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ORIGINAL ARTICLE

Obesity-related knowledge and body mass index: a national survey in Portugal

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Abstract

Purpose Obesity-related knowledge predicts weight control but previous studies only comprise individuals with excessive weight and assess very specific aspects of knowledge. This study aims to evaluate several domains of obesity-related knowledge according to the body mass index (BMI) in a representative sample of Portuguese-speaking dwellers in mainland Portugal.

Methods A sample of 1624 participants aged 16–79 years was analyzed. Eighteen questions comprising eight obesity domains were asked: prevalence, physical activity, number of calories, adiposity location, causes, diagnosis, treatment and consequences; each one was dichotomized into correct/incorrect knowledge.

Results The majority of Portuguese-speaking dwellers recognized the benefits of physical activity, the risks of abdominal obesity and most consequences of excessive weight, independently of their BMI. However, knowledge gaps were identified regarding prevalence, calories and BMI diagnosis. BMI influenced specific obesity-related knowledge: participants with a normal BMI knew the BMI formula more often, identified 22 as normal BMI more frequently and had the highest proportion of correct knowledge regarding the number of calories an adult should eat; obese individuals identified natural products as not being good treatments for obesity more often. After adjusting for age, sex and educational level, obese individuals identified natural products and supplements as not being good obesity treatments more often.

Conclusions Obesity-related knowledge gaps (prevalence, calories, and diagnosis) were identified among Portuguese adults. Moreover, correct knowledge does not necessarily translate into a healthier BMI. Besides the dissemination of accurate information, public health interventions should focus on the transfer of knowledge to behaviors that will guarantee better weight management.

Evidence-based medicine rankings Level V: Opinions of respected authorities, based on descriptive studies, narrative reviews, clinical experience, or reports of expert committees.

Keywords Body mass index · Obesity-related knowledge · Survey · Weight control

Introduction

The last epidemiological transition is characterized by a shift from infection to several chronic diseases, including obesity [1], alongside an increase in life expectancy and a fast rise in educational attainment [2]. In 2015, 12.0% of adults worldwide were obese and a high body mass index (BMI) accounted for 4.0 million deaths globally [3]. Specifically in Portugal, the most recent estimates show an obesity prevalence above 20% among adults [4]. Moreover, a high BMI is a risk factor for an expanding set of chronic diseases including cardiovascular diseases, diabetes mellitus [5] and many cancers [6], reflecting a major challenge

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to chronic disease prevention and health across the life course around the world.

One construct that might differentiate individuals who are successful and unsuccessful at losing weight is health literacy [7]. This term refers to the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate health decisions [8]. Individuals with a more favorable socioeconomic position are more likely to have good health than those with lower positions [9], with health literacy being a potential modifiable risk factor in the pathway between socioeconomic disparities and health. Although lower health literacy is often observed in people with less education, highly educated people may also have poor health literacy skills [10]. As supported by recent systematic reviews, low health literacy is consistently associated with poorer health outcomes but regarding its association with obesity, literature is still inconsistent and insufficient [11], namely among European adults [12]. Thus, more studies are needed to elucidate possible relations between health literacy and excessive weight, toward a better understanding of the role of improving knowledge in maintaining good health.

Specifically concerning excessive weight, adults report the need to have more and better knowledge about health behaviors to prevent obesity [13]. Recognizing such a need, the National Health Plan of Portugal 2011–2016 (revised and extended to 2020) is focused on the promotion of health literacy as a factor that promotes the adoption of healthier lifestyles [14].

However, obesity-related knowledge embraces several domains besides healthy lifestyles. Previous studies analyzed very specific aspects of obesity knowledge, namely its consequences [15, 16] or other related diseases [17], and gaps and misconceptions in other less studied obesity domains, such as diagnosis or treatment, remain unknown. Particularly among obese individuals, knowledge regarding the consequences of obesity is low [15] but it can be considered one of the strongest predictors of help-seeking for weight control [18]; therefore, it might be considered in future interventions tackling excessive weight.

At the same time, obesity awareness is not necessarily translated into a healthier BMI [19]. In fact, a discrepancy exists between individuals' beliefs about effective weight loss practices and their dieting behaviors [20]. As an example, nutrition knowledge only has modest effects on food choice, suggesting that knowing what constitutes a healthy diet does not necessarily mean that people incorporate healthy habits into their daily routines [21]. Regarding other obesity-related knowledge domains, this relation is still understudied and more evidence about this theme is crucial. Since factors associated with obesity are complex, and encompass psychological and emotional components [22, 23], research still needs to underscore whether educational approaches alone are enough to reduce the obesity epidemic.

In addition, previous work specifically about obesity-related knowledge focused on very detailed populations, such as people with diabetes [17], Latin adolescents [24], pregnant women [25] and individuals with excessive weight [18], and the comparison according to individuals' BMI is not seen often as a priority in the analysis. Considering that most of these populations might be more aware of the depicted disease, we hypothesize that obesity-related knowledge in a population-based sample could be lower and that individuals with higher BMI may present lower levels of knowledge.

This paper fills this gap in research, by analyzing obesity-related knowledge in eight different domains (prevalence, physical activity, number of calories, adiposity location, causes, diagnosis, treatment and consequences), and examining how it differs between individuals with different BMI, in a representative sample of Portuguese-speaking dwellers in mainland Portugal.

