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Review Article

Trends of BMI and prevalence of overweight and obesity in Portugal (1995–2005): a systematic review

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Abstract

Objective: Locale-specific data on BMI and overweight/obesity are necessary to understand how the obesity epidemic is evolving in each setting. We aimed to describe the temporal trends of mean BMI and prevalences of overweight/obesity in studies that evaluated Portuguese adults and older people.
Design: Systematic review, conducted via a PubMed search up to January 2011 and independent reference screening and data extraction. Twenty-one eligible studies were identified. Data were extracted from the published reports and obtained from the authors of seven of the largest studies. Adjusted ecological estimates of mean BMI and prevalences of overweight/obesity were computed by linear regression.
Results: Between 1995 and 2005, when using data obtained from anthropometric measurements, overweight prevalence increased by 3·2 % and 3·5 % and obesity prevalence by 7·4 % and 1·3 % among women and men, respectively, while mean BMI did not vary meaningfully. When using self-reported information, mean BMI increased by 0·8 kg/m^2 and 0·9 kg/m^2, overweight prevalence by 3·5 % and 3·7 % and obesity prevalence by 5·8 % and 5·5 % among women and men, respectively. Results from the 20-year-old conscripts (1960–2000) showed a marked increase in these outcomes in the last decades.
Conclusions: Our results show an important increase in overweight/obesity in younger ages. The trends in the indicators derived from self-reported data suggest an increase in awareness of the importance of overweight/obesity among the population.

Keywords
BMI
Obesity
Trends
Portugal

The health consequences of obesity range from non-fatal but debilitating complaints with an adverse effect on quality of life to an increased risk of premature death(1). Obesity is an important determinant of hypertension(2) and hyperlipidaemia(2), type 2 diabetes mellitus(2), metabolic syndrome(3), CVD(4) and cancer(5). Worldwide, it accounts for more than 33·4 million disability-adjusted life years(6) and at least 2·8 million deaths per year in adults(7).

Recent evidence from Western Europe in the last decades suggests that the prevalence of obesity has increased among children(8) and adults(9). Locale-specific reliable and robust data on BMI distribution and overweight/obesity prevalence at a population level are necessary to understand the magnitude and trends of the obesity epidemic in each setting, as well as to monitor the impact of public health measures.

The most comprehensive data on the distribution of BMI and frequency of overweight and obesity in Portugal come from the National Health Surveys(10–12) (self-reported), young men evaluated for military recruitment(13,14) and two recent national surveys(15,16). However, accurate estimation of the burden of morbidity and mortality associated with overweight and obesity in Portugal requires the best use of all available resources to obtain detailed information for different age groups and populations across the widest possible time span. A systematic review may allow their identification and description in a standardized format, taking into account the methodological aspects from each study that may compromise their internal and external validity, namely the recruitment of the participants and the methods for assessment of height and weight.

We therefore conducted a comprehensive systematic review to critically summarize the evidence from studies that quantified the distribution of BMI and the frequency of overweight or obesity, to estimate the trends of these indicators in adult Portuguese populations.

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Methods

Search strategy

We searched PubMed from inception up to January 2011, to identify original reports and review articles providing data on the distribution of BMI and overweight/obesity in Portuguese populations; the search expression is provided in the systematic review flowchart (Fig. 1).

Eligibility criteria and screening of reference lists

Two reviewers independently evaluated the studies in three consecutive steps, following predefined criteria, to determine the eligibility of each report. The first two steps relied on the same criteria. In step 1 the exclusion of irrelevant studies was decided by considering only the title and abstract; when the abstract of a particular article was not available, the article was selected for evaluation in step 2, except when the title unequivocally presented information for exclusion (e.g. case report, studies of risk factors in a specified population). The full texts of studies selected for step 2 were then evaluated to decide on their eligibility and availability of relevant data. The studies selected for step 3 were re-evaluated to determine their adequacy for extraction of relevant data.

The decisions taken independently by the two reviewers were compared in all steps and disagreements were resolved by consensus or after discussion with a third researcher. The agreement between the reviewers was 73·0 %, 81·7 % and 82·0 % in step 1, step 2 and step 3, respectively.

The criteria for exclusion of studies were the following: (i) reports not written in Portuguese, English, Spanish, French or Italian; (ii) studies not involving human subjects (e.g. *in vitro* or animal research); (iii) editorials or comments; (iv) reports not providing data specifically for Portuguese populations; (v) studies not evaluating adult populations; (vi) studies evaluating samples of participants not expected to represent the general population regarding the frequency of the cardiovascular risk factors under study (e.g. diabetics, athletes, sedentary elderly); and (vii) studies presenting insufficient characterization of the methods (e.g. not specifying the region where the sample was assembled, not describing the data collection procedures).

