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Prevalence of Abdominal Aortic Aneurysm in Men Aged 65—74 Years in a Metropolitan Area in North-East Spain

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WHAT THIS PAPER ADDS

The prevalence of abdominal aortic aneurysm (AAA), detected by measuring the internal diameter, in men aged 65—74 years in a Metropolitan area in north-east Spain was 2.3% (95% CI 1.30—3.77%). This low prevalence is consistent with previous reports in northern Europe during the past decade. AAA diagnosis was associated with smoking, myocardial infarction and being taller than the median. The association with height might have implications for the definition of AAA in a southern European population.

Background: A declining prevalence of AAA and a shift in the distribution towards the older population have been observed during the last decade in Europe. The aim was to estimate the current screening prevalence of AAA in men aged 65—74 years in a metropolitan area in north-east Spain and to identify associated risk factors.

Methods: A cross sectional prevalence study in men registered in L'Hospitalet Primary Healthcare Services (Barcelona, Spain) was performed. There were 619 randomly selected subjects (expected prevalence of aneurysm, 5%; accuracy of estimation, $\pm$2%; loss to follow up, 30%). Exclusion criteria were life expectancy $<$1 year, limited quality of life, previous diagnosis of AAA, prior aorto-femoral surgery, and non-Caucasian. The following were measured: internal diameter of the infrarenal abdominal aorta using ultrasound, cardiovascular risk factors, personal (heart disease, stroke, peripheral vascular disease) and family history (AAA), physical examination, and blood tests. We estimated the prevalence and 95% confidence interval of AAA, and used logistic regression analysis to identify risk factors for AAA.

Results: Among the 651 individuals included in the analysis the prevalence of aneurysm was 2.30% (95% CI, 1.30—3.77%). In the regression analysis, AAA was associated with smoking (0—10, 11—20, or $>$20 cigarettes/day), diagnosis of myocardial infarction, and being taller than the median (165 cm).

Conclusions: The current screening prevalence of AAA among men aged 65—74 years in a metropolitan area in north-east Spain is similar to that in northern Europe. Smoking, myocardial infarction, and height were associated with the presence of AAA.

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INTRODUCTION

Abdominal aortic aneurysm (AAA) is a widening of the abdominal aorta that is often asymptomatic. The main risk is rupture, which has a prehospital mortality rate of 59—83%.[1] AAA can be diagnosed non-invasively using abdominal ultrasound, which has 95% sensitivity and almost 100% specificity.[1,2] Ultrasound studies indicate that AAA has a prevalence of 4.1—14.2% and 0.35—6.2% among men and women over 65 years of age, respectively.[3,4] The main risk factors are reported to be male gender, advanced age, and

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smoking.[1,3,4] A positive family history of AAA, coronary artery disease, cerebrovascular disease, atherosclerosis, hypercholesterolemia, and hypertension has also been found to be associated with AAA, and diabetes mellitus is a protective factor.[1,3,4] Various systematic reviews have shown a 40–50% reduction in AAA mortality as a result of screening programs among men at 65 years of age, although it is not clear whether these programs improve all-cause mortality, and the results are still the subject of debate.[1,5–7]

Screening programs implemented in various countries in Europe during the last decade, and other studies, have highlighted a decline in the prevalence of detected AAA, currently reported to be 1.8–2.6% at 65 years of age.[8–11] An epidemiological change has also been observed, with increasing numbers of admissions for non-ruptured aneurysms and elective surgery in individuals over 75 years, and decreasing numbers in younger individuals,[12] suggesting a shift in the distribution of AAA towards the older population. These changes are thought mainly to be due to a decrease in the prevalence of smoking, the main modifiable risk factor for AAA,[9,10,12,13] and increased life expectancy, which lengthens the period for development of the disease.