Methods

Study design

This study is based on a national survey conducted in 2012, with the purpose of assessing knowledge and health behaviors in Portugal, as previously described [26]. Those aged 16–79 years, living in a private residence in mainland Portugal, residing in localities with at least 10 inhabitants and, independently of their nationality and literacy, able to speak and understand Portuguese, were eligible for the study. A representative sample of Portuguese-speaking dwellers in mainland Portugal was selected, using a multistage sampling design, defined according to the results of the 2001 Portuguese Census [27]. A probabilistic sampling procedure, stratified by NUTS II—Territorial Nomenclature Units for Statistical Purposes, level II (North, Centre, Lisbon, Alentejo and Algarve) and by the number of inhabitants in geographical units with at least 10 dwellings (< 2000, 2000–9999, 10,000–9,999, 20,000–100,000, > 100,000), was used to select 150 geographical units, among which a total of 585 starting points were designated for the selection of households through standard random route procedures. All the potentially eligible dwellers were identified in each selected household and only the one whose previous birthday was closest to the date of this contact was invited. From the 2294 eligible dwellers, 1624 individuals completed face-to-face interviews, using a structured questionnaire (response rate: 70.8%).

Data collection

A specific questionnaire was built to assess obesity-related knowledge, described in detailed elsewhere [28]. Briefly, after a literature review and an exhaustive inventory of the existing questionnaires on the subject, the research team was responsible for preparing the thematic guidelines and questions to be included in the questionnaire. To prevent the questionnaire from being developed from a theoretical point of view only, focus groups with the general public were conducted by a specialized company, aiming to explore the universe of questions raised in each thematic module. Based on information from all the mentioned sources, a questionnaire encompassing 18 questions was performed including eight different domains: prevalence (1 item), physical activity (1 item), number of calories (1 item), adiposity location (1 item), causes (1 item), diagnosis (3 items), treatment (5 items) and consequences (5 items). Cronbach's alpha for all items was 0.69, indicating good reliability [29]. The description of the questions and the respective answer options are detailed in Table 1. The original Portuguese version is available in a Supplementary Table.

During face-to-face interviews, sociodemographic characteristics, weight and height were self-reported. Participants'

Table 1 Description of the questions and their respective answer options used to assess obesity-related knowledge (English-translated version)

Obesity-related questions	Answer options
Prevalence	
Out of every 100 Portuguese, how many have excessive weight or obesity?	Open-ended question **(46–65%)**
Physical activity	
Regular physical activity reduces abdominal fat accumulation?	**Yes**; No
Calories	
In general, to prevent weight gain, how many calories should a healthy adult with moderate physical activity eat per day?	< 1200; 1201–1500; **1501–2500**; 2501–3500; 3501–4500
Adiposity location	
From the following body parts, where does fat accumulation present higher health risks?	Thighs; arms, **abdominal region/belly**; buttocks
Causes	
Can you please indicate two of the most important causes of excessive weight/obesity?	Open-ended question **(Diet and physical exercise)**
Diagnosis	
How is the body mass index of a person 1.70 m tall and weighing 80 kg calculated?	80/170; **80/1.7^2**; 1.70/80^2
I will read several body mass index values. Please tell me the corresponding BMI categories:	
22	Morbid obesity; obesity; excessive weight; **normal weight**, underweight
32	Morbid obesity; **obesity**; excessive weight; normal weight, underweight
Treatment	
Natural products (teas, herbal products…) are a good treatment for obesity	Yes; **No**
Dietary supplements are good for weight loss	Yes; **No**
Diuretics are a good treatment for obesity	Yes; **No**
Laxatives are a good treatment for obesity	Yes; **No**
Using plastic wrap around the waist or thighs helps lose weight	Yes; **No**
Consequences	
Of the following health problems, which can result from obesity	
Type 2 diabetes	**Yes;** No
Heart attack	**Yes;** No
Hypertension	**Yes;** No
Knee pain	**Yes;** No
Cancer	**Yes;** No

The answers that were considered correct are bolded

"Does not know" and "does not answer" could be selected as answers in every question

age was collected as a continuous variable and later categorized into four ordinal categories (16–29, 30–49, 50–69, 70–79 years). Education was collected as a continuous variable considering the number of complete years of schooling and later categorized (0–4, 5–9, 10–12, > 12 years). BMI was defined as a person's weight in kilograms divided by the square of the person's height in meters (kg/m^2). It was calculated based on the self-reported weight and height, and categorized according to the World Health Organization´s definition: underweight (< 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) and obese (≥ 30 kg/m^2) [30]. Given the low frequency of underweight participants ($n = 36$), they were not able to be considered as an independent BMI category and were assumed to be considerably different from individuals with a normal BMI to be aggregated in the same category; therefore, they were excluded from the present analysis.

Statistics

Sample characteristics are presented as counts and proportions for categorical variables. To compare the proportions of correct obesity-related knowledge across BMI categories, the Chi-square test was used.

