of these groups and included them in our analyses without further adjustments. Our subgroup analyses are limited to sex, BMI category, the continent where the study was conducted, and study-specific age and socioeconomic status categories. Confounder adjustment was only performed for age and socioeconomic status. In view of the applicability of numerous studies to the European context, it should be noted that nationally representative US studies investigate populations with overweight prevalence rates of about 70% (13), whereas in most European countries, including Germany, the prevalence rates are considerably lower (16). Additional studies from Europe and Germany, especially nationally representative surveys, are required to gain a better understanding of the relevance of this issue and shape everyday doctor–patient contacts accordingly.

Conflict of interest statement
The authors declare that no conflict of interest exists.

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Translated from the original German by Ralf Thoene, MD.

Key messages

- The self-classification as underweight, normal weight, overweight, or obese is often inaccurate.
- Underestimation of the BMI category is generally more common than overestimation.
- Male, older, and overweight persons are prone to underestimating their BMI category.
- From a global perspective, it is difficult to draw general conclusions on weight self-perception, given the large, most likely cultural, differences observed.
- Physicians should dedicate more time to discussing the actual weight status with patients. Special attention should be paid to groups of patients known to commonly underestimate their weight status.

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► Supplementary material

For eReferences please refer to:
www.aerzteblatt-international.de/ref1520

eMethods, eTables:
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Supplementary material to:

Misclassification of Self-Reported Body Mass Index Categories

A Systematic Review and Meta-Analysis

by Romy Freigang, Anne-Kathrin Geier, Gordian Lukas Schmid, Thomas Frese, Andreas Klement, and Susanne Unverzagt

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eMETHODS

Citation

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(last accessed on 18 November 2019)

Searches

PubMed (MEDLINE), EMBASE and The Cochrane Library will be searched for relevant studies for inclusion in this review. The literature search will be performed using structured search strings developed in collaboration with a librarian of the Leibzig University Library. The full search terms are listed below. The database searches were not restricted by language or publication date.

PubMed search:
(weight [Title] OR obesity [Title] OR "body mass index" [Title]) AND (perception* [Title] OR interpretation* [Title] OR accuracy [Title] OR awareness [Title] OR perceive* [Title] OR self-perception [Title] OR self-perceive* [Title] OR misperception*[Title] OR underestimation* [Title] OR validity [Title])

EMBASE search:
([weight or obesity or „body mass index"].ti.) AND ([perception* or perceive* or self-perception* or self-perceive* or misperception* or underestimation* or validity or interpretation* or accuracy or awareness].ti.)

Cochrane Library search:
([weight OR obesity OR "body mass index"]:ti) AND ([perception* OR perceive* OR self-perception* OR self-perceive* OR misperception* OR underestimation* OR validity OR interpretation* OR accuracy OR awareness]:ti)

Study screening and data extraction

The titles and abstracts of the studies identified from the database searches will be independently assessed by two reviewers based on the inclusion criteria (RF and GLS). Where eligibility for inclusion is unclear due to missing information in the abstract, the full articles will be retrieved for clarification. Studies for which abstracts but not full-text articles are available will be excluded from this review.

The references of the included research studies and review articles will be searched manually for further relevant citations by one reviewer (RF). The retrieved full-text articles will then be appraised by two reviewers independently (RF and GLS) with regard to their eligibility for inclusion.

Once a final list of the studies included in this review has become available, the following information will be entered by the same two reviewers into the data extraction table, if available:

- Author(s), year of publication;
- Study design;
- Country where the study was conducted;
- Study population (number of participants);
- Participant demographics (age, nationality, sex ratio);
- Details of the index test and the reference test (clinical setting, measuring instruments and units used, self-reported BMI classification, objectively measured data with calculated BMI category);
- Data measured (body weight, body height, average BMI);
- Primary outcomes (differences between self-reported and calculated BMI category);
- Secondary outcomes (extent of discrepancies within various subgroups).

Any disagreements with regard to the results will be resolved by discussion with a third independent reviewer (TF) to reach a consensus. The reasons for the exclusion of studies, based on titles and abstracts, as well as the evaluation of the full-text articles retrieved will be fully documented.

Date of PROSPERO registration
17 October 2017

Date of publication of this version
4 January 2018

eBOX

Modified quality criteria (QUADAS-2) (12)

Domain 1: Representativeness of participants

Risk of bias*1:

- Was a consecutive or random sample of participants enrolled?*2
- Was a case–control design with different inclusion criteria avoided?*2
- Did the study avoid exclusion of participants with medical weight problems?*2

Applicability: Is there concern that the included patients do not match the review question?*3

Domain 2: Index test

Risk of bias*1:

- Were measures taken to exclude systematic errors in the conduct of the index test described?*2
- Were the questions and answer options described?*2
- Were the subjects informed that their answers were checked in a reference test?*2

Applicability: Are there concerns that the index test, its conduct, or its interpretation do not match the review question?*3

Domain 3: Reference test

Risk of bias*1:

- Were the WHO criteria used?*2
- Were calibrated or standardized measuring tools used to measure body weight and height?*2
- Were standardized measures used to prevent systematic errors when measuring body weight and height?*2

Applicability: Are there concerns that the basic condition as defined by the reference standard does not match the review question?*3

Domain 4: Description of timing

Risk of bias*1:

- Were the results of at least 95% of the included participants reported and less than 5% excluded because of missing values?*2
- Were the reasons described for missing data as well as dropouts?*2
- Was information given on whether the reported BMI classes were based on accurate self-perception, underestimation, or overestimation?*2

