PUBLIC HEALTH 128 (2014) 214–221

Available online at www.sciencedirect.com

Public Health

journal homepage: www.elsevier.com/puhe

Review Paper

Trends in prevalence of diabetes mellitus and mean fasting glucose in Portugal (1987–2009): a systematic review

M. Pereira [a,b,*], H. Carreira [a,b], N. Lunet [a,b], A. Azevedo [a,b]

[a] Department of Clinical Epidemiology, Predictive Medicine and Public Health, University of Porto Medical School, Alameda Prof Hernani Monteiro, 4200-319 Porto, Portugal

[b] Institute of Public Health of the University of Porto, Rua das Taipas n° 135, 4050-600 Porto, Portugal

ARTICLE INFO

Article history:
Received 13 November 2012
Received in revised form
7 November 2013
Accepted 7 December 2013
Available online 20 February 2014

Keywords:
Diabetes mellitus
Epidemiology
Glucose
Risk factors

ABSTRACT

Objectives: To assess time trends of the prevalence of diabetes and mean blood glucose in Portuguese adults.

Study design: Systematic review.

Methods: The search strategy included Pubmed search and screening of bibliographic references of the review articles. Sex-specific linear regression models, with survey year and participants' age as independent variables, were used to predict prevalence estimates of self-reported diabetes and mean fasting glucose.

Results: Twenty-seven eligible studies were identified. Time trends of objectively defined diabetes could not be quantified due to the heterogeneity of the diagnostic criteria. Between 1987 and 2009, the prevalence of self-reported diabetes remained approximately constant in young adults, while it increased in middle-aged and older adults, more than two-fold among women and three-fold among men. In the same period, mean fasting glucose increased 7 mg/dL among women and 8 mg/dL among men.

Conclusions: The prevalence of self-reported diabetes and mean fasting glucose increased in the last two decades, demanding for effective strategies to reverse this tendency and to manage the increasing number of people with diabetes in the Portuguese population.

Introduction

In 2011, 4.6 million people aged 20–79 died from diabetes, accounting for 8.2% of all-cause mortality in this age range worldwide.[1] People with diabetes have a lower life expectancy by approximately 12 years.[2] Diabetes is also associated with important morbidity, particularly a high absolute risk of major coronary events,[3,4] and other disabling consequences like renal failure and blindness.[5,6]

In the last decade, cases of glycaemia and diabetes have increased globally, paralleling the increasing trends in body mass index[7] and population ageing. Some 366 million people worldwide, corresponding to 8.3% of the adult population, were estimated to have diabetes in 2011.[1] If these trends continue, it is estimated that by 2030 a total of 552 million

* *Corresponding author*. Tel.: +351 22 551 36 52; fax: +351 22 551 36 53.
E-mail addresses: martasfp@med.up.pt, martasfpereira@hotmail.com (M. Pereira).

0033-3506/$ – see front matter
http://dx.doi.org/10.1016/j.puhe.2013.12.009

people will have diabetes.[1] However, there is considerable variation in time trends across countries and regions, making generalizations based on subjective assessments of similarities of populations unadvisable.[8] Furthermore, understanding the secular development of the epidemiology of diabetes in different settings is important to define goals for public health interventions and to predict the morbidity and mortality burden of this condition in the short term.

The most comprehensive data on the frequency of diabetes mellitus in Portugal comes from the self-reported data of the National Health Surveys,[9–12] and only recently were three national surveys carried out using standardized criteria for diabetes identification.[13–15] However, an accurate estimation of the frequency of diabetes 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 methods and conditions for glucose measurement and criteria for definition of diabetes.

We therefore conducted a systematic review to critically summarize the evidence from studies that provided data on the distribution of diabetes mellitus and fasting blood glucose levels in Portuguese adults, in order to analyse time trends.

Methods

The present systematic review was conducted as part of a more comprehensive review that addressed the distribution of six major cardiovascular risk factors, including hypertension,[16] obesity,[17] dyslipidaemia,[18] diabetes mellitus, smoking and physical inactivity, in Portuguese adults. The current analysis only considers studies with data on the prevalence of diabetes and/or mean blood glucose. This systematic review was prepared in strict compliance with PRISMA guidelines for systematic reviews.

Search strategy

We searched Pubmed from inception to November 2011, to identify original reports and review articles providing data on the distribution of the prevalence of diabetes and mean fasting glucose levels in Portuguese populations; the search expression is provided in the systematic review flowchart (Fig. 1). The reference lists of the review articles addressing the distribution of cardiovascular risk factors in Portugal were screened to identify potentially eligible original reports.