All 18 questions covering eight obesity domains were previously dichotomized into correct and incorrect knowledge about obesity (correct options are bolded in Table 1). For data analysis, the options "Does not know" and "does not answer" were coded as incorrect. To estimate the association between BMI and each specific item regarding obesity-related knowledge, prevalence ratios (PR) and the respective 95% confidence intervals (95% CI) were computed using Poisson regression models, adjusted for sex, age and level of education. In all regression models, PR estimates were computed by comparing overweight and obese individuals with individuals with normal BMI (reference category). For sample characteristics and regression models, the product of design and population weights was computed and used in all analyses. The former was used to compensate for the unequal probability of selection, and the latter to correct for the discrepancy between the sample composition and Portuguese-speaking dwellers regarding sex, age, education, marital status, NUTS II distribution and size of the geographical units.

Statistical analyses were performed using Stata 11.0 (StataCorp LP, College Station, TX, USA).

Results

Participants' characteristics are depicted in Table 2, according to their BMI. Approximately, half of the men and women presented excessive weight, and the distribution of BMI was similar for both sexes ($p = 0.224$). Only individuals aged 16-29 presented a normal BMI more frequently (75.9%), with more than half of the individuals from 30 years onwards being overweight or obese ($p < 0.001$). Of the least educated participants, over a fifth of the participants were obese, contrasting with less than 4% among the most educated ones ($p < 0.001$) (Table 2).

Table 2 Participants' characteristics, according to BMI (weighted percentage; $n = 1476$)

	BMI (%)			*p*
	Normal	Overweight	Obese	
Overall	48.8	34.9	16.3	
Sex				
Men	47.2	37.7	15.1	
Women	50.6	31.9	17.5	0.224
Age (years)				
16–29	75.9	18.0	6.1	
30–49	43.3	39.4	17.3	
50–69	32.5	44.4	23.1	
70–79	38.2	38.7	23.1	< 0.001
Education (years)				
0–4	33.5	43.9	22.6	
5–9	45.8	36.4	17.8	
10–12	62.3	25.6	12.1	
> 12	72.5	23.6	3.9	< 0.001

BMI body mass index

Figure 1 shows the proportions of correct obesity-related knowledge according to individuals' BMI and considering the 18 items of the questionnaire. Overall, more than three quarters of Portuguese inhabitants knew that regular physical activity reduces abdominal fat accumulation, and that abdominal obesity presents higher health risks, and correctly identified heart attack, hypertension and knee pain as obesity consequences, independently of their BMI. In contrast, correct knowledge regarding prevalence, calories, the two main causes of excessive weight and cancer as a consequence of obesity was attained by less than 40% of participants. Less than 25% of participants answered correctly to any of the three items of the diagnosis domain. More specifically, those with a normal BMI recognized the BMI formula significantly more often (14.1% vs. 6.7% and 7.2% of overweight and obese participants, respectively, $p = 0.001$), and identified 22 as normal BMI more frequently (24.2% vs. 17.5% and 9.6% of overweight and obese individuals, respectively, $p = 0.002$). Significant differences in obesity-related knowledge according to BMI were also found in the treatment domain. Particularly, obese individuals acknowledged that natural products are not a good treatment for obesity more often (42.1% vs. 31.0% and 38.6% of normal BMI and overweight individuals, respectively, $p = 0.030$). Individuals with a normal BMI were