In light of these changes, it might be necessary to reassess screening strategies for AAA, particularly the screening age for men. Therefore, it is now especially important to know the current prevalence of AAA among 65–74 year old men and the associated risk factors. A study conducted among 65 year old men in a rural area in the north of Spain in 2009 reported an AAA prevalence of 4.7%,[14] which is relatively high. This study measured the maximum external diameter; a 2–5 mm difference between the external and internal diameters[2,15] can result in a marked difference in prevalence estimates. More recently, another study performed among 65–80 year old men in a rural health care center in Spain reported a prevalence of 3.3% (95% CI, 1.1–5.5%).[16] In this case, ultrasound measurements were performed by general practitioners without diameter specification and the results have yet to be validated.

The objective of the present study was to estimate the current prevalence of AAA in men aged 65–74 years in a metropolitan area in north-east Spain using ultrasound measures of the internal diameter of the aorta, and to identify associated risk factors.

METHODS

We performed a cross sectional prevalence study. Our target population was the 12,122 men aged 65–74 years registered at the 13 centers of the L'Hospitalet Primary Health Services, Barcelona, an urban area with a total population of 251,848 (municipal register 2007). We computed a required sample size of 619 subjects, assuming a population prevalence of 5%,[3,4] 5% bilateral alpha risk, 2% accuracy, and 30% loss to follow up. Subjects were selected according to a computer based random sampling process from the registered lists of the 13 primary care centers. The number of subjects was proportional to the registered population in each center. An invitation letter was sent to all subjects explaining the objective and the procedures of the study, and informing them that they would be contacted to arrange an interview at the health care center. A telephone number was also included for further information. A reminder letter was sent after 2 months. The exclusion criteria were severe disease (life expectancy < 1 year), limited quality of life (home care, institutionalization, or Barthel index < 90), previous diagnosis of AAA, aorto-femoral surgery, and non-Caucasian ethnicity (initially established by phone according to birthplace and confirmed during the interview). This group was excluded to ensure sample homogeneity because of the high predominance of Caucasian origin and reported differences in AAA prevalence according to ethnicity.[17,18] Data were collected during interviews conducted by five general practitioners visiting the various health care centers, by reviewing clinical histories, and by physical examination; an appointment for blood extraction was issued if there were no available data for the previous 6 months. Aortic ultrasound was performed at the reference center by four specialists in radiology.

Following a pilot study, interviews were conducted between September 2007 and June 2010.

Variables

Aneurysm was defined as a maximum internal aortic diameter (infrarenal, anteroposterior, or transverse) ≥ 30 mm. We also collected data on age, anthropometric measures (height, weight, body mass index [BMI] $=$ kg/m^2, body surface area,[19] and waist circumference measured at the iliac crest), systolic and diastolic blood pressure (mean of two measures), smoking (non-smoker, active smoker, ex-smoker; number of pack-years), and blood assays (total, low-density lipoprotein [LDL] and high-density lipoprotein [HDL] cholesterol, triglycerides, and glycemia in mmol/L). We considered hypertension (previous coded diagnosis, or pharmacologic treatment), diabetes mellitus (DM) (previous coded diagnosis or pharmacologic treatment), hypercholesterolemia (total cholesterol ≥ 6.2 mmol/L or pharmacologic treatment), obesity (BMI ≥ 30 kg/m^2), abdominal obesity (waist circumference > 102 cm), and metabolic syndrome.[20] Data on personal history of cardiovascular diseases (angor pectoris, myocardial infarction, intermittent claudication, cerebral vascular disease) were obtained from clinical histories, and family history from the clinical interview.

All participants were thoroughly informed about the aims of the study during the first visit, and gave written consent. The study protocol was approved by the Clinical Research Ethics Committee of Jordi Gol Institute for Primary Care Research (Institut d'Investigació en Atenció Primària [IDIAP]) (7Z07/001).