Eligibility criteria and screening of reference lists

Studies were excluded when fulfilling the following criteria, defined *a priori*: written in languages other than Portuguese, English, Spanish, French or Italian; research not involving humans (*e.g. in vitro* or animal research); editorials, reviews or comments; not providing data specifically for Portuguese subjects; not evaluating adult populations; evaluating samples of participants not expected to represent the general population regarding the frequency of the cardiovascular risk factors under study (*e.g.* athletes, sedentary elderly); not presenting data on diabetes prevalence or mean glucose levels; insufficient characterization of the methods (*e.g.* not specifying the region where the sample was assembled, not describing the data collection procedures).

The screening of the reference lists was accomplished in three consecutive steps. In step 1 the exclusion of irrelevant studies was decided by considering only the title and abstract; the article was selected for evaluation in step 2 except when the title or abstract (when available) unequivocally presented information for exclusion. 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 data extraction.

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.

The decisions taken independently by the two reviewers were compared in all steps and the disagreements were resolved by consensus or after discussion with a third researcher.

Data extraction

Two investigators independently collected data from the studies selected for the systematic review on period of data collection, recruitment place, geographical coverage of the study (regional/national), type of population studied (*e.g.* general population, primary health care users, occupational group, volunteers, university students and pharmacy attendants), type of sampling (probability or non-probability), sample size and participants' mean age and sex. 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 (three years). When a study did not present the mean age of the participants in each age group we assumed the mid-point of the age interval. When an age group also included subjects aged 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. For surveys that reported data by age group but provided open age intervals at the extremes, we estimated the midpoint of the highest/lowest categories by adding or subtracting the width of the adjacent class to the lowest/highest value, respectively, of the extreme classes (*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).

The source of data on the presence of diabetes or fasting blood glucose (*e.g.* biochemical tests, self-report or clinical records), the device for glucose measurement and the fasting status of participants upon blood withdrawal were also extracted. Age- and sex-specific estimates of prevalence of diabetes and blood glucose levels, and the respective criterion for the definition of the former, were extracted whenever available.