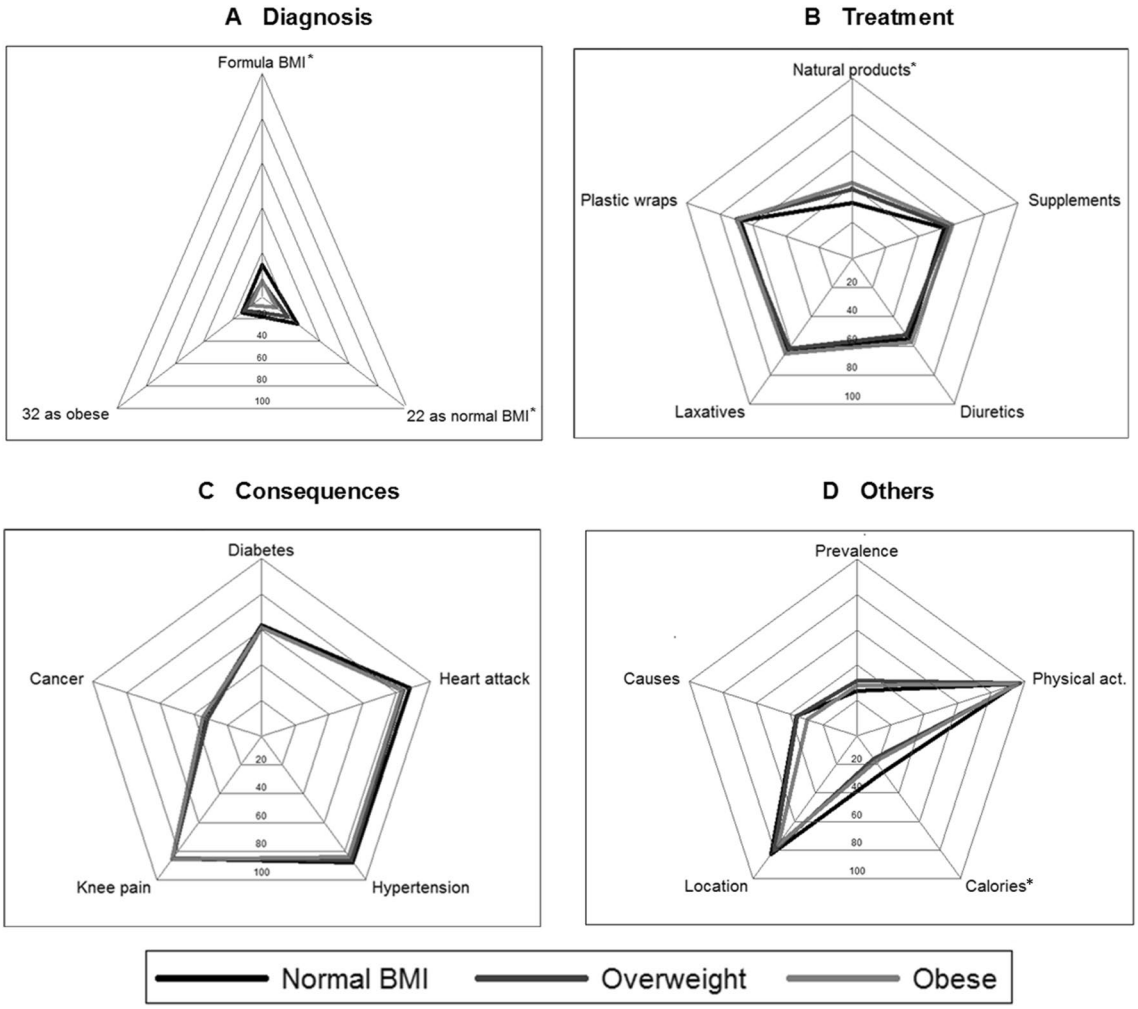

Fig. 1 Proportion of Portuguese-speaking dwellers in mainland Portugal that reported correct obesity-related knowledge, according to their BMI. *BMI* body mass index, *Physical act*. physical activity. *Differences were statistically significant among BMI categories ($p < 0.05$)

more likely to know the number of calories a healthy adult with moderate physical activity should eat per day (25.4% vs. 16.4% and 17.9% of overweight and obese dwellers, respectively, $p = 0.008$) (Fig. 1).

Table 3 presents the association between obesity-related knowledge and BMI, considering each item separately. After adjustment for sex, age and level of education, significant associations were found only in the treatment domain. In particular, the proportion of individuals who knew that natural products (PR = 1.30; 95% CI 1.03–1.65) and supplements (PR = 1.19; 95% CI 1.01–1.41) are not a good treatment for obesity was higher among obese participants than among those with a normal BMI (Table 3).

Discussion

The majority of Portuguese-speaking dwellers recognized the benefits of physical activity, the health risks of abdominal obesity, and that heart attack, hypertension and knee pain can be consequences of excessive weight, independently of their BMI. In contrast, misconceptions were identified mainly regarding prevalence, calories and BMI diagnosis. Differences according to participants' BMI were only found in the items concerning calories, diagnosis and treatment. A higher proportion of individuals with a normal BMI knew how many calories a healthy

Table 3 Association between obesity-related knowledge and BMI categories

	BMI		
	PR (95% CI)[a]		
	Normal	Overweight	Obese
Obesity domains			
Prevalence	1	1.32 (1.00–1.75)	1.23 (0.87–1.73)
Physical activity	1	1.03 (0.99–1.07)	1.01 (0.96–1.06)
Calories	1	0.89 (0.64–1.23)	1.03 (0.69–1.53)
Adiposity location	1	0.99 (0.91–1.08)	0.94 (0.85–1.04)
Causes	1	1.10 (0.86–1.40)	0.99 (0.72–1.36)
Diagnosis			
BMI formula	1	0.82 (0.52–1.29)	1.05 (0.59–1.87)
22 as normal BMI	1	1.11 (0.78–1.57)	0.66 (0.39–1.12)
32 as obese	1	1.32 (0.85–2.06)	0.89 (0.49–1.60)
Treatment			
Natural products	1	1.20 (0.95–1.52)	1.30 (1.03–1.65)
Supplements	1	1.12 (0.96–1.31)	1.19 (1.01–1.41)
Diuretics	1	1.00 (0.85–1.18)	1.12 (0.94–1.33)
Laxatives	1	1.04 (0.92–1.19)	1.14 (0.98–1.32)
Plastic wraps	1	1.08 (0.96–1.22)	1.10 (0.96–1.26)
Consequences			
Diabetes	1	1.03 (0.89–1.18)	1.03 (0.87–1.21)
Heart attack	1	0.98 (0.91–1.05)	0.97 (0.89–1.06)
Hypertension	1	0.99 (0.92–1.06)	0.97 (0.88–1.07)
Knee pain	1	1.03 (0.95–1.11)	1.04 (0.95–1.15)
Cancer	1	0.97 (0.73–1.28)	1.06 (0.79–1.42)

BMI body mass index, *CI* confidence interval, *PR* prevalence ratio

[a]Adjusted for sex, age and level of education

adult should eat per day, recognized the BMI formula and correctly identified 22 as normal BMI. An opposite trend was found for the items comprising the treatment domain: when compared to individuals with a normal BMI, a higher proportion of individuals with excessive weight or obesity correctly stated that natural products and supplements are not a good treatment for obesity.