When more than one report referred to the same study, we considered the one providing data for the largest sample or, when the sample was the same, we used the source presenting the results with more detail, although any of these reports could be used to collect information on the study characteristics. When two publications studied the same sample but reported complementary results that would be lost if only one was considered, both reports were considered eligible for data extraction, although the study was considered only once in the data analyses.

The reference lists of the review articles addressing the distribution of cardiovascular risk factors in Portugal were screened to identify potentially eligible original reports.

Data extraction

Two investigators independently evaluated the selected studies to extract the following data for sample characterization: (i) sample characteristics (gender, age, sample size); (ii) type of population (general population, blood donors, university students, occupational groups, primary health care users, volunteers or mixed); (iii) sampling strategy (probability or not probability sampling); and (iv) geographical coverage (national or regional).

Quantitative data on the distribution of BMI and/or overweight/obesity, the criteria to define overweight/obesity and the methods used for data collection (e.g. anthropometric measurements, self-report or abstraction from clinical records) were also extracted. Age- and sex-specific estimates were extracted whenever available. When a study did not present the mean age of the subjects in each age group we assumed the mid-point of the age interval. When an age group also included subjects below 18 years old (e.g. age group 17–20 years), we computed the mid-point and excluded the data if the mid-point year was lower than 17·5 years old.

Differences in the data extracted by the two investigators were discussed until consensus, involving a third investigator whenever necessary.

From five of the largest national studies representing participants within a wide age range[10–12,15,17] and the two largest studies with regional coverage[18,19] we obtained age- and sex-specific estimates directly from the authors. This was not possible for one of the largest national studies[16] due to technical problems that the authors of the original investigation were unable to overcome.

Data analysis

We summarized the evidence from studies that evaluated samples of the general population.

Estimates obtained from self-reported information and anthropometric measurements were treated separately. Data referring to conscripts included a large amount of information measured with standardized methodology, on a narrow age range and covering a wider time span, since 1960, and were also used in specific analyses. Clinical record information referred to studies reporting data on conscripts and therefore was treated as anthropometric measurements.

Data are summarized in figures depicting the age- and sex-specific estimates (whenever available) of mean BMI, prevalence of overweight (BMI = 25·0–29·9 kg/m^2 or BMI = 25·0–30·0 kg/m^2, as available in the original reports) and prevalence of obesity (BMI ≥ 30·0 kg/m^2 or BMI > 30·0 kg/m^2, as available in the original reports). Each figure includes lines representing the sex-specific prediction for mean BMI or prevalence of overweight/obesity, as applicable, based on linear regression models including the mean age of subjects and a corresponding quadratic term as independent variables.

We fitted multiple linear regression models using age- and sex-specific mean BMI, the prevalence of overweight and the prevalence of obesity as the dependent variables, and the following independent variables: year of data collection, geographical coverage, mean age of the subjects and squared mean age. The equations obtained by linear regression were used to compute adjusted ecological estimates of mean BMI, prevalence of overweight and prevalence of obesity in two different calendar years (1995 and 2005) for each gender at the age of 50 years. Data referring to the years before 1995 were available mainly for conscript samples and the available data referring to years after 2005 were scarce; therefore we opted not to provide estimates requiring extrapolation beyond the 10-year period between 1995 and 2005. As one or more estimates of the outcomes were extracted from each study, corresponding to different age strata, the confidence intervals were calculated using robust estimates of the standard errors. This accounts for the dependence among the observations from the same study.

The analyses were conducted using the STATA statistical software package version 9·2 (StataCorp, College Station, TX, USA).

Results

We identified twenty-one studies eligible for the systematic review[10–30] (Fig. 1 and Table 1), reporting data collected from 1960 to 2009. Eleven investigations evaluated national/mainland samples[10–12,14–17,21,26,29–31]. In fourteen studies the data on weight and height were obtained by anthropometric measurements[13–17,20–28], in six they were self-reported[10–12,19,29,30] and one reported data collected with both methods[18].

In both genders, the mean BMI and the prevalence of overweight/obesity increased during adulthood until the age of 60 years; lower values were observed in the elderly, regardless of the method of data collection. Men presented a higher mean BMI than women up to the fourth decade of life, regardless of the method of assessment. Among older subjects the mean BMI was higher in women when weight and height were obtained from anthropometric measurements; no sex differences were observed in self-reported data. The prevalence of overweight was higher among men, regardless of age and method of assessment, although the sex differences were less pronounced in the younger and older subjects (Fig. 2).