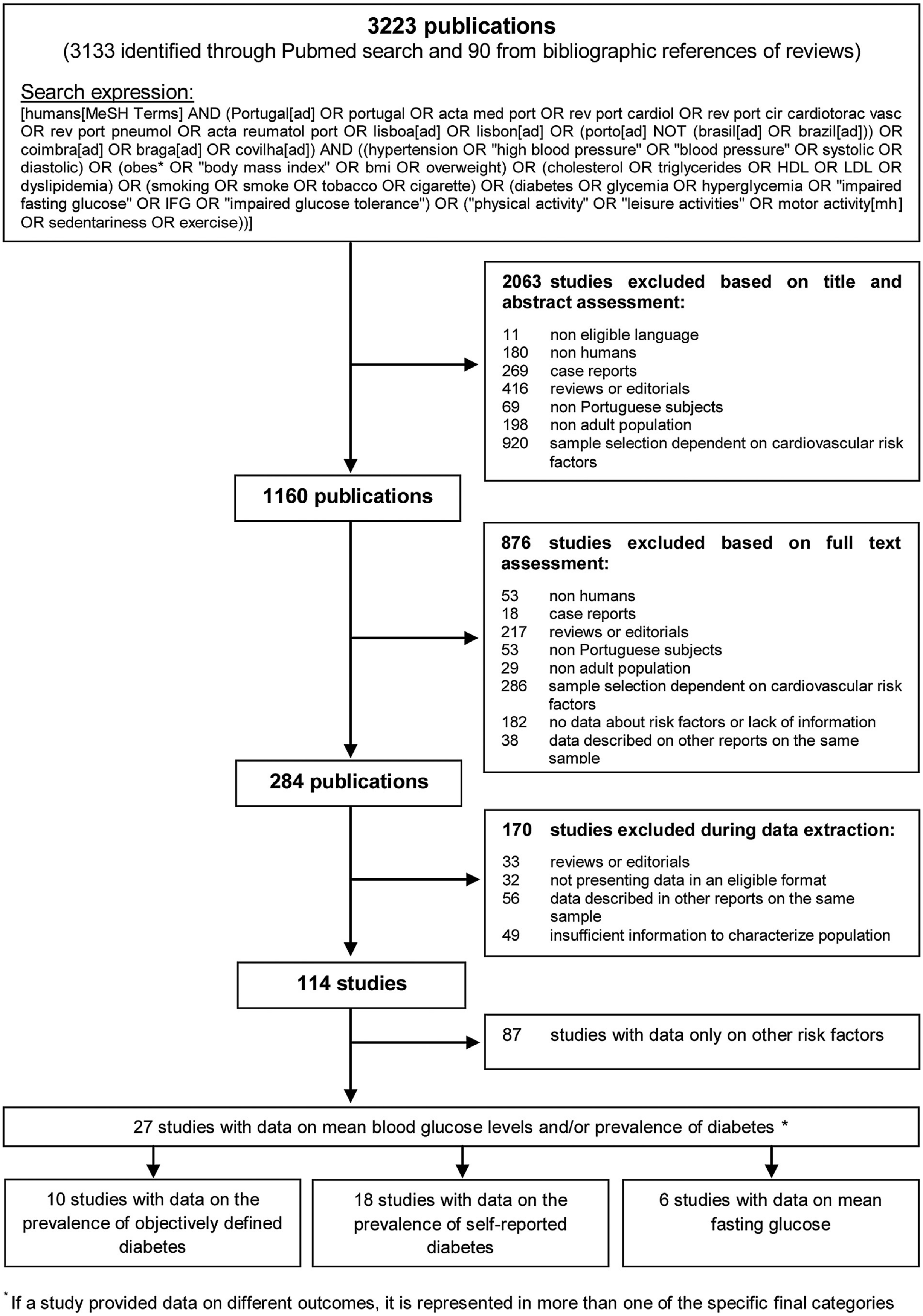


Fig. 1 – Systematic review flowchart.

When only graphs were presented we extracted the data by reading from projections to axes; the articles were excluded when no accurate reading was possible. From the six largest studies involving subjects within a wide age range we obtained age- and sex-specific estimates directly from the authors.

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

Data analysis

Studies that did not present data stratified by sex were excluded from all quantitative analyses, as well as one study addressing specifically type 1 diabetes. Studies relying on non-fasting blood glucose in the whole or part of the sample were included to provide estimates of objectively defined diabetes. However, they were only included if appropriate cut-offs, different from criteria used for fasting glucose, were used to define diabetes, but excluded from analyses on mean blood glucose. We considered self-reported diabetes, previous diagnosis of diabetes and being on treatment as equivalent criteria for the definition of self-reported diabetes, under the assumption that the proportion of treated among aware is very high.

Data are summarized in figures depicting the age and sex-specific estimates (whenever available) of the prevalence of self-reported diabetes and mean fasting glucose, as available in the original reports. Each figure includes lines representing the sex-specific prediction for prevalence of self-reported diabetes and mean fasting glucose, as applicable, based on linear regression models including the mean age of subjects and a quadratic term, whenever necessary, as independent variables.

We fitted multiple linear regression models using the age and sex-specific estimates of the prevalence of diabetes and mean fasting glucose as dependent variables, and the following independent variables: year of data collection and participants' mean age. We hypothesized that a quadratic term of age could improve a model fit given the flattening of the increase in prevalence with advanced age,[19] but since these terms were not significant, we did not include them in the final models. We studied the role of an interaction term between survey year and age, which had a significant effect only for self-reported diabetes. The equations obtained by linear regression were used to compute adjusted ecological estimates of prevalence of self-reported diabetes and mean fasting glucose in two extreme calendar years for which data were available (1987 and 2009) at specific ages (30, 50, 70 years) aiming to represent young, middle-aged and older adults. 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.

Results

We identified 27 studies eligible for the systematic review (Fig. 1), published between 1989 and 2011.[9–15,20–39] The detailed description of the methodological characteristics and results presented in the primary data sources are presented in a Supplementary file, available online. Ten studies presented data on the prevalence of objectively defined diabetes, 18 studies on the prevalence of self-reported diabetes and six studies on mean blood glucose. Twelve studies assessed representative samples at mainland or national level, of which four were National Health Surveys. Most studies considered samples of the general population (16 studies) or users of primary health care centers (eight studies). Among the 12 studies with data on blood glucose measurements, used either for estimation of mean blood glucose or prevalence of objectively defined diabetes, six did not identify the method used to measure glucose and in four not all participants were in fasting conditions when blood glucose was measured. Seven studies did not present the results stratified by sex and nine did not stratify the results by age groups (Supplementary file, available online).

Prevalence of diabetes

Overall, 25 studies presented data on diabetes prevalence, using 10 different criteria to define diabetes (Supplementary appendix, available online).

Time trends of objectively defined diabetes could not be quantified due to the heterogeneity of the criteria for the diagnosis of diabetes and the scarcity of data pertaining to each criterion. The prevalence of objectively defined diabetes ranged from 0.0%, when defined as fasting glucose >110 mg/dL, among male university students, in 2005, to 40.0%, when defined as fasting glucose ≥126 mg/dL and/or previous diagnosis and/or being on pharmacological treatment, among women aged 85–93 years, in 1999–2003. In general, the proportion of subjects with high fasting glucose increased with age and was higher among men, regardless of the criterion used to define the outcome.