Independently of the BMI stratum, less than a third of the participants presented correct knowledge about the prevalence of excessive weight in the Portuguese population, which actually varies between 50% and 65% [31]. Previous literature reveals a trend in the Portuguese population of underestimating this prevalence [28], possibly reflecting a generational shift in social norms related to body weight characterized by a greater acceptance and normalization of excessive weight [32]. Consequently, people might be less aware of the need for weight loss, limiting the effectiveness of public health campaigns for that purpose.

Despite Portuguese-speaking dwellers' awareness about the importance of healthy choices in their dietary habits for obesity prevention, only a small proportion correctly identified the number of calories a healthy adult should consume per day, namely those with excessive weight. Previous findings based on the General Nutrition Knowledge Questionnaire found a high level of nutrition knowledge among adults, and no significant correlation between levels of nutrition knowledge and BMI [33], but this questionnaire does not include questions regarding the amount of calories; therefore, an objective comparison with our results is not possible. In fact, knowledge about eating habits can be very complex and comprises a variety of aspects such as nutrients, dietary recommendations and diet–disease relationship [34], which cannot be measured in a single question about calories.

The diagnosis of obesity had the lowest proportion of correct answers regarding all items. The few studies assessing knowledge about methods to measure BMI were conducted in Ghana and Bangladesh among people with diabetes, and provided conflicting results with proportions of adequate knowledge ranging from 39% [35] to 99% [17]. Overall, people are not aware of their own BMI category and tend to perceive their weight inaccurately [36–38], with this inaccuracy being higher as BMI increases [36, 38]. Our results call attention to the need of explaining in detail the meaning of BMI as well as its calculation and interpretation. Alongside a diagnosis, the use of images might lead to a greater understanding of medical information [39], especially benefiting patients with low literacy [40] and other ways of communicating health information may be necessary regarding obesity diagnosis. Similarly, physicians report to be poorly informed and ill-prepared to manage obesity [41], and they might benefit from training regarding knowledge transference into behavioral changes.

The proportion of people who incorrectly identified natural products as an appropriate treatment for obesity is relatively high. This might be explained by the positive attitude of the Portuguese adult population toward the use of natural products as a way of managing potential adverse effects of pharmaceuticals [42]. Such "magic bullet" approaches to weight loss are still used by many people who are normally willing to waive the inherent risks of using non-evidence-informed products [43]. However, the conviction on the efficiency of these types of solutions for weight reduction was more frequent among individuals with a normal BMI than in those with a high BMI, which might be a consequence of a prior negative experience among the latter. In fact, despite people not perceiving the consumption of over the counter pills, drinks or supplements as particularly successful or acceptable, they are more commonly used than empirically tested interventions for weight reduction [20]. The incorrect knowledge about obesity treatments contributes to reinforce the pervasiveness of negative attitudes and stigmatization toward obese individuals in Western societies, in the sense that misconceptions regarding easy solutions for

losing weight reproduce the stereotype of an obese person as lazy, unsuccessful and noncompliant with treatments [44]. Thus, it is urgent for researchers and clinicians to improve communications with the public about efficacious weight loss programs.

Less than 40% of Portuguese-speaking dwellers identified cancer as a consequence of obesity. Misconceptions regarding the cancer risk associated with obesity were already previously stated in the literature [16, 45]. Although obesity is only associated with certain types of cancer [46], which may partially explain the results observed, the coherence of our results with previous literature suggests that health promotion campaigns concerning obesity should emphasize cancer as a potential outcome for obese individuals.

All the remaining items of the consequences domain revealed an opposite trend: a high proportion of individuals was aware that diabetes, heart attack, knee pain and hypertension are common obesity consequences, which is in accordance with previous literature [16, 45]. The importance of physical activity to reduce abdominal fat accumulation was also widely recognized, benefiting from the constant presence of such a message in health promotion campaigns and in the media. However, this awareness does not necessarily mean that people know specific physical activity recommendations [13] and this type of knowledge might not be translated in healthy behaviors [47]. Nevertheless, a recent multidisciplinary brief intervention program aiming for lifestyle changes toward weight loss was able to show significant long-term improvements in obesity-related knowledge, along with weight reduction [21], hypothesizing a possible causal relation between them, but this aspect warrants further investigation.

Overall, a higher proportion of misconceptions were achieved in the obesity domains more related with numbers, possibly reflecting low levels of numeracy among Portuguese adults.

Obesity is linked with poorer eating self-regulation [48] which, in turn, might lead to eating disorders. Since obesity and eating disorders share common risk factors and, according to the public opinion, are both seen as serious public health concerns [49], it could be fruitful to develop integrated public health interventions considering both conditions, give that prevention programs tackling these two health problems still need to be refined [50].

The innovativeness and major strength of this study lies in the characterization of obesity-related knowledge regarding several domains in a representative sample of the general population, joining other recent studies focused on several domains of other chronic diseases, such as diabetes, hypertension or cancer [51, 52]. With the present study, we were able to provide a holistic and complete overview of obesity-related knowledge in a representative sample of Portuguese-speaking dwellers. By highlighting the specific obesity domains with more knowledge gaps, we expect to provide evidence capable of influencing future public health strategies that, in turn, should invest and delineate targets in very specific areas of obesity-related knowledge. Likewise, we were able to highlight that having knowledge about certain obesity aspects is not necessarily associated with a healthy BMI; therefore, weight management approaches should not be purely educational and should encompass other techniques targeting behavioral changes.