Statistical analysis

We performed a descriptive analysis, computing mean and standard deviation, measures for quantitative variables, and proportions with 95% CI for qualitative variables. Smoking was analyzed using the following variables: habit (non-smoker; active, or ex-smoker), tobacco consumption in active smokers and ex-smokers (cigarettes/day), and a variable that combines habit and consumption (0—10 cigarettes/day; 11—20 cigarettes/day, >20 cigarettes/day). The prevalence and 95% CI of AAA were calculated in this sample. The association between variables and the diagnosis of AAA was tested using the chi-test for qualitative variables; the Student *t*-test was used for quantitative variables (or the Mann—Whitney U-test, a non-parametric alternative for non-normally distributed variables). To identify independent predictors of AAA, a logistic regression analysis was performed including all clinically relevant variables or those with $p \leq .10$ in the bivariate analysis. All statistical analyses were performed using PASW Statistics v19 (SPSS, Chicago, IL, USA).

RESULTS

The process of subject selection used in this study is shown in Fig. 1. Of all eligible subjects, 67% agreed to participate; no difference was observed in age between individuals who were included and those who were not (70.2 ± 2.6 vs. 70.3 ± 2.8 years respectively, $p = .6$). Among included individuals, there were no differences in age, risk factors (hypertension, DM, smoking), or cardiovascular disease between subjects with and without an ultrasound result.

The final sample included 651 subjects with a mean age of 70.2 ± 2.6 years; overall, 18.3% of individuals were active smokers, 31.6% obese, 53.3% hypertensive, 24.5% diabetic and 22.7% had some cardiovascular disease (Table 1).

AAA was diagnosed in 15 subjects (30—44 mm, 14 cases; 45—54 mm, 1 case), corresponding to a prevalence of 2.3% (95% CI, 1.30—3.77%). The mean maximum interior aortic diameter was 34.8 ± 5.0 mm and 19.2 ± 2.9 mm in individuals with and without AAA, respectively. A histogram of aortic diameters is shown in Fig. 2.

No significant differences were observed in age between individuals with and without AAA (70.2 ± 3.0 and 70.2 ± 2.6 years, respectively; $p = .96$). Regarding anthropometric characteristics, individuals with AAA were generally taller (higher proportion of individuals taller than the median, 165 cm), had greater body surface area, waist circumference, and abdominal obesity ($p < .05$, Table 1). No aneurysms were detected in non-smokers (AAA prevalence in smokers/ex-smokers 3.22%; 95% CI, 1.81—5.25%). The percentage of smokers/ex-smokers was higher in individuals with AAA, as was the number of cigarettes smoked per day (21.1 ± 7.2 in AAA vs. 16.2 ± 11.4 in no AAA; $p < .05$) and pack-years (35.4 ± 14.1 vs. 27.4 ± 23.1; $p < .05$), but not the number of years smoking (35.5 ± 11.6 vs. 31.6 ± 14.6; $p > .05$) or the number of years since quitting (17.2 ± 8.2 vs. 18.9 ± 11.3; $p > .05$). No significant differences were observed between individuals with and without AAA in the prevalence of hypertension, DM, hypercholesterolemia, metabolic syndrome, or cardiovascular disease, with the exception of myocardial infarction, which was higher in individuals with AAA ($p < .05$).

Only two subjects had a family history (first-degree relatives) of AAA, and both had a normal aortic diameter (≤24 mm).

Finally, logistic regression analysis indicated that smoking (combined habit and consumption variable), myocardial infarction, and being taller than the median were significantly associated with the presence of AAA (Table 2).