*1 Judged as high, low, or unclear. Judgement is based on the following signaling questions; risk of bias judged as high if one of the signaling questions was answered with no, judged as low if all questions were answered with yes or no more than one question was answered as unclear; in all other cases judged as unclear.
*2 Answer options: yes, no, unclear
*3 Answer options: low (high applicability), high (low applicability), unclear

eTable 1

Characteristics of the included studies

Study		Study participants			Index test			Reference test
Reference	Country/ period	Study population included in analysis	Number n (% women)	Age (years) Mean ± SD Median (range)	Method	Question	Answer options	BMI categories (% per category)
Agrawal 2014 (e10)	India 2003	Ever-married women, except pregnant women, women in childbed & underweight women	322 (100)	38.4 (20–54)	Interview	"I feel I am…"	"Less than normal weight", "normal weight", "more than normal weight"	NW/OW/O (39.1/37.3/ 23.6)
Akgöz 2017 (e8)	Turkey 2015	Women from 2 health centers with high and low SES	300 (100)	57.2 ± 4.8 (50–65)	Interview with record sheets	"In your opinion, which of the following refers to your body:"	"Thin", "normal", "overweight", "fat", "extremely fat"	UW/NW/OW/O (0.7/15.7/28.7/ 55.0)
Akindele 2017 (e11)	Nigeria 2012–2013	Overweight and obese adults	567 (66.0)	n.s.	Questionnaires	"How do you describe your body weight?"	"Underweight", "normal weight", "a little overweight", "very overweight"	OW/O (54.1/45.9)
Akinpelu 2015 (e12)	Nigeria 2006	Rural residents	183 (48.6)	40.2 ± 13.0 (18–71)	Interview	"Which of the following terms/words best describe the way you perceive your body size?"	"Underweight", "normal weight", "overweight", "obese", "morbidly obese"	UW/NW/OW/O (3.8/61.2/29.0/ 6.0)
Barichella 2011 (e13)	Italy 2008	Adults attending the 'Obesity Day' initiative	914 (66.2)	51.1 ± 14.2	Questionnaires	n.s.	"Normal weight", "overweight", "mildly obese", "moderately/severely obese"	UW+NW/ OW/O (27.9/34.8/37. 3)
Barzuca 2013 (e9)	Romania, n.s.	Untrained students (n = 78), athletes (n = 17), patients on dialysis (n = 15)	110 (50.9)	26.0 ± 13.0 (19–72)	Questionnaires	"How do you perceive your weight?"	"Under normal value", "around normal value", "above normal value"	UW/NW/ OW+O (8.2/60.9/30.9)
Baur 2012 (e6)	USA, n.s.	Firefighters from the Midwest	768 (0)	37.6 ± 8.5	Questionnaires	"I think my body weight is…"	"Underweight (skinny)", "healthy/normal or muscular", "overweight", "obese (fat)"	NW/OW/O (12.4/50.9/36. 7)
Blokstra 1999 (23)	Netherlands 1995	Participants in an observational program (MORGEN project), except pregnant women, diabetics, and cancer patients	4601 (53.2)	(20–65)	Questionnaires	"How would you describe your current weight?"	"Too big", "too little", "just right"	NW/OW/O (54.3/35.4/10. 3)
Caleychetty 2016 (e14)	Mauritius 2009	Representative cross-section, except pregnant women	5736 (52.7)	46 (20–74)	Questionnaires	"Do you think your current weight is …"	"Too low", "about right", "a little too high", "much too high"	UW/NW/OW/O (5.2/44.1/34.5/ 16.2)
Colchero 2014 (14)	Mexico 2006	Representative cross-section, except pregnant women	32 052 (60.0)	43.3 ± 0 (> 20)	Questionnaires	n.s.	"Low weight", "normal weight", "overweight", "obese"	UW/NW/OW/O (0.8/28.2/39.9/ 31.1)
DeVille-Almond 2011 (e1)	United Kingdom 2007	Male drivers at motorway service stations	263* (0)	52 (42–60)	Questionnaires	"How would you describe yourself?"	"Thin", "just right", "overweight", "obese"	NW/OW/O (19.4/46.0/34. 6)
Dorosty 2014 (e15)	Iran 2010	Female staff of an urban health center, except pregnant, nursing, or underweight women	542 (100)	37.3 ± 8.9	Questionnaires	"Do you imagine yourself as…"	"Underweight", "normal weight", "overweight", "obese"	NW/OW/O (53.5/31.4/15. 1)
Drumond 2012 (e16)	Mexico 2009	College applicants	3622 (52.1)	(18–20)	n.s.	n.s.	"Severely underweight/ underweight", "normal", "overweight", "obese"	UW/NW/ OW/O(7.4/62. 0/21.0/9.6)
Duncan 2014 (e17)	South Africa 2012	Hypertensive patients in a rural health center	466 (n.s.)	58 ± 13.8 (23–98)	Questionnaires	"Do you personally think that you are ... ?"	"Underweight", "normal weight", "overweight", "I don't know"	UW/NW/OW/O (3.9/33.9/26.8/ 35.4)