When weight and height were obtained from anthropometric measurements, the age distribution of the prevalence of obesity was similar to that observed for mean BMI. Self-reported data yielded higher prevalences among women aged above 30 years; sex differences were smaller among the older subjects and absent among the younger (Fig. 2).

Between 1995 and 2005, when considering data obtained by anthropometric measurements, among women the estimated mean BMI varied by −0·4 (95 % CI −1·1, 0·3) kg/m^2, while the prevalence of overweight increased by 3·2 (95 % CI −2·3, 8·7) % and the prevalence of obesity increased by 7·4 (95 % CI −10·3, 25·0) %. Among men, the variation in mean BMI was 0·1 (95 % CI −0·3, 0·5) kg/m^2, the prevalence of overweight increased by 3·5 (95 % CI 1·8, 5·2) % and the prevalence of obesity increased by 1·3 (95 % CI 0·7, 2·0) %. In 2005, among women at 50 years of age, the estimates of mean BMI and prevalences of overweight and obesity were 27·0 (95 % CI 26·1, 27·9) kg/m^2, 40·5 (95 % CI 31·9, 49·1) % and 22·6 (95 % CI 14·5, 30·8) %, respectively. Among men, the corresponding estimates were 26·9 (95 % CI 25·7, 28·1) kg/m^2, 52·7 (95 % CI 50·0, 55·3) % and 19·0 (95 % CI 17·4, 20·5) %, respectively (Fig. 3).

When considering self-reported data, between 1995 and 2005 the estimates referring to women varied by 0·8 (95 % CI 0·5, 1·2) kg/m^2 for mean BMI, 3·5 (95 % CI −0·5, 7·6) % for the prevalence of overweight and 5·8 (95 % CI 4·1, 7·4) % for the prevalence of obesity. Among men, in the same period the variation was 0·9 (95 % CI 0·5, 1·2) kg/m^2 for mean BMI, 3·7 (95 % CI −7·4, 14·8) % for the prevalence of overweight and 5·5 (95 % CI 3·5, 7·4) % for the prevalence of obesity. In 2005, at 50 years of age, the estimated mean BMI, prevalence of overweight and prevalence of obesity among women were 26·8 (95 % CI 26·2, 27·4) kg/m^2, 39·7 (95 % CI 37·3, 42·0) % and 21·9 (95 % CI 19·1, 24·7) %, respectively. Among men, the estimated mean BMI was 26·8 (95 % CI 26·5, 27·2) kg/m^2, the prevalence of overweight was 48·5 (95 % CI 43·4, 53·5) % and the prevalence of obesity was 17·4 (95 % CI 15·1, 19·8) % (Fig. 3).

Figure 4 depicts the data on Portuguese male conscripts, obtained from the recruitment centre in Lisbon (1960–1990) and from all Portuguese recruitment centres (1986–1999). The former shows an increase in mean BMI and overweight/obesity prevalences, mainly between 1985 and 1990, with no clear tendency before that. The latter depicts an increase in the prevalence of overweight from 10·5 % in 1986 to 21·3 % in 2000. In the same period the prevalence of obesity also increased, with a nearly threefold variation in the last 5 years, from 1·6 % in 1995 to 4·2 % in 2000.

Discussion

The present study provides the most comprehensive assessment of the trends in the distribution of BMI and overweight/obesity in Portuguese adults and older people. On the one hand, when considering weight and height obtained from anthropometric measurements, there were small variations in mean BMI and the prevalence of overweight/obesity increased in both women and men between 1995 and 2005. Self-reported data showed a rather marked increase in the distribution of all these outcomes in the same period, especially for mean BMI and obesity, suggesting an increased awareness of the importance of excess weight among the population. On the other hand, data from Portuguese conscripts showed an important