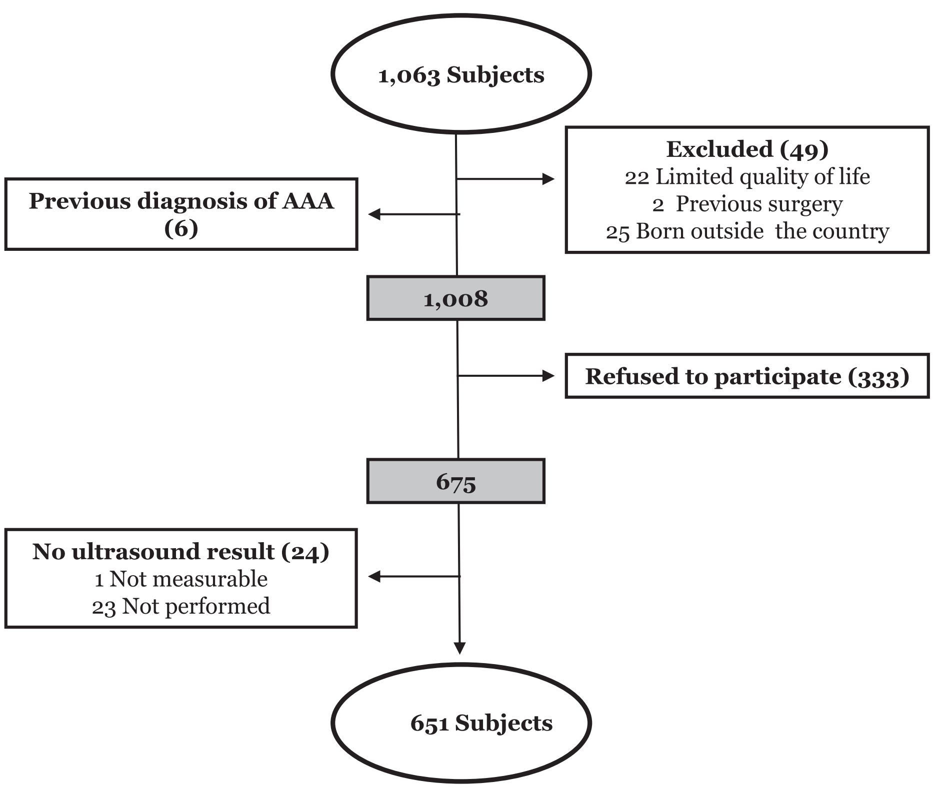

Figure 1. Subject selection process.

Table 1. Characteristics of 65- to 74-year-old men included in this study ($n = 651$), overall and according to the presence of AAA.