Study		Study participants			Index test			Reference test
Reference	Country/ period	Study population included in analysis	Number n (% women)	Age (years) Mean ± SD Median (range)	Method	Question	Answer options	BMI categories (% per category)
El-Kassas 2016 (e4)	Lebanon 2015	Health science students without physical impairment, chronic metabolic disease, or drug use	369 (86.4)	19.6 ± 1.7 (18–25)	Structured interview with record sheets	n.s.	"Underweight", "normal", "overweight", "obese"	UW/NW/OW/O (4.3/63.4/27.6/ 4.6)
Faber 2005 (e18)	South Africa, n.s.	Women of a rural South African village	187 (100)	33.5 ± 8.9 (25–55)	Interview	n.s.	"Too thin", "about right", "too fat"	NW/OW/O (28.9/41.2/29. 9)
Gao 2017 (e19)	China 2012	Overweight and obese persons in a northeastern province of China	10 177* (51.6)	(18–79)	Questionnaires	n.s.	"Very thin", "normal weight", "overweight", "too fat"	OW/O (70.2/29.8)
Griger 2015 (16)	Germany 2008 –2011	Representative cross-section	6886 (52.2)	(18–79)	Questionnaires	"Do you think you are…?"	"Much too thin", "a little bit too thin", "about the right weight", "a little bit too fat", "much too fat"	UW/NW/OW/O (1.3/37.1/37.8/ 23.9)
Harris 2016 (e20)	USA 2004 –2006	Low-income, obese African American women, except pregnant women and women with diseases/medications with an effect on weight	118 (100)	41.7 ± 14.4	Questionnaires	"I feel I am …"	"Underweight", "normal weight", "overweight", "obese"	O (100)
Hendley 2011 (e21)	USA, n.s.	Black and white city dwellers in Atlanta	429* (67.4)	50.4 ± 9.4 (30–66)	Telephone interview	"How would you describe your weight? Would you say…"	"Underweight", "about right", "overweight", "obese"	UW + NW/ OW/O (27.2/32.1/ 40.7)
Herbert 2017 (e22)	Australia 2011 –2012	Representative cross-section, except pregnant women	7947* (52.4)	49 ± 17.6	Personal interview	n.s.	"Acceptable weight", "underweight", "overweight"	UW/NG/ OW/O (1.5/34.4/36.4/ 27.7)
Howard 2008 (e23)	Australia 2004 –2007	Residents of an Australian city	2382 (50.0)	n.s.	Computer-assisted telephone interview	"In terms of your weight, do you consider yourself to be …"	"Too thin", "a little thin", "normal weight", "a little overweight", "very overweight"	UW/NW/OW/O (1.6/31.6/38.0/ 29.0)
Irani 2007 (19)	USA 2006	Family medicine clinic patients, except pregnant women and mentally ill patients	356 (73.3)	45 (18–65)	Questionnaires	n.s.	"Underweight", "just right", "overweight", "obese", "severly obese"	UW/NW/OW/O (0.6/17.7/24.7/ 57.0)
Jáuregui 2016 (e24)	Spain, n.s.	Semiprofessional dancers	72* (74.0)	21.2 ± 3.1 (18–32)	Questionnaires	"What do you think of yourself in terms of weight?"	"Very overweight", "slightly overweight", "about the right weight", "slightly underweight", "very underweight"	NW (100)
Jeffs 2016 (e25)	New Zealand 2011, 2013–2015	Pregnant women between 11–13 WG	638* (100)	31.2 ± 5.2 (18.2–49)	Questionnaires	"What weight do you consider yourself?"	"Underweight", "normal weight", "overweight", "obese"	UG/NW/OW/O (1.1/53.3/29.3/ 16.3)
Johnston 2014 (e26)	United Kingdom 1997 –1998, 2002	Overweight and obese, working age respondents	9089 (47.8)	42.8 ± 9.8 (25–60)	Interview and questionnaires	"Given your age and height, would you say that you are …?"	"About the right weight", "too heavy", "too light"	OW +O (100)
Kim 2018 (e27)	South Korea 2001, 2005, 2013	Representative cross-section without pregnant women	16 559 (57.3)	n.s.	Interview with standardized questionnaires	"How do you perceive your body size?"	"Very thin", "slightly thin/normal", "a little obese", "severely obese"	UW/NW/OW/O (4.4/63.9/28.1/ 3.5)

Study		Study participants			Index test			Reference test
Reference	Country/ period	Study population included in analysis	Number n (% women)	Age (years) Mean ± SD Median (range)	Method	Question	Answer options	BMI categories (% per category)
Kirk 2008 (e7)	Tonga 2004	Patients and nurses, except pregnant women	102 (62.6)	35.2 ± 14.0	Questionnaires	Rating on a scale from 1 to 5	1 – "underweight", 2 – "ideal weight", 3 – "overweight", 4 – "obese", 5 – "very obese"	UW+NW/ OQ/O (12.1/36.4/ 51.4)
Loret de Mola 2012 (e28)	Peru 2007	Urban residents, rural residents, migrants	983 (53.0)	48 (>30)	Questionnaires	"For your age, do you perceive your weight to be … ?"	"Low weight", "normal", "overweight", "obese"	UW/NW/OW/O (0.7/40.9/38.3/ 20.1)
Maruf 2012 (e29)	Nigeria, n.s.	Health science students	120* (55.8)	22.3 ± 1.9 (21–29)	n.s.	n.s.	"Underweight", "normal weight", "overweight", "obese"?	UW/NW/OW/O (0.8/81.7/15.0/ 2.5)
Minsky 2013 (e30)	USA 2009	Patients with serious mental illness	586 (48.0)	n.s.	n.s.	n.s.	"Underweight", "normal", "overweight", "obese"	UW/NW/OW/O (3.8/24.7/30.9/ 40.6)
Mogre 2014 (e31)	Ghana 2013	Outpatients in a type 2 diabetes clinic	200 (77.0)	56.2 ± 12.1	Questionnaires	"Do you think your weight is: ... ?"	"About the right weight", "underweight", "overweight", "obese"	UW/NW/OW + O (7.0/61.0/32.0)
Mogre 2015 (e32)	Ghana 2013	Students, except pregnant or nursing women	368 (35.9)	23.0 ± 2.8	Questionnaires	"How do you perceive your weight?"	"Underweight", "normal weight", "overweight", "obese"	UW/NW/OW + O (4.9/82.1/13.0)
Monteagudo 2015 (15)	Netherlands 2008 –2009	Representative cross-section of older people	1282* (53.6)	72.5 ± 8.1 (60–96)	Questionnaires	"How would you classify your body weight?"	"Do not know", "underweight", "normal weight", "overweight", "obese"	UW/NW/OW/O (0.4/29.0/46.4/ 24.2)
Moore 2010 (27)	USA 2004 –2006	African American women in urban health centers without long-term medication, pre-existing diseases, or current pregnancy	323 (100)	37.6 ± 13.6	Questionnaires	"I feel I am…"	"Underweight", "normal weight", "overweight", "obese"	UW/NW/OW/O (1.5/18.3/25.7/ 54.5)
Mueller 2014 (20)	USA 2009	Outpatients in a general internal medicine clinic	507* (50.6)	62.9 ± 14.9	Questionnaires	"Which of the following best describes your weight?"	"Underweight", "about right", "overweight", "obese"	UW/NW/OW/O (2.2/27.2/38.1/ 32.6)
Muhihi 2012 (e33)	Tanzania, n.s.	Middle-aged patients	209 (45.0)	53.7 ± 6.1 (44–66)	Questionnaires	"How do you perceive your current body weight?"	"Underweight", "normal for my age", "overweight/obese"	UW/NW/OW/O (4.8/39.2/32.5/ 23.4)
Murillo 2016 (e2)	USA 2007 –2010	Hispanic, black, and white Americans with overweight or obesity	7992 (48.8)	48.3 ± 26.8	Interview and questionnaires	n.s.	"Overweight", "underweight", "about the right weight"	OW + O (100)
Peltzer 2012 (e34)	South Africa, n.s.	University students, except health science students	289 (65.4)	n.s.	Questionnaires	n.s.	"Very underweight", "somewhat underweight", "normal weight", "somewhat overweight", "very overweight"	UW/NW/OW + O (11.4/65.4/ 23.2)
Phetla 2017 (24)	South Africa, n.s.	Healthcare professionals	209* (82.4)	37.8 ± 9.2 (21–63)	Questionnaires	n.s.	"Underweight", "normal weight", "overweight", "obese"	UW/NW/OW/O (2.4/24.4/21.0/ 52.2)
Prinsloo 2014 (e35)	South Africa 2007	Female patients at a healthcare center	301* (100)	28.3 ± 8.8 (18–50)	Questionnaires	n.s.	"Underweight", "normal weight", "overweight"	UW/NW/OW/O (1.0/22.7/32.2/ 44.1)
Rahman 2010 (e36)	USA 2008 –2010	Female patients in a reproductive clinic	2224 (100)	21.4 ± 2.1 (18–25)	Questionnaires	"How would you describe your weight?"	"Very underweight", "slightly underweight", "about the right weight", "slightly overweight", "very overweight"	NW/OW/O (47.8/24.8/ 27.5)