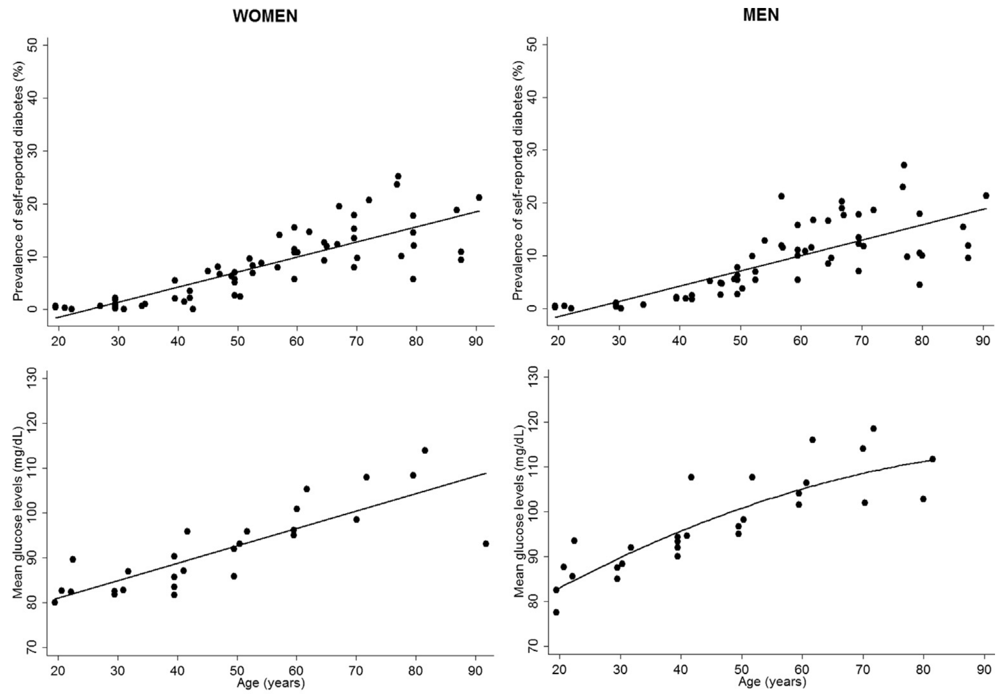
The prevalence of self-reported diabetes increased with age, both in women and men (Fig. 2), with no significant differences between sexes.

Table 1 depicts the estimated prevalence of self-reported diabetes in 1987 and 2009, in women and men at 30, 50 and 70 years of age. In this period, the prevalence of self-reported diabetes remained approximately constant among younger adults, while it increased in middle-aged and older adults, more than doubling among women and tripling among men. In 2009, the prevalence of self-reported diabetes estimated from the linear regression model was 8.6% and 9.4%, assuming an average age of 50 years, among women and men, respectively (Table 1).

Mean fasting glucose levels

Mean fasting glucose levels increased linearly with age in women and men (Fig. 2). Mean fasting glucose was 6 mg/dL [95% confidence interval (95%CI): 2–10] higher among men, independently of the year of survey and age.

Between 1987 and 2009, mean fasting glucose increased 7 mg/dL (95%CI: 1–12) among women and 8 mg/dL (95%CI: 0–19) among men. In 2009, assuming an average age of 50, the mean glucose levels were 96 mg/dL and 103 mg/dL, among women and men, respectively (Table 1).



The lines represent the sex-specific prediction for prevalence of self-reported diabetes and mean fasting glucose, as applicable, based on linear regression models including the mean age of subjects and a quadratic term, whenever necessary, as independent variables.

Fig. 2 – Prevalence of self-reported diabetes and mean fasting glucose according to age, in women and men.

Discussion

We describe an important increase in the prevalence of self-reported diabetes in middle-aged and older adults, and in mean fasting glucose in all adult ages, both in women and men, in the last two decades, in Portugal.

This review represents the most comprehensive analysis of estimates of diabetes prevalence and mean blood glucose in Portugal to date. Our results are based on an extensive literature search that allowed the analysis of long-term trends of both prevalence of diabetes and mean glucose, taking into account the methodological variation among studies. Nevertheless, some limitations need to be acknowledged. The utilization of a single search engine could decrease the completeness of the review. However, we may assume that studies including larger samples and more thorough methods were more likely to be published in journals with wider circulation that are indexed in Medline. Furthermore, our search strategy included the screening of the bibliographic references of the review articles addressing the cardiovascular risk factors, fulfilling a potential gap of information due to smaller studies published in non-indexed journals. Since successful publication is not likely to be determined by the prevalence of a condition, we do not expect publication bias to be a major issue in this review.