	n	Overall ($n = 651$) Mean ± SD or % (CI 95%)	No AAA ($n = 636$) Mean ± SD or % (CI 95%)	AAA ($n = 15$) Mean ± SD or % (CI 95%)	p
Age (years)	651	70.2 ± 2.6	70.2 ± 2.6	70.2 ± 3.0	0.96
Weight (kg)	651	78.3 ± 11.3	78.1 ± 11.2	83.9 ± 14.1	0.07
Height (cm)	651	165.3 ± 5.9	165.3 ± 5.6	167.9 ± 6.2	0.12
Height > 165 cm	651	47.5 (43.6–51.3)	46.9 (43.0–50.7)	73.3 (48.1–89.1)	0.04
BMI (kg/m^2)	651	28.6 ± 3.7	28.6 ± 3.7	29.6 ± 3.9	0.30
BSA (m^2)	651	1.86 ± 0.14	1.85 ± 0.14	1.90 ± 3.2	0.03
Waist circumference (cm)	646	99.2 ± 8.9	99.1 ± 8.9	103.8 ± 7.4	0.02
Obesity	651	31.6 (28.2–35.3)	31.4 (28.0–35.2)	40.0 (19.8–64.3)	0.58
Abdominal obesity	646	34.7 (31.1–38.4)	34.1 (30.5–37.9)	60.0 (35.8–80.2)	0.05
SBP (mmHg)	651	139.0 ± 15.3	139.0 ± 15.3	137.7 ± 12.7	0.64
DBP (mmHg)	651	77.8 ± 8.6	77.8 ± 8.6	79.2 ± 8.2	0.38
Total Cholesterol (mmol/L)	637	5.1 ± 0.9	5.1 ± 0.9	4.9 ± 0.9	0.53
LDL Cholesterol (mmol/L)	599	3.1 ± 0.8	3.1 ± 0.8	2.9 ± 0.8	0.61
HDL Cholesterol (mmol/L)	601	1.4 ± 0.4	1.4 ± 0.4	1.4 ± 0.4	0.88
Triglycerides (mmol/L)	605	1.4 ± 0.7	1.4 ± 0.7	1.5 ± 0.6	0.24
Smoking habit	651				0.01
Smoker/ex-smoker	466	71.6 (67.9–75.0)	70.9 (67.3–74.3)	100 (79.6–100)	
No-smoker	185	28.4 (25.0–32.1)	29.1 (25.7–32.7)	0.0 (0.0–20.4)	
Tobacco consumption	631				<0.0005
0–10 cigarettes/day	378	58.1 (56.1–63.7)	61.2 (57.4–65.0)	6.7 (0.2–32.0)	
11–20 cigarettes/day	177	27.2 (24.5–31.6)	27.1 (23.6–30.6)	66.7 (38.4–88.2)	
>20 cigarettes/day	76	11.7 (9.5–14.6)	11.7 (9.2–14.2)	26.7 (7.8–55.1)	
Hypertension	651	53.3 (49.5–57.1)	53.1 (49.3–57.0)	60.0 (35.8–80.2)	0.80
DM	650	24.5 (21.3–27.9)	24.6 (21.4–28.1)	20.0 (7.1–45.2)	1
Hypercholesterolemia	651	45.2 (41.4–49.0)	44.8 (41.0–48.7)	60.0 (35.8–80.2)	0.30
Metabolic syndrome	651	31.6 (28.2–35.3)	31.1 (27.7–34.8)	53.3 (30.1–75.2)	0.09
Any cardiovascular disease	651	22.7 (19.7–26.1)	22.3 (19.3–25.7)	33.3 (15.8–58.3)	0.35
Angor pectoris	650	9.7 (7.5–12.2)	9.4 (7.4–12.0)	20.0 (7.1–45.2)	0.17
Myocardial infarction	651	6.9 (5.2–9.1)	6.4 (4.8–8.6)	26.7 (10.9–52.0)	0.02
CVD	650	9.2 (7.2–11.7)	9.4 (7.4–12.0)	0.0 (0.0–20.4)	0.38
Intermittent claudication	647	4.8 (3.4–6.7)	4.7 (3.3–6.7)	6.7 (1.2–29.8)	0.53

BMI: body mass index; BSA: body surface area; DBP: diastolic blood pressure; DM: diabetes mellitus; CVD: cerebral vascular disease; SD: standard deviation; SBP: systolic blood pressure.

DISCUSSION

In this sample, the prevalence of AAA detected by screening in men aged 65–74 years was 2.30%. Aortic diameter could be visualized in 99.8% of subjects, similar to previously reported rates.[1] The AAAs detected were small, all under the surgical threshold (55 mm), also as previously reported.[1,2]

The response rate, 67%, was within the range obtained in other population based studies of AAA,[8–10,14] and studies on risk factor prevalence performed in Spain.[21]

AAA screening studies performed over the past decade in Europe have observed a lower prevalence in men at 65 years, currently under 2%,[8–10] except in Scotland (5.1%),[22] an area with a high prevalence of ischemic cardiopathy,[23] which is associated with AAA. In Gloucestershire, UK,[8] the prevalence of AAA declined from 4.8% in 1990 to 1.1% in 2009. This decrease is mainly thought to be due to a decrease in smoking, as well as the generalization of preventive treatments for hypercholesterolemia and hypertension.[9,10,12,13] Lower screening-detected AAA prevalence has also been reported in older subjects, 2.3% in Swedish 70 year old men,[24] and more recently 3.3% in men aged 65–74 years in Denmark.[11]