Study		Study participants			Index test			Reference test
Reference	Country/ period	Study population included in analysis	Number n (% women)	Age (years) Mean ± SD Median (range)	Method	Question	Answer options	BMI categories (% per category)
Rouiller 2016 (22)	Switzerland 2009 –2012	Urban population	4786 (53.2)	57.7 ± 10.5 (40–80)	Interview	"Currently, how do you consider your weight?"	"Too thin", "adequate weight", "too fat"	NW/OW/O (44.2/38.8/17.0)
Shin 2015 (e37)	South Korea 2007 –2012	Representative cross-section	33 704 (57.6)	n.s.	Interview	"In your opinion, how do you perceive your body?"	"Thin", "normal", "fat"	UW/NW/OW + O (4.5/63.5/32.0)
Sinhababu 2007 (e38)	India 2004	Students of a nursing training center	176 (100)	n.s.	Questionnaires	n.s.	"Thin", "normal", "fat"	UW/NW/OW/O (33.5/61.4/5.1/0)
Strassnig 2005 (e3)	USA, n.s.	Psychiatric patients in an outpatient clinic	143 (46.2)	43.3 ± 8.6	Structured interview	"Do you consider yourself now being …?"	"Underweight", "about acceptable weight", "slightly overweight", "very overweight", "extremely overweight"	UW + NG / OW/O (17.5/22.4/60.1)
Van Minnen 2011 (e39)	Australia, n.s.	Patients with type 2 diabetes in an Australian urban community	1272 (51.0)	64.0 ± 11.2	Questionnaires	"Do you perceive yourself as overweight?"	n.s.	UW + NW/ OW/O (18.1/40.0/42.0)
Veggi 2004 (e5)	Brazil 1999	University employees, except pregnant or nursing women and employees with BMI-influencing disease	3498 (54.4)	(22–59)	Questionnaires	n.s.	"Highly above ideal", "slightly above ideal", "ideal", "slightly below ideal", "highly below ideal"	UW/NG/ OW +OA (1.6/40.4/58.0)
Ver Ploeg 2008 (13)	USA 1999–2004	Representative cross-section without pregnant or nursing women and underweight persons	8419 (48.2)	n.s. (≥ 20)	n.s.	n.s.	"Overweight", "underweight", "about the right weight"	UW/NW/ OW + O (0/29.3/70.7)
Wang 2017 (21)	USA 2010–2012	High school employees, except pregnant women and women with childbirth <6 months ago	623 (65.0)	44.6 ± 11.3	Questionnaires	n.s.	"Very underweight", "somewhat underweight", "just right", "somewhat overweight", "very overweight"	UW/NW/OW/O (0/33.9/38.8/27.3)

* Discrepancies between the number of study participants and the number of participants included in the analysis of the BMI category;
O, obesity; n.s., not stated; n, number of participants; NW, normal weight; SD, standard deviation; SES, socioeconomic status; WG, weeks' gestation; UW, underweight; OW, overweight

eTABLE 2

Influence of socioeconomic status, education, income, and work on accurate BMI categorization