Although the lack of some methodological information in some reports impaired an appropriate detailed characterization of all studies (Supplementary appendix, available online), those that failed to report on methodological characteristics deemed essential to interpret the evidence were excluded from our review.

In the included studies, we observed a considerable heterogeneity across the investigations, regarding target populations, methods for determining blood glucose and criteria for defining diabetes. Since some studies referred to selected population samples, such as primary health care users, we

Table 1 – Prevalence of self-reported diabetes and mean fasting glucose, predicted from linear regression models of each outcome on participants' age and year of survey, for specific ages, in women and men.

	Year	Women			Men		
		30 years	50 years	70 years	30 years	50 years	70 years
Prevalence of self-reported diabetes[a]	1987	2.0 (0.0–4.4)	4.3 (1.2–7.3)	6.6 (2.5–10.6)	1.6 (0.0–3.5)	3.0 (0.6–5.4)	4.4 (0.7–8.1)
% (95% CI)	2009	1.4 (0.0–3.9)	8.6 (6.8–10.4)	15.8 (12.7–19.0)	1.8 (0.0–4.1)	9.4 (8.2–10.7)	17.0 (14.7–19.4)
[11 studies, 65 age- and sex-specific estimates]							
Mean fasting glucose	1987	82 (81–83)	89 (86–92)	96 (89–103)	86 (83–88)	95 (88–102)	104 (92–115)
mg/dL (95% CI)	2009	89 (82–95)	96 (93–98)	103 (101–104)	94 (86–103)	103 (95–112)	112 (102–123)
[4 studies, 28 age- and sex-specific estimates]							

95% CI – 95% confidence interval.
[a] This model includes an interaction term between the year of survey and participants' age.

performed a sensitivity analysis using only the results from the studies involving samples of the general population (data not shown). Since the conclusions remained the same, we kept all studies in our final analysis. We aimed at including studies that considered samples of the Portuguese population, however we cannot ensure that migrants were excluded in all samples since this specific information was hardly ever reported in the original studies, precluding the evaluation of its potential impact in our results. Additionally, we included the geographical coverage of the studies as an independent variable in the models, but the results also did not change meaningfully. In statistical analyses on mean blood glucose, we excluded studies based on random blood glucose, but no other quality indicators such as duration of fasting or laboratory methods were considered in model fitting, since they were not systematically reported in the primary studies. Assessment of trends using population-based studies must take these factors into account, either by restricting to comparable criteria or by converting scales when possible. The heterogeneity of the criteria used in primary studies for diagnosis of diabetes precluded a quantitative analysis of trends in objectively defined diabetes in our study. However, this partially results from the continuous debate on and refinement of such criteria, with diabetes definitions varying among expert committees and over time.[40,41] Changes in criteria for diagnosis over time are also expected to directly influence the prevalence of self-reported diabetes. However, the awareness of a diagnosis of diabetes is intimately related with the need for pharmacologic treatment and the threshold for initiation of treatment is expected to depend on the overall risk and not only on blood glucose levels. Therefore, despite the impossibility of knowing the specific contribution of the proportion of people with diabetes, the proportion of diabetics diagnosed and the awareness of patients diagnosed to the change in the prevalence of self-reported diabetes over time, this reflects a complex construct whose relevance goes beyond having blood glucose above a specified cut-off. The interpretation of the trends in self-reported diabetes should be made in light of this perspective. Therefore, although the fluctuations in the diagnostic criteria for diabetes could affect the decision to treat at individual level and the prevalence of diabetes at a population level, the public health implications remain largely unaffected, since the cardiovascular risk associated with the serum glucose level will not depend on using one cut-off vs another.

We have considered being on treatment for diabetes as an equivalent criterion of self-reported diabetes and previous diagnosis of diabetes. A sensitivity analysis excluding the only study that used this criterion yielded virtually the same results. Additionally, we were not able to ensure that the self-reported diabetes only included type 2 diabetes. However, since the analysis regarded adult populations and there is no reason to believe that the prevalence of type 1 diabetes changed visibly during this period, we assumed that trends in self-reported diabetes reflect mainly changes in type 2 diabetes.