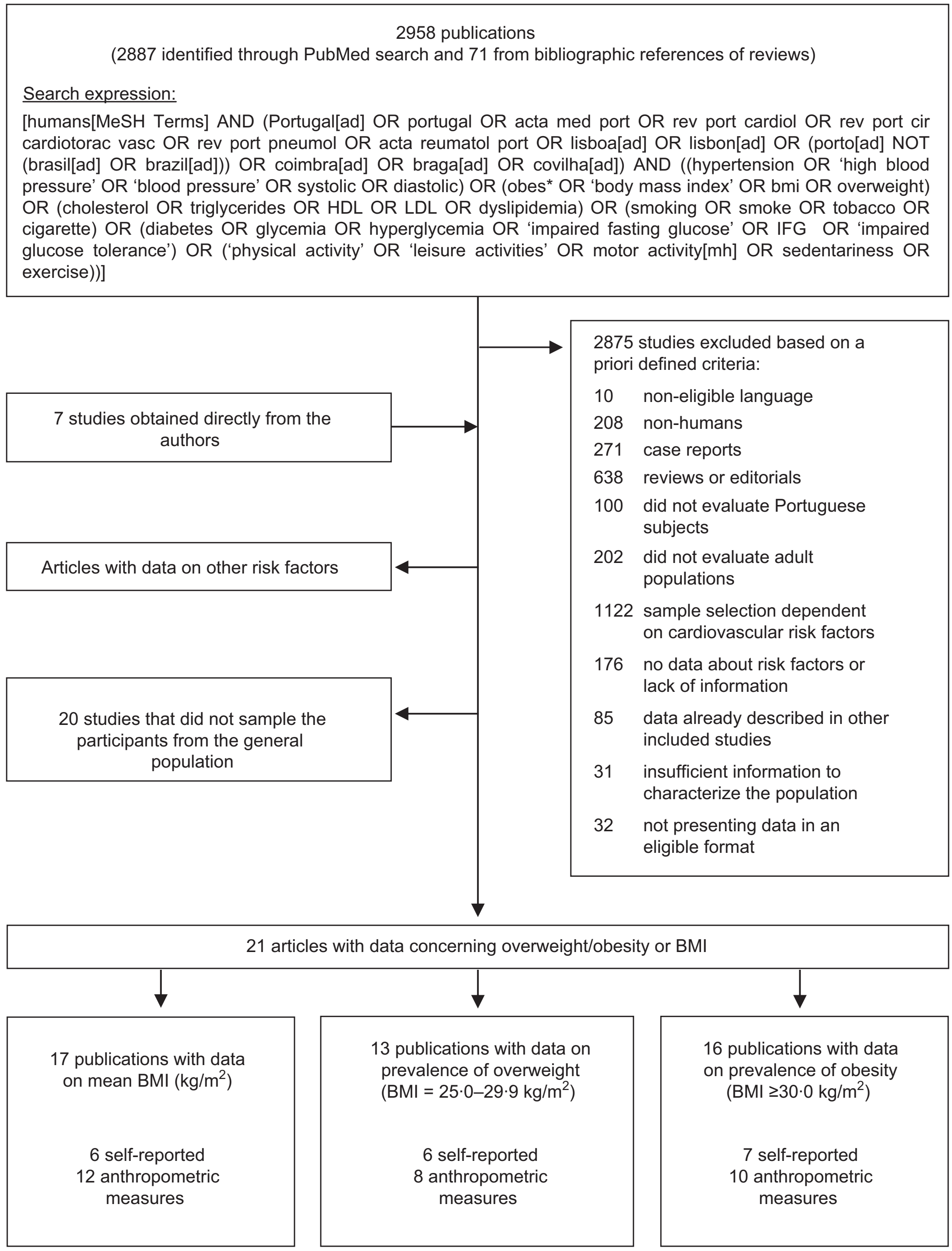

Fig. 1 Flowchart showing the systematic review process. The exclusion of studies was performed in three consecutive steps applying previously defined criteria. Studies that provided data on mean BMI and/or prevalence of overweight/obesity in samples other than from the general population were not considered

upward trend in the distribution of BMI and overweight/obesity in the last decades, depicting an increasing burden of disease among younger adults.

An important strength of the present study is the extensive literature search that provided data not only from larger national studies but also from smaller studies that generally have lower visibility, as well as the inclusion of stratum-specific estimates obtained from the authors of the larger studies. The included studies involved large samples and the majority presented sex- and age-stratified data. However, some limitations need to be addressed, namely those resulting from the ecological nature of the summary estimates and the diversity of methodological and reporting options adopted in the primary sources of evidence. In fact, two studies were conducted involving samples obtained by a non-probability sampling process and very few reported the participation rate, contributing to expected selection bias whose magnitude cannot be assessed. The studies included in the systematic review are heterogeneous regarding the methods to evaluate weight and height, the