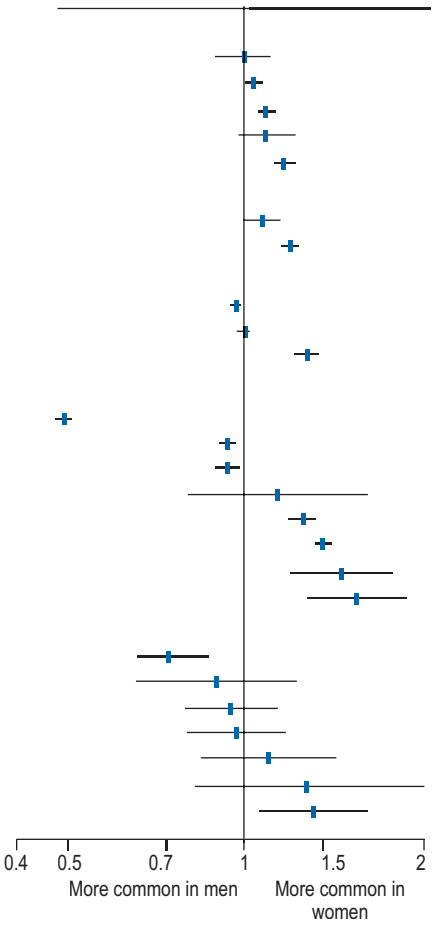
Study	Categories	Comparison*1	Prevalence of accurate BMI categorization	Result [95% CI]
Socioeconomic status				
Akgöz 2017	Lower middle class, middle class, upper middle class, and upper class	Lower middle class vs. upper middle class and upper class	56/197 (28.4%) vs. 32/70 (45.7%)	OR: 0.47 [0.27; 0.83]
Griger 2015	Low, middle, high	Low vs. high	Women: 49/98 (50.1%) vs. 139/247 (56.3%) Men: 55/95 (58.4%) vs. 92/172 (53.5%) Total: 104/193 (53.9%) vs. 231/419 (55.1%)	OR*2: 0.95 [0.68; 1.34]
Education (highest educational attainment)				
Akgöz 2017	Primary school or less, secondary school & upper secondary school, university & higher	Primary school vs. university	49/180 (27.2%) vs. 25/46 (54.3%)	OR: 0.31 [0.16; 0.61]
Akindele 2017	Primary school, secondary education, tertiary education, graduates	Primary school vs. graduates		aOR: 1.02 [0.50; 2.11]
Akinpelu 2015	Illiterate, primary, secondary, tertiary education	Illiterate vs. tertiary education	44/78 (56.4%) vs. 10/21 (47.6%)	OR: 1.42 [0.54; 3.74]
Barichella 2011	Years of education	1 year less education		aOR: 0.84 [0.71; 1.01]
Dorosty 2014	≤ 12 years, >12 years	≤ 12 years vs. >12 years	61/94 (64.9 %) vs. 320/448 (71.4 %)	aOR*4: 0.45 [0.21; 0.96]
Irani 2007	<8 years, >8 years but not university, university, graduates	<8 years vs. university or graduates	6/60 (10.9 %) vs. 55/149 (36.9 %)	OR: 0.19 [0.08; 0.47]
Jeffs 2016	Attended high school, secondary school leaving certificate, university degree	Attended high school, vs. university degree	67/121 (55.4%) vs. 276/382 (72.2%)	OR*3: 0.48 [0.31; 0.73]
Minsky 2013	Secondary school-leaving certificate or less, attended university	Secondary school-leaving certificate or less vs. attended university	171/427 (40.3%) vs. 80/162 (49.4%)	OR: 0.68 [0.48; 0.99]
Monteagudo 2015	Low (primary school), middle (secondary school), high (university)	Low vs. high	144/293 (49.0 %) vs. 173/271 (63.9 %)	OR: 0.55 [0.39; 0.77]
Mueller 2014	Less than secondary school-leaving certificate, secondary school-leaving certificate, attended university, university degree, graduates	Less than secondary school-leaving certificate vs. graduates	n.s./31 vs. n.s./122	aOR*4: 0.41 [0.16; 0.97]
Murillo 2016	No secondary school-leaving certificate, secondary school-leaving certificate	No secondary school-leaving certificate vs. secondary school-leaving certificate	2448/3708 (66.0%) vs. 3154/4284 (73.6%)	OR*3: 0.41 [0.16; 0.97]
Rahman 2010	Attended secondary school, secondary school-leaving certificate, attended university	Attended secondary school vs. attended university	OW: 183/259 (70.6%) vs. 319/370 (86.2%) NW: 167/197 (84.8%) vs. 270/330 (81.8%) Total: 350/456 (76.8%) vs. 589/700 (84.1%)	OR: 0.62 (0.46–0.84)
Rouiller 2016	Low (compulsory education or apprenticeship), middle (upper secondary school), high (university degree)	Low vs. high	1819/2513 (72.4%) vs. 788/1040 (75.8%)	OR: 0.84 [0.71; 0.99]
Income				
Akgöz 2017	Income < expenses, Income = expenses, Income > expenses	Income < expenses vs. income > expenses	60/191(31.4%) vs. 7/10 (70%)	OR: 0.20 [0.05; 0.79]
Harris 2016	< $ 15 000. ≥ $ 15 000	<$ 15 000 vs. ≥ $ 15 000	6/72 (8.3%) vs. 13/46 (28.3%)	OR: 0.23 [0.08; 0.66]

Study	Categories	Comparison*[1]	Prevalence of accurate BMI categorization	Result [95% CI]
Rahman 2010	< $ 30 000. ≥ $ 30 000	<$ 30 000 vs. ≥ $ 30 000	OW: 716/923 (77.6%) vs. 120/147 (81.6%) NW: 680/814 (83.5%) vs. 122/139 (87.8%) Total: 1396/1737 (80.4%) vs. 242/286 (84.6%)	OR: 0.74 [0.53; 1.05]
Work				
Akindele 2017	Unemployed, retired, employed	Unemployed vs. employed		aOR*[4]: 0.39 [0.16; 0.94]
Akinpelu 2015	Unemployed, blue-collar, white-collar	Unemployed vs. white-collar	24/34 (70.6 %) vs. 7/19 (36.8 %)	OR: 4.11 [1.25; 13.51]

*[1]Lowest vs. highest category,
*[2]Analysis was performed for normal-weight persons; in the study a comparison with the middle category was undertaken (with reporting of adjusted ORs),
*[3] adjusted ORs (aOR) are only reported for overestimation and underestimation,
*[4] Recalculation from inverse data;
n.s., not stated; NW, normal weight; OW, overweight