Unfortunately, we were not able to quantify trends in objectively defined diabetes, which precludes definite conclusions on the trends of diabetes. However, considering the trends in mean glucose levels, we may hypothesize a high burden of this disease in the Portuguese population in the time span considered. This is further supported by the increase in the prevalence of self-reported diabetes, which is likely to reflect both an increase in the awareness of diabetes and the trend towards higher mean levels of blood glucose. Current guidelines for the diagnosis of diabetes recommend a cut-off of fasting plasma glucose of 126 mg/dL. The absolute level of mean fasting glucose reported in this study was 93.4 mg/dL overall and in older ages approximated a lot to the diagnostic cut-off. Our results are in accordance with the trends in Western European populations, reported by a recent pooled analysis that assessed the variation in mean fasting glucose since 1980 worldwide.[8]

Despite men's higher mean glucose levels at all ages, we did not find differences in self-reported prevalence of diabetes by sex. We hypothesize that this pattern results from a lower use of health care services particularly primary care,[42] resulting in a lower proportion of diagnosis and consequently lower awareness among men.[14]

The time trends in prevalence of diabetes and mean glucose levels observed in our review are likely to be driven by the variation in exposure to important determinants of type 2 diabetes, such as physical inactivity, unhealthy diet and obesity.[43–45] In Portugal, there are no robust data on the trends in physical activity levels. However, data from the National Health Survey of 1998–1999 showed that 71% of the Portuguese adult population was sedentary.[11] The dietary pattern in the country markedly changed in the last decades, towards a more westernized diet.[46] The prevalence of overweight increased 3% and 4%, and the prevalence of obesity increased 7% and 1% among women and men, respectively, between 1995 and 2005, resulting in more than 40% of the Portuguese adults being overweight and around 20% obese in 2005. Specifically overweight and obesity markedly increased among young subjects between 1986 and 2000.[17] The apparent contrast with the constant prevalence of self-reported diabetes among young adults in the current study is likely related with a lower attendance to health care services and a considerable proportion of undiagnosed subjects at such young ages cannot be ruled out, since diabetes can remain asymptomatic for many years.[40] The variation in the mean glucose levels results from the balance between changes in lifestyles and in the uptake of anti-diabetic medications. The increase in prevalence of self-reported diabetes is expected to be accompanied by an increase in the uptake of pharmacological treatment, contributing to lower fasting glucose in treated diabetic patients. The estimates of mean glucose levels come from the whole samples, which also include treated diabetics, and thus reflect the true trend in population's risk, including primary and secondary prevention perspectives.

Numerous studies have found an inverse relation between the incidence of type 2 diabetes and education, occupation, and income,[47] putting people in lower socio-economic positions at a particularly high risk. This effect is particularly worrisome in the current scenario of economic and financial crisis which Portugal is going through, translated into increased unemployment, lower purchase power to access healthy foods and use of private physical activity facilities, and a general decrease in the quality of life of the population.[48]

The study of the trends of diabetes in Portugal contributed to an updated overview of the burden of diabetes in a Southern European country. These data provide information to support the need of evidence-based policies to implement effective public health interventions addressing diabetes as well as its determinants. The reported increase in prevalence of self-reported diabetes and mean fasting glucose requires the implementation of effective strategies to promote whole-population changes in body weight, regular physical activity and healthy diet as measures to prevent or delay the onset of type 2 diabetes.

Author statements

Acknowledgements

The authors gratefully acknowledge the availability of Dr. Elisabete Alves, Professor Doutor Henrique Barros, Dr. Daniel Bonhorst, Professor Doutor Massano Cardoso, Dr. Helena Cid, Dr. Luís Gardete Correia, Dr. Sofia Correia and Dr. Luís Negrão, who provided the age- and sex-stratified data from their original studies in a format different from that available on publications; and Catarina Vales and Vânia Rocha who helped in the screening of reference lists and data extraction.

Ethical approval

No ethical approval was needed for this study.

Funding

This study was funded by two grants from Fundação para a Ciência e a Tecnologia (PIC/IC/83006/2007 and PTDC/SAU-EPI/122460/2010).

Competing interests

None declared.