As limitations, weight and height were self-reported, which can lead to an underestimation of BMI [53]. However, on average, people are generally accurate at self-reporting their weight [54]; therefore, we do not expect to have substantially different results when using measured body weight and height. The questionnaire used to assess obesity-related knowledge was not previously validated and was only applied once, not allowing test–retest reproducibility to be assessed. However, through a sensitivity analysis, we observed that the higher the educational level, the greater the proportion of respondents who present correct obesity-related knowledge, which is in accordance with previous literature relating education and health knowledge [10] and supports the existence of convergent validity. Moreover, even though this work arises from a need described in the National Health Plan of Portugal 2011–2016, this plan was extended to 2020, meaning that the description of the knowledge of the Portuguese population is still an important contribution to sustain interventions aimed at promoting health literacy. Finally, the cross-sectional design of this study does not allow establishing a causal relation between obesity-related knowledge and BMI, when both pathways would be plausible.

Future research in this area should invest in assessing obesity-related knowledge in understudied populations, such as underweight individuals, and also considering domains where research is scarce. Moreover, in some domains, a deeper and more specific knowledge should be tested, namely comprising other aspects of physical activity that goes beyond its importance, and of dietary habits that goes beyond the number of calories. It would also be interesting to assess the extent to which this knowledge can be translated into healthy behaviors, and to test the existence of a longitudinal association between different topics of obesity-related knowledge and BMI.

In conclusion, knowledge gaps exist among Portuguese adults, but they depend on the obesity domain we are referring to: the majority recognize the benefits of physical activity, risks of abdominal obesity and most consequences of excessive weight, but knowledge gaps regarding prevalence, calories and diagnosis were identified. Also, in some obesity domains, correct knowledge is not necessarily translated in a healthier BMI meaning that, besides the dissemination of accurate information, public health programs tackling

obesity should focus on the transfer of knowledge to healthier behaviors that will guarantee a better weight management. This focus on translating knowledge to behaviors could be fostered through more investment in people-centered communication in clinical encounters [55], grounded on the use of non-medical language, illustrations, designing easy to read educational material that patients can take home to complement spoken instructions, and not assuming that communication has been achieved until demonstrated.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Ethics Committee of the University of Porto (33/CEUP/2012) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Oral informed consent was obtained from all individual participants included in the study.

References

1. Omran AR (2005) The epidemiologic transition: a theory of the epidemiology of population change. 1971. Milbank Q 83(4):731–757. https://doi.org/10.1111/j.1468-0009.2005.00398.x
2. Baker DP, Leon J, Smith Greenaway EG et al (2011) The education effect on population health: a reassessment. Popul Dev Rev 37(2):307–332. https://doi.org/10.1111/j.1728-4457.2011.00412.x
3. Afshin A, Forouzanfar MH, Reitsma MB et al (2017) Health effects of overweight and obesity in 195 countries over 25 years. N Engl J Med 377(1):13–27. https://doi.org/10.1056/NEJMoa1614362
4. Oliveira A, Araujo J, Severo M et al (2018) Prevalence of general and abdominal obesity in Portugal: comprehensive results from the National Food, nutrition and physical activity survey 2015–2016. BMC Public Health 18(1):614. https://doi.org/10.1186/s12889-018-5480-z
5. Singh GM, Danaei G, Farzadfar F et al (2013) The age-specific quantitative effects of metabolic risk factors on cardiovascular diseases and diabetes: a pooled analysis. PLoS One 8(7):e65174. https://doi.org/10.1371/journal.pone.0065174
6. Lauby-Secretan B, Scoccianti C, Loomis D et al (2016) Body fatness and cancer-viewpoint of the IARC Working Group. N Engl J Med 375(8):794–798. https://doi.org/10.1056/NEJMsr1606602
7. Carels RA, Selensky JC, Rossi J et al (2017) A novel stepped-care approach to weight loss: the role of self-monitoring and health literacy in treatment outcomes. Eat Behav 26:76–82. https://doi.org/10.1016/j.eatbeh.2017.01.009
8. Ratzan SC, Parker RM (2000) Introduction. In: Selden CR, Zorn M, Ratzan SC, Parker RM (eds) National Library of Medicine current bibliographies in medicine: Health literacy. National Institutes of Health (NLM Pub. No. CBM 2000–1), Bethesda
9. Mackenbach JP (2012) The persistence of health inequalities in modern welfare states: the explanation of a paradox. Soc Sci Med 75(4):761–769. https://doi.org/10.1016/j.socscimed.2012.02.031
10. van der Heide I, Wang J, Droomers M et al (2013) The relationship between health, education, and health literacy: results from the Dutch Adult Literacy and Life Skills Survey. J Health Commun 18(Suppl 1):172–184. https://doi.org/10.1080/10810730.2013.825668
11. Berkman ND, Sheridan SL, Donahue KE et al (2011) Low health literacy and health outcomes: an updated systematic review. Ann Intern Med 155(2):97–107. https://doi.org/10.7326/0003-4819-155-2-201107190-00005
12. Michou M, Panagiotakos DB, Costarelli V (2018) Low health literacy and excess body weight: a systematic review. Cent Eur J Public Health 26(3):234–241. https://doi.org/10.21101/cejph.a5172
13. Roberts K, Marvin K (2011) Knowledge and attitudes towards healthy eating and physical activity: what the data tell us. National Obesity Observatory, Oxford
14. Direção-Geral da Saúde (2015) Plano Nacional de Saúde Revisão e Extensão a 2020. Lisboa
15. Swift JA, Glazebrook C, Anness A et al (2009) Obesity-related knowledge and beliefs in obese adults attending a specialist weight-management service: implications for weight loss over 1 year. Patient Educ Couns 74(1):70–76. https://doi.org/10.1016/j.pec.2008.07.045
16. Winston GJ, Caesar-Phillips E, Peterson JC et al (2014) Knowledge of the health consequences of obesity among overweight/obese Black and Hispanic adults. Patient Educ Couns 94(1):123–127. https://doi.org/10.1016/j.pec.2013.09.022
17. Obirikorang Y, Obirikorang C, Odame Anto E et al (2016) Knowledge and lifestyle-associated prevalence of obesity among newly diagnosed type II diabetes mellitus patients attending diabetic clinic at komfo anokye teaching hospital, kumasi, ghana: a hospital-based cross-sectional study. J Diabetes Res 2016:9759241. https://doi.org/10.1155/2016/9759241
18. Annunziato RA, Lowe MR (2007) Taking action to lose weight: toward an understanding of individual differences. Eat Behav 8(2):185–194. https://doi.org/10.1016/j.eatbeh.2006.04.004
19. Alasmari HD, Al-Shehri AD, Aljuaid TA et al (2017) Relationship between body mass index and obesity awareness in school students. J Clin Med Res 9(6):520–524. https://doi.org/10.14740/jocmr2987w
20. Varnado-Sullivan PJ, Savoy S, O'Grady M et al (2010) Opinions and acceptability of common weight-loss practices. Eat Weight Disord 15(4):e256–e264. https://doi.org/10.1007/BF03325307
21. Cannon S, Lawry K, Brudell M et al (2016) Appetite for change: a multidisciplinary team approach to behavioral modification for weight management in a community health group setting. Eat Weight Disord 21(4):661–668. https://doi.org/10.1007/s40519-016-0274-8