eFIGURE 1

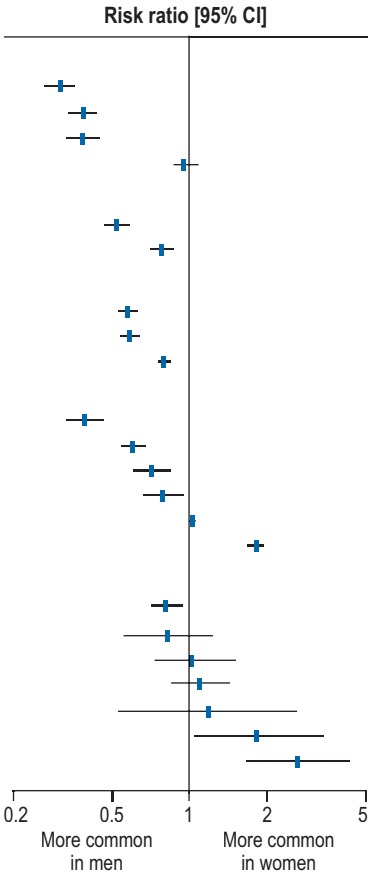
Study	Women Cases	Women N	Men Cases	Men N	RR [95% CI]
Europe					
Monteagudo 2015	347	687	298	595	1.01 [0.90; 1.12]
Giger 2015	2769	3592	2454	3294	1.03 [1.01; 1.06]
Blokstra 1999	1874	2446	1534	2155	1.08 [1.04; 1.11]
Barichella 2011	382	605	180	309	1.08 [0.97; 1.21]
Rouiller 2016	2011	2545	1539	2241	1.15 [1.11; 1.19]
Australia					
Howard 2008	684	1193	637	1188	1.07 [0.99; 1.15]
Herbert 2017	3183	4167	2437	3780	1.18 [1.15; 1.22]
Asia					
Shin 2015	12 240	19 428	9244	14 276	0.97 [0.96; 0.99]
Kim 2018	5705	9494	4214	7066	1.01 [0.98; 1.03]
Gao 2017	2532	5249	1887	4928	1.26 [1.20; 1.32]
America					
Ver Ploeg 2008	1288	4057	2873	4362	0.48 [0.46; 0.51]
Colchero 2014	7126	19 232	5062	12 820	0.94 [0.91; 0.97]
Veggi 2004	1272	1903	1127	1595	0.95 [0.90; 0.99]
Irani 2007	93	261	30	95	1.13 [0.80; 1.58]
Drumond 2012	1311	1886	976	1736	1.24 [1.17; 1.30]
Murillo 2016	3081	3820	2521	4172	1.33 [1.30; 1.37]
Minsky 2013	143	281	108	305	1.44 [1.19; 1.74]
Mueller 2014	153	257	98	250	1.52 [1.26; 1.83]
Africa					
Mogre 2015	86	132	202	236	0.76 [0.66; 0.87]
Muhihi 2012	41	94	56	115	0.90 [0.67; 1.21]
Maruf 2012	53	67	44	53	0.95 [0.80; 1.13]
Peltzer 2012	114	177	61	92	0.97 [0.81; 1.17]
Akinpelu 2015	53	89	51	94	1.10 [0.85; 1.41]
Mogre 2014	68	154	16	46	1.27 [0.82; 1.96]
Akindele 2017	188	374	75	193	1.29 [1.06; 1.59]



Forest plot for the effect of sex on accurate BMI categorization with subgroups for 5 continents;
CI, confidence interval; N, number of participants; RR, risk ratio

eFIGURE 2

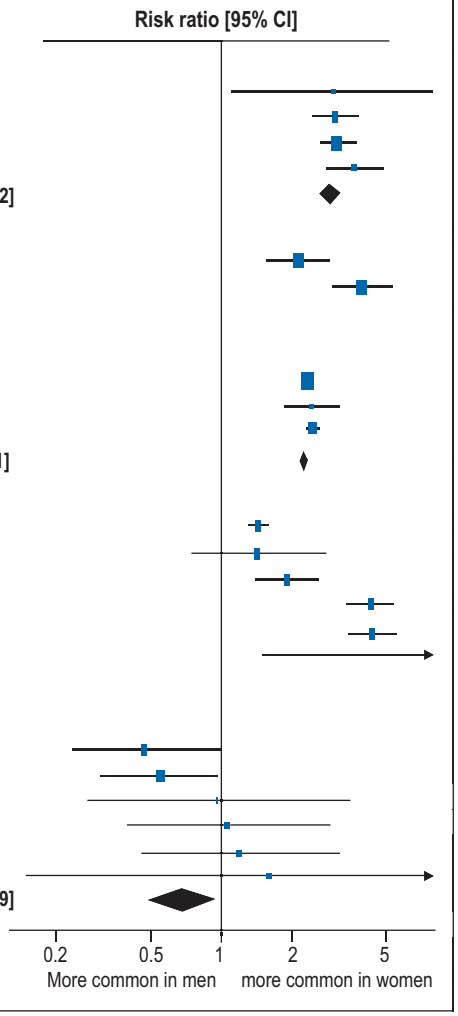
Study	Women Cases	Women N	Men Cases	Men N	RR [95% CI]
Europe					
Griger 2015	222	3592	666	3294	0.31 [0.26. 0.35]
Rouiller 2016	272	2545	640	2241	0.37 [0.33; 0.43]
Blokstra 1999	222	2446	519	2155	0.38 [0.33; 0.44]
Monteagudo 2015	323	687	292	595	0.96 [0.85; 1.07]
Australia					
Herbert 2017	737	4167	1287	3780	0.52 [0.48; 0.56]
Howard 2008	384	1193	493	1188	0.78 [0.70; 0.86]
Asia					
Kim 2018	1685	9494	2209	7066	0.57 [0.54; 0.60]
Shin 2015	2914	19428	3697	14 276	0.58 [0.55; 0.60]
Gao 2017	2514	5249	2963	4928	0.80 [0.77; 0.83]
America					
Veggi 2004	176	1903	383	1595	0.39 [0.33; 0.45]
Drumond 2012	447	1886	698	1736	0.59 [0.53; 0.65]
Minsky 2013	118	281	182	305	0.70 [0.60; 0.83]
Irani 2007	138	261	64	95	0.78 [0.66; 0.94]
Colchero 2014	11 192	19 232	7335	12 820	1.02 [1.00; 1.04]
Ver Ploeg 2008	2395	4057	1396	4362	1.84 [1.75; 1.94]
Africa					
Akindele 2017	186	374	118	193	0.81 [0.70; 0.95]
Akinpelu 2015	28	89	36	94	0.82 [0.55; 1.23]
Mogre 2014	70	154	20	46	1.05 [0.72; 1.52]
Muhihi 2012	49	94	54	115	1.11 [0.84; 1.46]
Maruf 2012	12	67	8	53	1.19 [0.52; 2.69]
Peltzer 2012	43	177	12	92	1.86 [1.03; 3.35]
Mogre 2015	36	132	24	236	2.68 [1.68; 4.29]