Table 1 Main characteristics of the studies included in the systematic review

First author, year of publication	Year of data collection	Sampling process	Representativeness	Participation rate (%)	Source of data on BMI	Gender	Total sample size	Age (years)		Age-specific estimates	Mean BMI (kg/m^2)	Overweight prevalence (BMI = 25·0–29·9 kg/m^2)	Obesity prevalence (BMI ≥ 30·0 kg/m^2)
								Range	Mean				
Intersalt group, 1988[20]	1987†	Not probability	Regional	Not specified	Measured	F, M	198	20–59	–	Yes	Yes	No	No
Baptista, 1992[21]	1990–1991	Probability	National‡	81	Clinical records	M	74 567	20¶	–	No	Yes	Yes	No††
Martins, 1993[22]	1993	Probability	Regional	Not specified	Measured	F, M	1600	15–73¶	–	Yes	No	Yes	Yes
de Groot, 1996[23]	1993	Probability	Regional	Not specified	Measured	F, M	28	79–80	–	No	Yes	No	Yes§§
INE, 1997[12]*	1995–1996	Probability	National§	Not specified	Self-reported	F, M	39 887	18–84¶	–	Yes	Yes	No††	Yes
de Castro, 1998[13]	1960–1990	Probability	Regional	Not applicable‖	Clinical records	M	2383	20	–	No	Yes	Yes	Yes
Simões, 2000[24]	1998–1999	Probability	Regional	Not specified	Measured	F, M	340	25–44	–	Yes	No	No	Yes
Torres, 2000[25]	1999†	Probability	Regional	Not specified	Measured	M	87	25–65	44·3**	No	Yes	No	No
INE, 2000[10]*	1998–1999	Probability	National§	Not specified	Self-reported	F, M	34 800	18–80¶	–	Yes	Yes	Yes	Yes
Santos, 2003[18]*	1998–2003	Probability	Regional	70	Measured Self-reported	F, M	2488	18–93	52·9	Yes	Yes	Yes	Yes
Nobre, 2004[26]	1994–1995 1998–1999	Probability	National‡	Not specified	Clinical records	M	152 617	20	20·8**	No	Yes	Yes‡‡	Yes‡‡
de Groot, 2004[27]	1988–1989	Probability	Regional	Not specified	Measured	F, M	222	70–75	–	No	Yes	No	No
do Carmo, 2006[16]	1995–1998	Probability	National§	Not specified	Measured	F, M	4328	18–64	–	Yes	Yes	Yes	Yes
Padez, 2006[14]	1986–1990 1992–2000	Probability	National‡	Not applicable‖	Clinical records	M	850 081	18	–	No	No	Yes	Yes
de Macedo, 2007[17]*	2003–2004	Probability	National§	Not specified	Measured	F, M	4992	18–90	46	Yes	Yes	Yes	Yes
Santos, 2008[19]*	2004	Not probability	Regional	87·6	Self-reported	F, M	9991	18–65	37·8	Yes	Yes	Yes	Yes
do Carmo, 2008[15]*	2003–2005	Probability	National§	80	Measured	F, M	8053	18–64	–	Yes	Yes	Yes	Yes
Freitas, 2008[28]	2007†	Probability	Regional	Not specified	Measured	M, F, MF	510	24–68	47·47	No	Yes	No	Yes
INE, 2009[11]*	2005–2006	Probability	National	Not specified	Self-reported	F, M	22 553	15–90	–	Yes	Yes	Yes	Yes
Correia, 2009[29]	2009	Probability	National§	Not specified	Self-reported	M, F	1769	40–89¶	–	Yes	Yes	Yes	Yes
Bonhorst, 2010[30]	2009	Probability	National	Not specified	Self-reported	MF	10 447	40–101	59·1	No	No	Yes	Yes

F, female; M, male; MF, male and female.
*Age- and sex-specific estimates obtained directly from the authors.
†When the period of data collection was not reported, we assumed the publication year minus the median difference between the publication year and date of data collection in the articles for which that information was available (1·5 years).
‡Data from mainland Portugal and islands.
§Data from mainland Portugal.
‖Data retrospectively obtained from registers of anthropometric evaluation of all the evaluated conscripts.
¶For surveys that did not report the age range of the participants but reported data by age groups, we considered the upper/lower limit by assuming the same width for extreme classes as that of the closest class (e.g. for surveys reporting data in participants aged <30, 30–39, 40–49 and ≥50 years, we considered the overall range as 20–59 years).
**Weighted mean.
††Overweight and obesity prevalence defined by criteria other than BMI = 25·0–29·9 kg/m^2 and BMI ≥ 30·0 kg/m^2, respectively.
‡‡Data not considered for analysis because they are duplicated from those described by Padez, 2006[14].
§§Prevalence of obesity considered even when overweight was defined as BMI ≥ 30·0 kg/m^2.