22. Lee BY, Bartsch SM, Mui Y et al (2017) A systems approach to obesity. Nutr Rev 75(suppl 1):94–106. https://doi.org/10.1093/nutrit/nuw049
23. Sainsbury K, Evans EH, Pedersen S et al (2019) Attribution of weight regain to emotional reasons amongst European adults with overweight and obesity who regained weight following a weight loss attempt. Eat Weight Disord 24(2):351–361. https://doi.org/10.1007/s40519-018-0487-0
24. McArthur L, Pena M, Holbert D (2001) Effects of socioeconomic status on the obesity knowledge of adolescents from six Latin American cities. Int J Obes Relat Metab Disord 25(8):1262–1268. https://doi.org/10.1038/sj.ijo.0801674
25. Nitert MD, Foxcroft KF, Lust K et al (2011) Overweight and obesity knowledge prior to pregnancy: a survey study. BMC Pregnancy Childbirth 11:96. https://doi.org/10.1186/1471-2393-11-96
26. Moura-Ferreira P LN, Silva S (Orgs) (2017) A informação sobre saúde dos Portugueses—Fontes, Conhecimentos e Comportamentos [Health information of the Portuguese—Sources, Knowledge and Behaviors] 1st edn. Associação para Investigação e Desenvolvimento da Faculdade de Medicina, Lisboa
27. Instituto Nacional de Estatística (2002) Censos 2001, Resultados Definitivos, XIV Recenseamento Geral da População, IV Recenseamento Geral da Habitacão. Instituto Nacional de Estatística, Lisboa
28. Henriques A, Azevedo A, Lunet N, Moura Ferreira P, Barros H, Carmo I, Silva S (2017) Conhecimento sobre Obesidade [Obesity-related knowledge]. In Moura-Ferreira P, Lunet N, Silva S (Orgs), A informação sobre saúde dos Portugueses—Fontes, Conhecimentos e Comportamentos [Health information of the Portuguese—Sources, Knowledge and Behaviors] (1st Ed). Lisboa: Associação para Investigação e Desenvolvimento da Faculdade de Medicina, p 83–101
29. Nunnaly J, Bernstein I (1994) Psychometric theory, 3rd edn. McGray-Hill, New York. https://doi.org/10.1177/014662169501900308
30. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults–The Evidence Report (1998) National Institutes of Health. Obes Res 6 Suppl 2:51S-209S. https://doi.org/10.1002/j.1550-8528.1998.tb00690.x
31. Ng M, Fleming T, Robinson M et al (2014) Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 384(9945):766–781. https://doi.org/10.1016/s0140-6736(14)60460-8
32. Burke MA, Heiland FW, Nadler CM (2010) From "overweight" to "about right": evidence of a generational shift in body weight norms. Obesity (Silver Spring) 18(6):1226–1234. https://doi.org/10.1038/oby.2009.369
33. O'Brien G, Davies M (2007) Nutrition knowledge and body mass index. Health Educ Res 22(4):571–575. https://doi.org/10.1093/her/cyl119
34. Milosavljevic D, Mandic ML, Banjari I (2015) Nutritional knowledge and dietary habits survey in high school population. Coll Antropol 39(1):101–107
35. Saleh F, Mumu SJ, Ara F et al (2012) Knowledge, attitude and practice of type 2 diabetic patients regarding obesity: study in a tertiary care hospital in Bangladesh. J Public Health Afr 3(1):e8. https://doi.org/10.4081/jphia.2012.e8
36. Easton JF, Stephens CR, Sicilia HR (2017) An analysis of real, self-perceived, and desired BMI: is there a need for regular screening to correct misperceptions and motivate weight reduction? Front Public Health 5:12. https://doi.org/10.3389/fpubh.2017.00012
37. Wills T, Fehin P, Callen B (2011) Body mass index knowledge of older adults and motivation to change. Br J Community Nurs 16(3):110, 112–115. https://doi.org/10.12968/bjcn.2011.16.3.110
38. Yang K, Turk MT, Allison VL et al (2014) Body mass index self-perception and weight management behaviors during late adolescence. J Sch Health 84(10):654–660. https://doi.org/10.1111/josh.12195