Barba et al.[14] reported a much higher AAA prevalence in the north of Spain in 2008–2009 (4.7%; 4.35%, excluding known aneurysms), and suggested that this might be because the benefit of lower smoking rates was not yet apparent. The lower prevalence of AAA in this study is not explained by age, which was higher than that in Barba et al. (70.2 ± 2.6 vs. 65 years, respectively), or by the prevalence of the main risk factors (similar in both studies, with the exception of peripheral artery disease, which was 7.3% in Barba et al., and was diagnosed using the ankle–brachial index). Rather, this could be due to methodological differences, in that the internal diameter was measured in this study, whereas Barba et al. measured the external diameter; the difference between these diameters has been reported to be 2–5 mm.[2,15]

Risk factors associated with the diagnosis of AAA

Consistent with previous reports, tobacco consumption was the main risk factor for AAA in this study.[9,14,18,17,25–29] The excess in prevalence associated with smoking is estimated to be 71–78%;[9,17,18] some studies suggest that smoking intensity is more important than smoking duration,[27] while

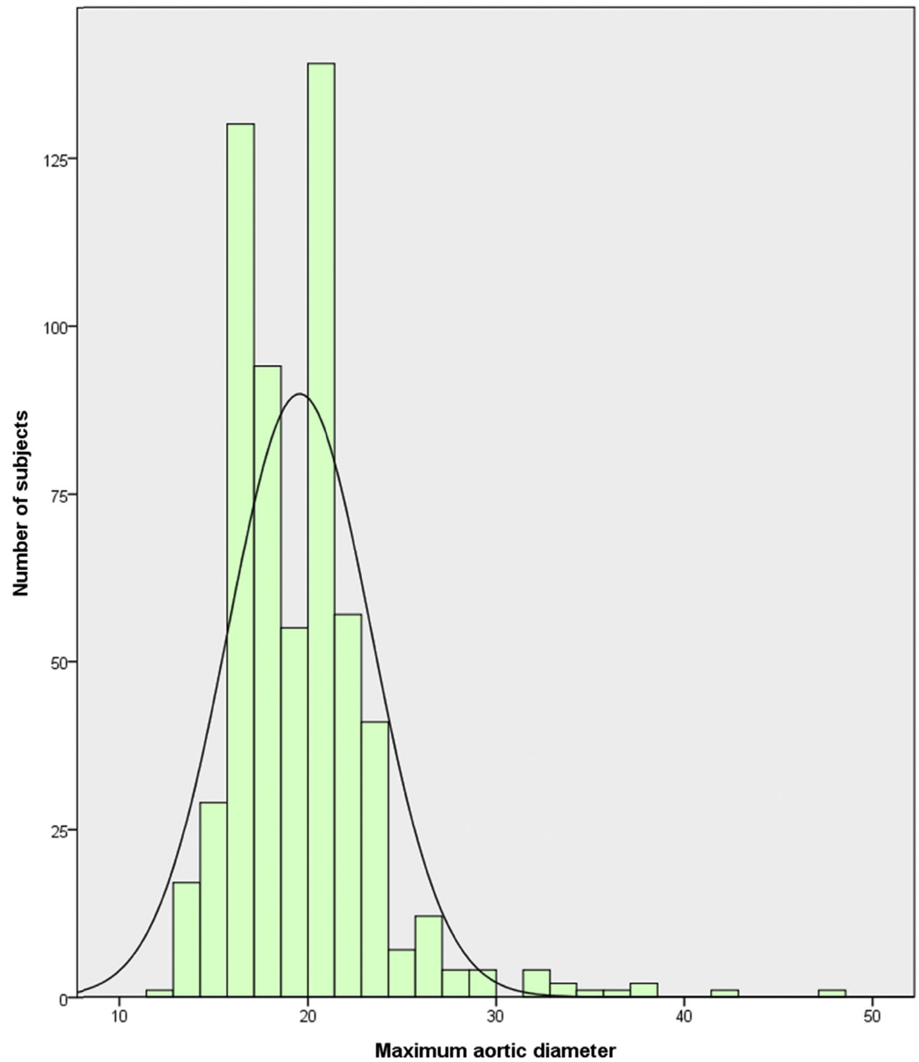

Figure 2. Aortic diameter distribution in the 65 to 74 year old men in the study.

others show the reverse.[30,31] Risk diminishes with time after quitting, although it persists for at least 10 years.[17,25] No aneurysms were observed in non-smokers, resulting in an AAA prevalence of 3.22% in smokers/ex-smokers. In the multivariate analysis, a significant association with AAA was only observed for the combined smoking variable, possibly due to the low number of cases.