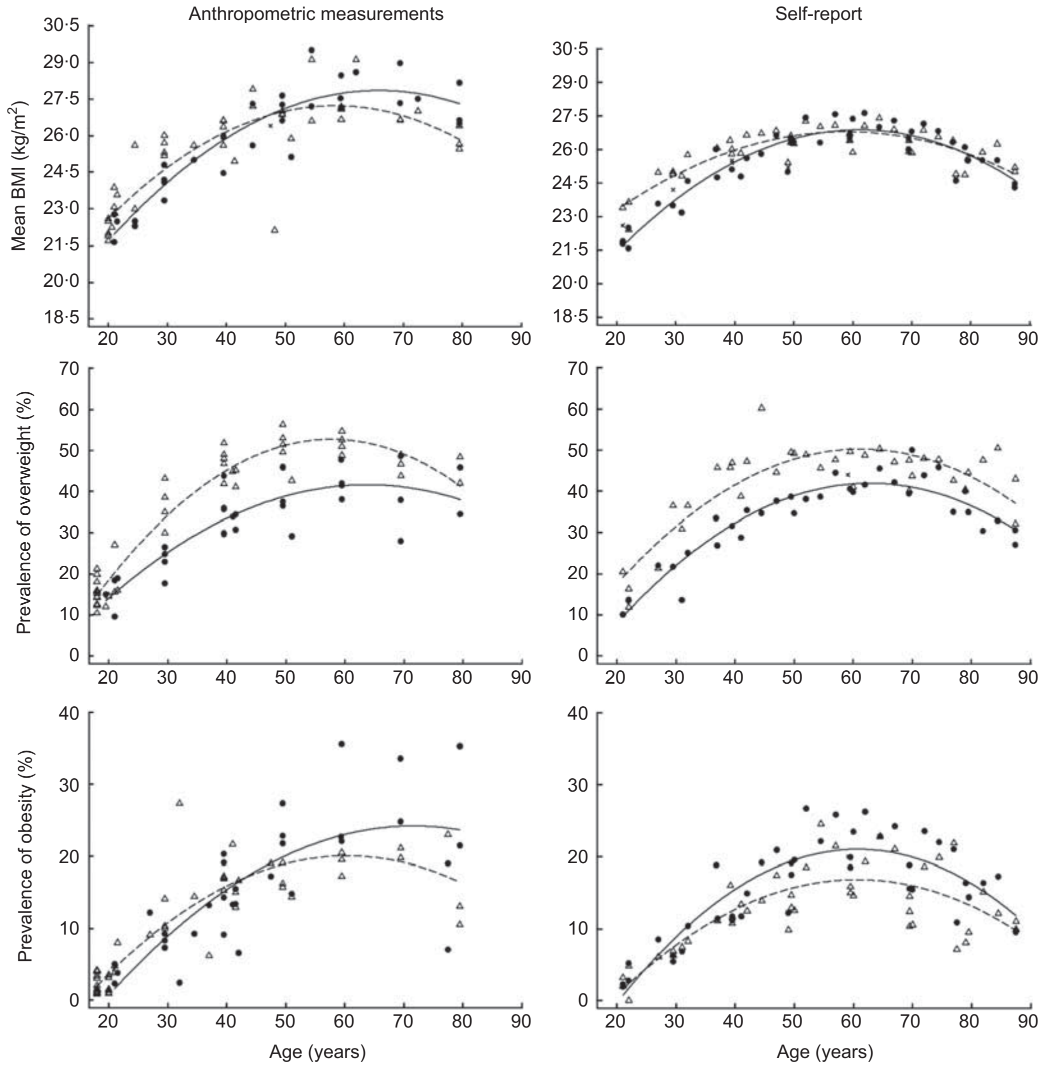

Fig. 2 Mean BMI (kg/m^2) and prevalence (%) of overweight (BMI = 25·0–29·9 kg/m^2) and obesity (BMI ≥ 30·0 kg/m^2) among Portuguese subjects, by age and gender (—●—, women; – – △ – –, men; ×, women and men), for data computed with measured and self-reported weight and height

cut-offs to define overweight and/or obesity, the age range of groups, the time of data collection, and regarding the quality of reporting of data and study methodological details. These limitations were overcome through stratified analyses, by sex and method of data collection, and through multivariate modelling of the data. Some estimates of the outcomes, obtained from the regression models, have relatively large confidence intervals. This width reflects the number of studies providing data for different ages and in any specific period, as well as between-study variability. However, our analysis is based on a comprehensive systematic review and we obtained sex- and age-specific estimates directly from the authors of the larger studies involving measures of weight and height. Therefore, the remaining imprecision is unavoidable, taking into account the available evidence referring to the Portuguese setting.