REFERENCES

1. *IDF Diabetes Atlas*. International Diabetes Federation; 2012.
2. Manuel DG, Schultz SE. Health-related quality of life and health-adjusted life expectancy of people with diabetes in Ontario, Canada, 1996–1997. *Diabetes Care* 2004;**27**:407–14.
3. Haffner SM, Lehto S, Ronnemaa T, Pyorala K, Laakso M. Mortality from coronary heart disease in subjects with type 2 diabetes and in nondiabetic subjects with and without prior myocardial infarction. *N Engl J Med* 1998;**339**:229–34.
4. Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. *Circulation* 2002;**106**:3143–421.
5. Colhoun HM, Lee ET, Bennett PH, Lu M, Keen H, Wang SL, Stevens LK, Fuller JH. Risk factors for renal failure: the WHO multinational study of vascular disease in diabetes. *Diabetologia* 2001;**44**(Suppl. 2):S46–53.
6. Centers for Disease Control and Prevention. Blindness caused by diabetes – Massachusetts, 1987–1994. *MMWR Morb Mortal Wkly Rep* 1996;**45**:937–41.
7. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, Singh GM, Gutierrez HR, Lu Y, Bahalim AN, Farzadfar F, Riley LM, Ezzati M. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet* 2011;**377**:557–67.
8. Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, Lin JK, Farzadfar F, Khang YH, Stevens GA, Rao M, Ali MK, Riley LM, Robinson CA, Ezzati M. National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2.7 million participants. *Lancet* 2011;**378**:31–40.
9. Instituto Nacional de Estatística. *Inquérito Nacional de Saúde 1987*; 1989.
10. Instituto Nacional de Estatística, Instituto Nacional de Saúde Dr. Ricardo Jorge. *Inquérito Nacional de Saúde 1995–1996*; 1997.
11. Instituto Nacional de Estatística, Instituto Nacional de Saúde Dr. Ricardo Jorge. *Inquérito Nacional de Saúde 1998–1999*; 2000.
12. Instituto Nacional de Estatística, Instituto Nacional de Saúde Dr. Ricardo Jorge. *Inquérito Nacional de Saúde 2005–2006*; 2009.
13. Perdigão C, Rocha E, Duarte JS, Santos A, Macedo A. Prevalence and distribution of the main cardiovascular risk factors in Portugal – the AMALIA study. *Rev Port Cardiol* 2011;**30**:393–432.
14. Gardete-Correia L, Boavida JM, Raposo JF, Mesquita AC, Fona C, Carvalho R, Massano-Cardoso S. First diabetes prevalence study in Portugal: PREVADIAB study. *Diabet Med* 2010;**27**:879–81.
15. Fiuza M, Cortez-Dias N, Martins S, Belo A. Metabolic syndrome in Portugal: prevalence and implications for cardiovascular risk-results from the VALSIM study. *Rev Port Cardiol* 2008;**27**:1495–529.
16. Pereira M, Carreira H, Azevedo A, Lunet N. Trends in hypertension prevalence (1990–2005) and mean blood pressure (1975–2005) in Portugal: a systematic review. *Blood Press* 2012;**21**(4):220–6.
17. Carreira H, Pereira M, Azevedo A, Lunet N. Trends of BMI and prevalence of overweight and obesity in Portugal (1995–2005): a systematic review. *Public Health Nutr* 2012;**28**:1–10.
18. Carreira H, Pereira M, Alves L, Lunet N, Azevedo A. Dyslipidaemia, and mean blood cholesterol and triglycerides levels in the Portuguese population: a systematic review. *Arq Med* 2012;**26**(3):112–23.
19. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. *Diabetes Care* 1998;**21**:1414–31.
20. dos Reis RP, dos Reis HP. Cardiovascular risk factors in the list of patients of a general practitioner. *Rev Port Cardiol* 1990;**9**:607–12.
21. Direcção Geral da Saúde – Divisão de Epidemiologia e Bioestatística. *Epidemiologia da Diabetes – Prevalência e incidência das suas complicações numa coorte de diabéticos Portugueses. Fase I – Estudo Transversal*; 1993.
22. Martins M, Rodrigues MO, Almeida MC, Fonseca A. Os resultados dos exames laboratoriais nos inquéritos CINDI n.° 1 (1987) e n.° 2 (1993). *Arquivos INSA* 1993;**19**.
23. Ribas MJ, Ramos JF. Detecção de Factores de Risco de Cardiopatia Isquémica – Estudo de uma lista de utentes. *Cardiologia-Actual* 1997;**7**:1911–9.
24. Canhão P, Falcao F, Pinho e Melo T, Ferro H, Ferro J. Vascular risk factors for perimesencephalic nonaneurysmal subarachnoid hemorrhage. *J Neurol* 1999;**246**:492–6.
25. Cardoso J, Mendonça M. Factores de Risco para Doença Aterosclerótica numa Força de Segurança Pública da Região Centro. *Cardiologia-Actual* 1999;**9**:2663–72.