An association was found between previous myocardial infarction and AAA, in line with several previous reports;[17,32,33] unlike in this sample, these previous studies also found an association with peripheral arterial disease[14,17,32] and cerebrovascular disease.[17]

Table 2. Independent predictors of AAA diagnosis in 65- to 74-year-old men included in this study ($n = 651$).

	Odds ratio	95% CI	*p*
Smoking			
0–10 cigarettes/day	1		0.017
10–20 cigarettes/day	20.4	2.6–162.2	0.004
>20 cigarettes/day	15.8	1.7–146.4	0.015
Myocardial infarction	5.1	1.4–18.4	0.013
Height > 165 cm	3.4	1.0–11.4	0.045

Various studies have described the association between AAA and anthropometric measures, including weight and height, together[34] or separately;[17] BMI;[18] waist circumference;[35] and between abdominal aorta diameter and body surface area.[36] The Western Australia Study[32] observed marked heterogeneity in the prevalence of AAA according to the individual's origin, with higher prevalence in those of Dutch or Scottish origin, and lower in those of Mediterranean origin, which was partially corrected by height for aneurysms larger than 5 cm. In this study, the association between AAA and being taller than the median suggests that height might be relevant for the diagnosis of AAA in a southern European population, with the standard diagnosis threshold of ≥3.0 cm diameter, which is usually considered to be greater than two standard deviations above the mean.[2]

Hypertension, DM, or hypercholesterolemia or related parameters analyzed in this study were not associated with AAA. Previous studies indicate that the association between hypertension and AAA is weaker than that between atherosclerosis and AAA.[3,37] DM has been shown to be a protective factor for AAA in some studies,[38] but without association in others.[9] Previous reports indicate an association between AAA and low HDL, but not with LDL.[39]

Limitations

The sample size was calculated for the main objective of estimating the prevalence of AAA, so this study may have insufficient power to detect differences between subjects with or without AAA. The low number of cases identified prevented the analysis of other interesting variables such as hypertension, statins, and antidiabetic treatments, and precluded their inclusion in the regression models; thus, the intervals for the odds ratios are large and the estimates should be interpreted with caution. A transversal study was performed, so the data for a specific time-point may not reflect the influence of factors during the period prior to the study. Intra- and inter-observer variability in ultrasound measures has been reported, with no evidence of superiority of anteroposterior or transverse diameters;[15] in the study they were performed by experienced radiologists but unfortunately neither intra- nor inter-variability was measured.

No significant difference was found in age between subjects who were included in the study and those who were excluded, nor in age or risk factors between subjects with and without an ultrasound result. The risk factor profile was similar to that in age-matched individuals who attended the l'Hospitalet Primary Care Services, and to that reported in other studies in the Spanish population[21] (Table S1, supplementary material). Therefore, it seems unlikely that this study has an important selection bias.

CONCLUSIONS

Using ultrasound screening to measure the internal diameter of the abdominal aorta, the prevalence of AAA in men aged 65—74 years in a Metropolitan area in north-east Spain was estimated to be 2.30% (95% CI, 1.30—3.77%), and it was found that AAA is associated with smoking, myocardial infarction, and being taller than the median. This low prevalence is consistent with previous reports in northern Europe over the past decade.

The association with height might have important implications for the definition of AAA in a southern European population and deserves further investigation. In addition, it would be desirable to reach a consensus on whether or not to use the internal or external diameter for the diagnosis of AAA, to enhance the comparability of different results.

CONFLICT OF INTEREST

None.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ejvs.2016.04.005.

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