Decreased physical activity, high-fat diets and an inability to adapt to diminished energy requirements are suggested to be the main determinants of the increase of mean BMI in populations[32]. Since the 1980s, Portugal has experienced a rapid economic increase, better social and housing conditions, and changed from a mostly agrarian society to one firmly oriented towards the service sector[33]. The economic improvements contributed to a higher frequency of sedentary behaviours and changes towards unhealthy eating habits, which are positively associated with BMI[34]. In Portugal, the per capita energy availability was 11 715 kJ/d (2800 kcal/d) in 1980, nearly 15 272 kJ/d (3650 kcal/d) in 1995 and approximately 15 690 kJ/d (3750 kcal/d) in 2003[35]. Data on physical activity trends in Portugal are not available. However, in 1997, from fifteen countries of the European Union, Portugal presented the highest rate of sedentary lifestyles (87·8 %)[36]. The National Health Survey conducted in 1998–1999 showed that overall 70·7 % of Portuguese aged over 15 years were sedentary[10].

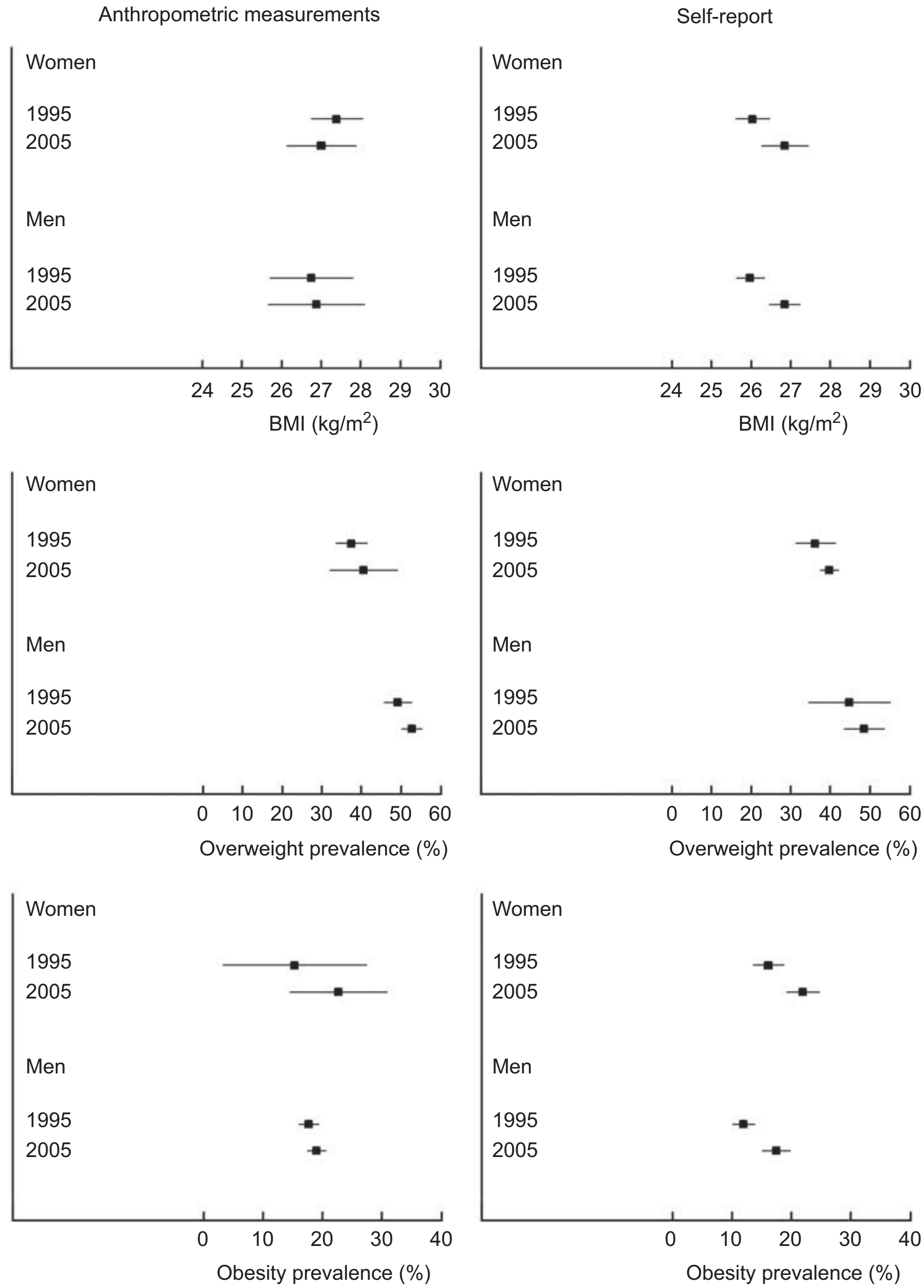

Fig. 3 Estimated mean BMI (kg/m^2), prevalence (%) of overweight (BMI = 25·0–29·9 kg/m^2) and prevalence (%) of obesity (BMI ≥ 30·0 kg/m^2) in 1995 and 2005 (with 95 % confidence intervals represented by horizontal bars), for Portuguese subjects aged 50 years, according to method for data collection on weight and height (measured and self-reported)

In the 10-year period evaluated, the mean BMI and the prevalences of overweight/obesity had a marked increase among younger subjects, in contrast to the modest increase observed overall. A cohort effect could explain the different trends by age, since the younger subjects lived in an obesity-favourable society since birth, while the older subjects only experienced the economic improvements during adulthood.