Forest plot for the effect of sex on underestimation of BMI category with subgroups for 5 continents;
CI, confidence interval; N, number of participants; RR, risk ratio

eFIGURE 3

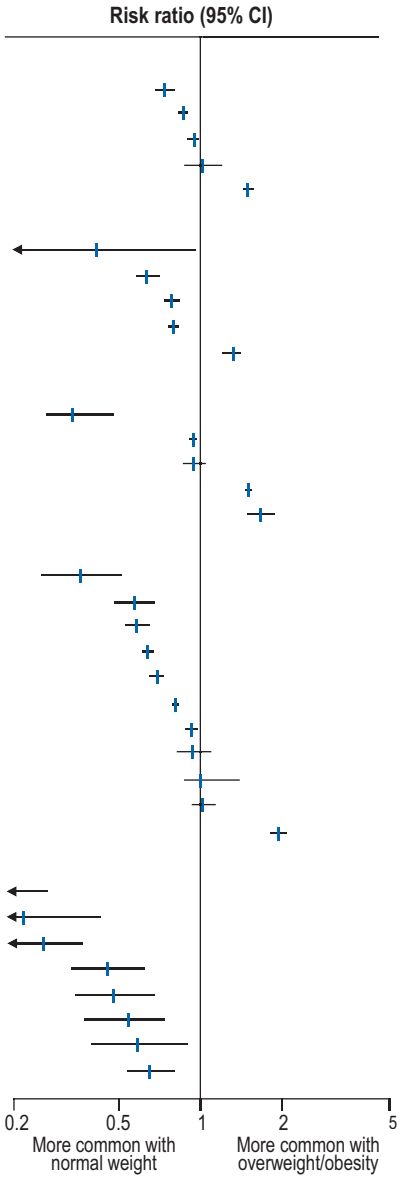
Study	Women Cases	Women N	Men Cases	Men N	RR [95% CI]
Europe					
Monteagudo 2015	17	687	5	595	2.94 [1.09; 7.93]
Blokstra 1999	350	2446	101	2155	3.05 [2.47; 3.78]
Griger 2015	601	3592	174	3294	3.17 [2.69; 3.72]
Rouiller 2016	262	2545	62	2241	3.72 [2.84; 4.88]
					I^2 = 0 %. 3.22 [2.87; 3.62]
Australia					
Howard 2008	125	1193	58	1188	2.15 [1.59; 2.90]
Herbert 2017	247	4167	56	3780	4.00 [3.00; 5.33]
No aggregation in the subgroup (I^2 = 89 %)					
Asia					
Shin 2015	4274	19 428	1335	14 276	2.35 [2.22; 2.49]
Gao 2017	203	5249	78	4928	2.44 [1.89; 3.16]
Kim 2018	2138	9494	643	7066	2.47 [2.28; 2.69]
					I^2 = 0%, 2.39 [2.28; 2.51]
America					
Colchero 2014	914	19 232	423	12 820	1.44 [1.29; 1.61]
Minsky 2013	20	281	15	305	1.45 [0.76; 2.77]
Drumond 2012	129	1886	62	1736	1.92 [1.42; 2.57]
Ver Ploeg 2008	374	4057	93	4362	4.32 [3.46; 5.40]
Veggi 2004	455	1903	85	1595	4.49 [3.59; 5.60]
Irani 2007	30	261	1	95	10.92 [1.51; 78.97]
No aggregation in the subgroup (I^2 = 96 %)					
Africa					
Mogre 2014	16	154	10	46	0.48 [0.23; 0.98]
Peltzer 2012	20	177	19	92	0.55 [0.31; 0.97]
Muhihi 2012	4	94	5	115	0.98 [0.27; 3.54]
Mogre 2015	6	132	10	236	1.07 [0.40; 2.89]
Akinpelu 2015	8	89	7	94	1.21 [0.46; 3.19]
Maruf 2012	2	67	1	53	1.58 [0.15; 16.98]
					I^2 = 0 %, 0.69 [0.48; 0.99]



Forest plot for the effect of sex on overestimation of BMI category with subgroups for 5 continents;
CI, confidence interval; N, number of participants; RR, risk ratio; I^2, heterogeneity