26. Instituto de Alimentação Becel. *Estudo Epidemiológico de Caracterização do Perfil Lipídico da População Portuguesa: Fundação Portuguesa de Cardiologia, Sociedade Portuguesa de Ateroesclerose*. Instituto Becel; 2001.
27. Fundação Portuguesa de Cardiologia. *Estudo Alto-Mar. Caracterização da População Portuguesa seguida em consulta de clínica geral com Alto e Muito Alto Risco Cardiovascular*; 2002.
28. Macedo A, Jorge Z, Lacerda Nobre E, Pratas S, Jacome de Castro J. Prevalence of type 1 diabetes mellitus in Portugal, 1995–1999: cohort of young men. *Diabet Med* 2003;**20**:418–9.
29. Santiago LM, Serra e Silva P. Coronary heart disease risk: the results of population screening by the Central Region Branch of the Portuguese Heart Foundation. *Rev Port Cardiol* 2003;**22**:1039–48.
30. Rocha E, Mello e Silva A, Nogueira P. Relation between hypertension and cardiovascular events-implications for coronary prevention. *Rev Port Cardiol* 2003;**22**:1215–24.
31. Teles AG, Carreira M, Alarcao V, Sociol D, Aragues JM, Lopes L, Mascarenhas M, Costa JG. Prevalence, severity, and risk factors for erectile dysfunction in a representative sample of 3,548 Portuguese men aged 40 to 69 years attending primary healthcare centers: results of the Portuguese erectile dysfunction study. *J Sex Med* 2008;**5**:1317–24.
32. Freitas AI, Mendonca I, Brion M, Sequeira MM, Reis RP, Carracedo A, Brehm A. RAS gene polymorphisms, classical risk factors and the advent of coronary artery disease in the Portuguese population. *BMC Cardiovasc Disord* 2008;**8**:15.
33. Brandão MP, Pimentel FL, Silva CC, Cardoso MF. Risk factors for cardiovascular disease in a Portuguese university population. *Rev Port Cardiol* 2008;**27**:7–25.
34. Correia S, Dinis P, Rolo F, Lunet N. Prevalence, treatment and known risk factors of urinary incontinence and overactive bladder in the non-institutionalized Portuguese population. *Int Urogynecol J Pelvic Floor Dysfunct* 2009;**20**:1481–9.
35. Lobão A, Marques P, Leite C, Almeida M, Araujo P, Cardoso V, Pinto ME, Vidal F. Smoking and cardiovascular risk factors in Barao do Corvo Health Center. *Acta Med Port* 2010;**23**:159–66.
36. Bonhorst D, Mendes M, Adragao P, De Sousa J, Primo J, Leiria E, Rocha P. Prevalence of atrial fibrillation in the Portuguese population aged 40 and over: the FAMA study. *Rev Port Cardiol* 2010;**29**:331–50.
37. Santos AC, Severo M, Barros H. Incidence and risk factors for the metabolic syndrome in an urban South European population. *Prev Med* 2010;**50**:99–105.
38. Alves E, Lunet N, Correia S, Morais V, Azevedo A, Barros H. Medical record review to recover missing data in a Portuguese birth cohort: agreement with self-reported data collected by questionnaire and inter-rater variability. *Gac Sanit* 2011;**25**:211–9.
39. Oliveira-Martins S, Oliveira T, Gomes JJ, Caramona M, Cabrita J. Factors associated with arterial hypertension in pharmacy users in Portugal. *Rev Saude Publica* 2011;**45**:136–44.
40. Rydén L, Standl E, Bartnik M, Van den Berghe G, Betteridge J, de Boer M, Cosentino F, Jonsson B, Laakso M, Malmberg K, Priori S, Ostergren J, Tuomilehto J, Thrainsdottir I. Guidelines on diabetes, pre-diabetes, and cardiovascular diseases: executive summary. *Eur Heart J* 2007;**28**:88–136.
41. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2012;**35**:S64–71.
42. Giraldes MR. Desigualdades regionais nos subsistemas de saúde em Portugal. *Análise Social* 2002;**XXXVII**:939–47.
43. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG, Willett WC. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med* 2001;**345**:790–7.
44. Holbrook TL, Barrett-Connor E, Wingard DL. The association of lifetime weight and weight control patterns with diabetes among men and women in an adult community. *Int J Obes* 1989;**13**:723–9.
45. Chan JM, Rimm EB, Colditz GA, Stampfer MJ, Willett WC. Obesity, fat distribution, and weight gain as risk factors for clinical diabetes in men. *Diabetes Care* 1994;**17**:961–9.
46. Marques-Vidal P, Ravasco P, Dias CM, Camilo ME. Trends of food intake in Portugal, 1987–1999: results from the National Health Surveys. *Eur J Clin Nutr* 2006;**60**:1414–22.
47. Lee TC, Glynn RJ, Pena JM, Paynter NP, Conen D, Ridker PM, Pradhan AD, Buring JE, Albert MA. Socioeconomic status and incident type 2 diabetes mellitus: data from the Women's Health Study. *PLoS One* 2011;**6**:e27670.
48. *The financial crisis and global health*. Geneva: World Health Organization; 2009.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.puhe.2013.12.009.