Despite the important increase in mean BMI recently described in Western Europe[9], some European countries[37–39] have reported a slowdown in the rate of increase. The observed increase in these outcome variables could be a herald of a levelling off of the obesity prevalence. However, considering the accelerated increase of the overweight/obesity prevalence in younger ages depicted by data from conscripts, a growing burden of obesity can be expected in the next generations in Portugal.

The improved literacy skills of the Portuguese population and the increasing access to health information are

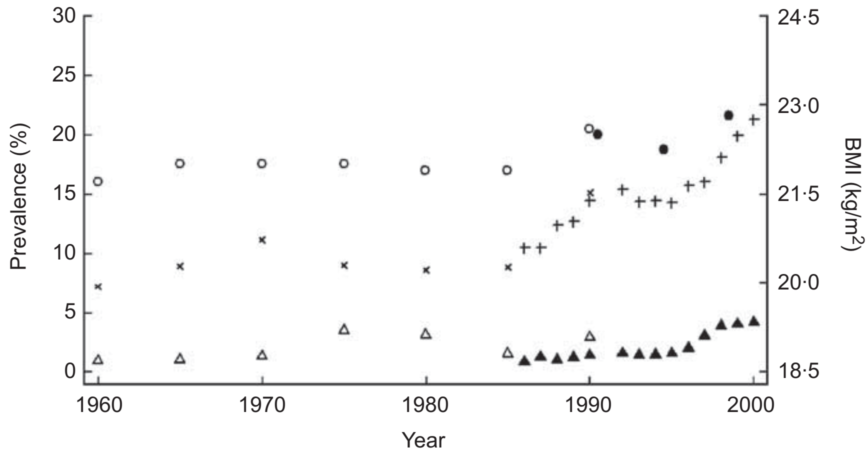

Fig. 4 Prevalence of overweight and obesity (%), and mean values of BMI (kg/m^2), in Portuguese male conscripts from 1960 to 2000 (●, BMI – Portugal; +, overweight – Portugal; ▲, obesity – Portugal; ○, BMI – Lisbon; ×, overweight – Lisbon; △, obesity – Lisbon)

key steps for the recognition of obesity as an important health-related problem [40]. Similarly to most Western countries, obesity was recognized as a health condition in Portugal only quite recently and has been widely discussed in recent years[41]. This is in accordance with the observed increase in mean BMI and overweight/obesity prevalence when weight and height were self-reported. Since we did not find an important increase for the same period with the data from the anthropometric measurements, the increase in self-reported data seems to reflect better knowledge by the population about their real weight. Similar trends of obesity prevalence computed with self-reported information have generally been observed in other countries, namely in Spain, with an increase of 7 % among men and 3 % among women between 1987 and 2000[42], and in France, with an overall increase of 4·5 % from 1997 to 2006[43].

We estimated that approximately half of the general population had excess body weight in 2005, demanding for effective interventions. Tackling obesity requires comprehensive measures that range from the management of those already with excess body weight to the prevention of weight gain among the whole population. In 2005, the Portuguese National Health Service approved a National Plan for Obesity Control targeting subjects of any age who have overweight or belong to specific groups (e.g. former smokers or family history of obesity)[44]. However, population-based approaches to prevent obesity ought to be more comprehensive, making healthy foods more accessible, providing opportunities for physical activity and involving educational and motivational messages targeting not only the general population but also worksites and societal and health-care organizations[45]. Ideally, whole-population approaches should increase healthful eating and physical activity without depending on the deliberate actions of individuals[45]. Influences on policy and legislation, namely by increasing taxes, have the advantage of potentially affecting a large part of the population[45].

Conclusions

Despite the increase in awareness of the importance of overweight/obesity and the modest increase in the prevalence of overweight/obesity observed in older subjects, the potential health benefits from reducing overweight and obesity cannot be overemphasized. Considering the increasing prevalence among younger subjects, a future increase in the overall burden of obesity can be expected. In this context, new information on measured weight and height of adults is necessary to update trends. The expected increase in obesity-related morbidity and mortality is worrisome, and research and interventions for the prevention and treatment of obesity should target younger subjects as a priority.

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