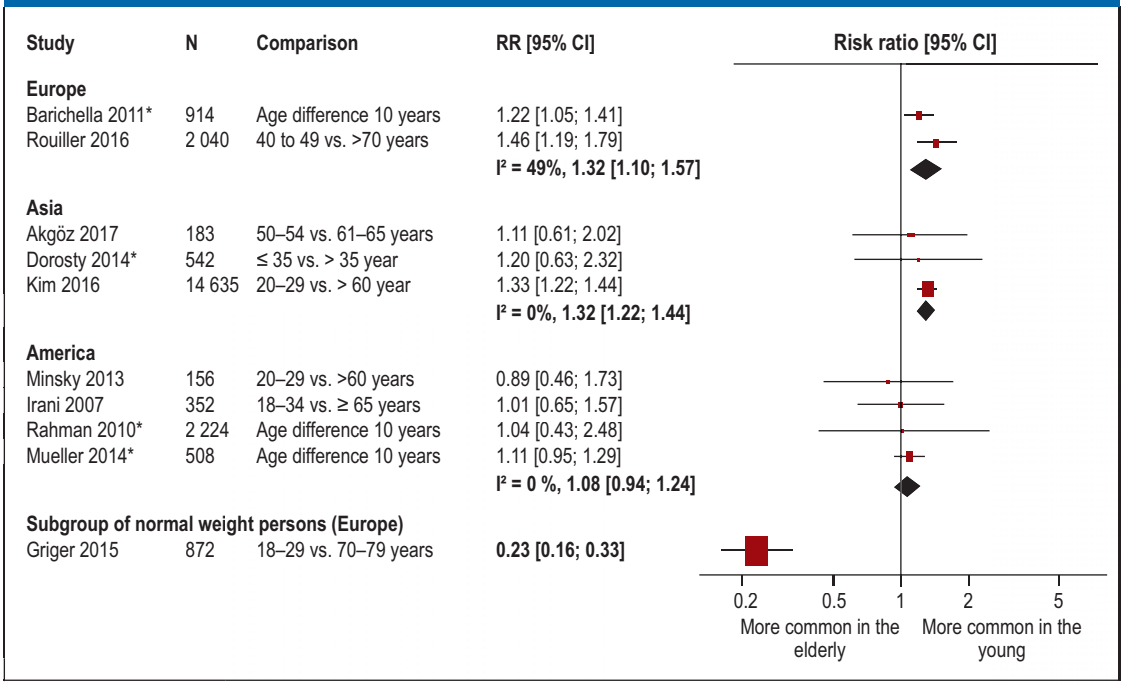
eFIGURE 4

Study	Overweight/obesity Cases	N	Normal weight Cases	N	RR [95% CI]
Europe					
Monteagudo 2015	563	905	319	375	0.73 [0.68; 0.78]
Rouiller 2016	1837	2669	1713	2117	0.85 [0.82; 0.88]
Blokstra 1999	1517	2103	1894	2499	0.95 [0.92; 0.99]
DeVille-Almond 2011	177	212	42	51	1.01 [0.88; 1.17]
Griger 2015	3679	4245	1472	2552	1.50 [1.45; 1.56]
Australia					
Kirk 2008	15	94	5	13	0.41 [0.18; 0.95]
Jeffs 2016	173	291	322	342	0.63 [0.57; 0.70]
van Minnen 2011	715	1042	203	230	0.78 [0.73; 0.83]
Herbert 2017	3304	5095	2247	2731	0.79 [0.77; 0.81]
Howard 2008	1236	1592	449	753	1.30 [1.22; 1.39]
Asia					
Akgöz 2017	72	251	36	47	0.37 [0.29; 0.48]
Kim 2016	2837	5247	8760	15 232	0.94 [0.91; 0.97]
Agrawal 2014	158	196	108	126	0.94 [0.85; 1.04]
Shin 2015	8699	10 788	11 540	21 396	1.50 [1.47; 1.52]
Dorosty 2014	225	252	155	290	1.67 [1.49; 1.88]
America					
Irani 2007	54	291	32	62	0.36 [0.26; 0.51]
Mueller 2014	144	358	98	138	0.57 [0.48; 0.67]
Baur 2012	349	673	85	95	0.58 [0.52; 0.64]
Ver Ploeg 2008	2444	5549	1717	2470	0.63 [0.61; 0.66]
Drumond 2012	600	1108	1776	2246	0.68 [0.65; 0.73]
Colchero 2014	13 069	22 737	6433	9045	0.81 [0.79; 0.82]
Rahman 2010	895	1162	892	1062	0.92 [0.88; 0.96]
Moore 2010	194	259	47	59	0.94 [0.81; 1.09]
Strassnig 2005	98	118	21	25	0.99 [0.82; 1.19]
Loret de Mola 2012	346	574	238	402	1.02 [0.92; 1.13]
Veggi 2004	1731	2028	624	1414	1.93 [1.82; 2.06]
Africa					
Duncan 2014	38	290	112	168	0.20 [0.14; 0.27]
Mogre 2014	8	64	70	122	0.22 [0.11; 0.42]
Faber 2005	32	133	50	54	0.26 [0.19; 0.35]
Muhihi 2012	36	117	56	82	0.45 [0.33; 0.61]
Mogre 2015	20	48	266	302	0.47 [0.34; 0.66]
Akinpelu 2015	24	64	75	112	0.56 [0.40; 0.79]
Maruf 2012	11	21	87	98	0.59 [0.39; 0.89]
Phetla 2017	82	153	42	51	0.65 [0.54; 0.79]



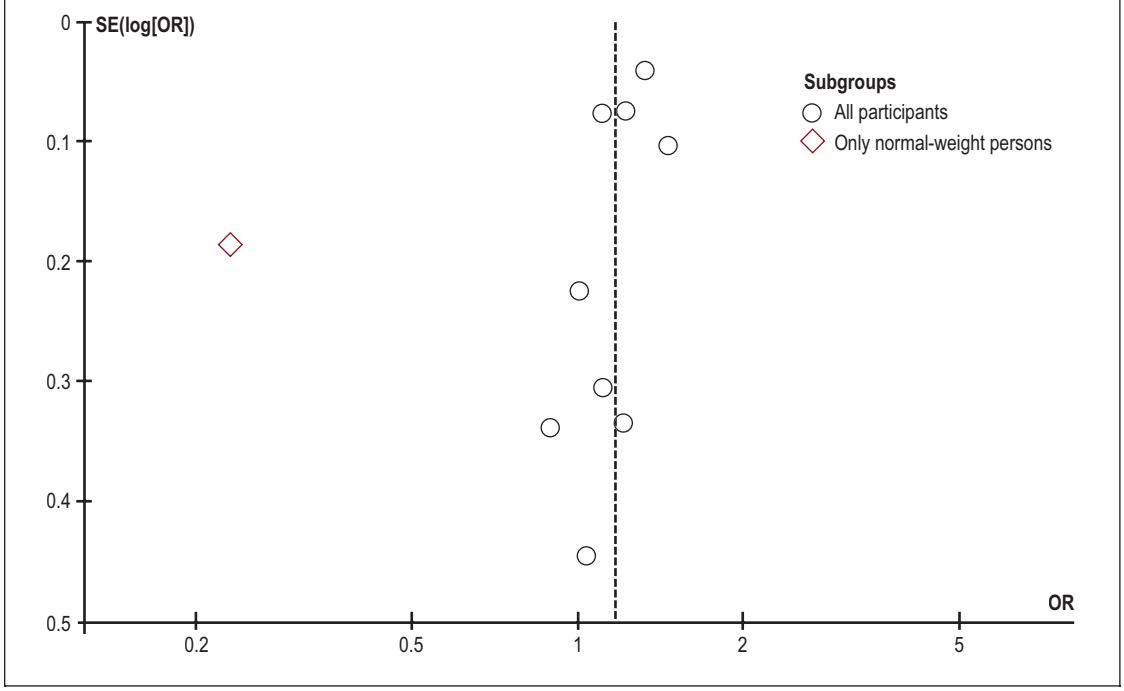
Forest plot for the effect of normal weight or overweight on accurate BMI categorization with subgroups for 5 continents;
CI, confidence interval; N, number of participants; RR, risk ratio

eFIGURE 5



Forest plot for the effect of age on accurate BMI categorization with subgroups for continents and the subgroup of exclusively normal-weight participants, *results with confounder adjustment
I², heterogeneity; CI, confidence interval; N, number of participants; OR, odds ratio; vs., versus

eFIGURE 6



Funnel plot for the effect of age on accurate BMI categorization
Log(OR), logarithmized odds ratio; SE, standard error