39. Phelps EE, Wellings R, Griffiths F et al (2017) Do medical images aid understanding and recall of medical information? An experimental study comparing the experience of viewing no image, a 2D medical image and a 3D medical image alongside a diagnosis. Patient Educ Couns 100(6):1120–1127. https://doi.org/10.1016/j.pec.2016.12.034
40. Houts PS, Doak CC, Doak LG et al (2006) The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. Patient Educ Couns 61(2):173–190. https://doi.org/10.1016/j.pec.2005.05.004
41. Terre L, Hunter C, Poston WS et al (2007) Treatment of obesity in the primary care setting: are we there yet? Eat Disord 15(2):135–143. https://doi.org/10.1080/10640260701190659
42. Lopes N (coord), Pegado E, Raposo H et al (2009) Medicamentos e Pluralismo Terapêutico. Consumos, Lógicas e Racionalidades Sociais—Relatório Estatístico. CIES-IUL, Lisboa
43. Ferraro ZM, Patterson S, Chaput JP (2015) Unhealthy weight control practices: culprits and clinical recommendations. Clin Med Insights Endocrinol Diabetes 8:7–11. https://doi.org/10.4137/cmed.s23060
44. Puhl RM, Heuer CA (2009) The stigma of obesity: a review and update. Obesity (Silver Spring) 17(5):941–964. https://doi.org/10.1038/oby.2008.636
45. Soriano R, de Leon Ponce, Rosales S, Garcia R et al (2012) High knowledge about obesity and its health risks, with the exception of cancer, among Mexican individuals. J Cancer Educ 27(2):306–311. https://doi.org/10.1007/s13187-011-0298-8
46. American Institute for Cancer Research (2007) World Cancer Research Fund. Food, nutrition, physical activity and the prevention of cancer: a global perspective: a project of World Cancer Research Fund International. American Institute for Cancer Research, Washington, D.C.
47. Gross DP (2012) Knowledge translation and behaviour change: patients, providers, and populations. Physiother Can 64(3):221–224. https://doi.org/10.3138/ptc.64.3.ge1
48. Campos-Uscanga Y, Gutierrez-Ospina G, Morales-Romero J et al (2017) Self-regulation of eating and physical activity is lower in obese female college students as compared to their normal weight counterparts. Eat Weight Disord 22(2):311–319. https://doi.org/10.1007/s40519-016-0338-9
49. Bullivant B, Mitchison D, Skromanis S et al (2019) Elucidating individuals' beliefs about the severity of eating disorders and obesity: implications for public health programs. Eat Weight Disord. https://doi.org/10.1007/s40519-019-00708-6
50. Stice E, Desjardins CD, Shaw H et al (2019) Moderators of two dual eating disorder and obesity prevention programs. Behav Res Ther 118:77–86. https://doi.org/10.1016/j.brat.2019.04.002
51. Costa AR, Silva S, Moura-Ferreira P et al (2016) Health-related knowledge of primary prevention of cancer in Portugal. Eur J Cancer Prev 25(1):50–53. https://doi.org/10.1097/cej.0000000000000125
52. Song Y, Ma W, Yi X et al (2013) Chronic diseases knowledge and related factors among the elderly in Jinan, China. PLoS One 8(6):e68599. https://doi.org/10.1371/journal.pone.0068599
53. Krul AJ, Daanen HA, Choi H (2011) Self-reported and measured weight, height and body mass index (BMI) in Italy, the

Netherlands and North America. Eur J Public Health 21(4):414–419. https://doi.org/10.1093/eurpub/ckp228
54. Shapiro JR, Anderson DA (2003) The effects of restraint, gender, and body mass index on the accuracy of self-reported weight. Int J Eat Disord 34(1):177–180. https://doi.org/10.1002/eat.10166
55. Paiva D, Silva S, Severo M et al (2017) Limited health literacy in portugal assessed with the newest vital sign. Acta Med Port 30(12):861–869. https://doi.org/10.20344/amp.9135