

INCIDENCE OF ERECTILE DYSFUNCTION IN MEN 40 TO 69 YEARS OLD: RESULTS FROM A POPULATION-BASED COHORT STUDY IN BRAZIL

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ABSTRACT

Objectives. To estimate the incidence of erectile dysfunction (ED) in Brazilian men 40 to 69 years old at study entry during an average 2-year follow-up and study the effect of age, socioeconomic status, and medical conditions on the risk of developing ED.

Methods. We analyzed data from a randomly sampled cohort of men living in Salvador, Bahia (Brazil), a racially diverse city with a population of 2.3 million. A total of 602 men completed the baseline interview in 1998 and 501 completed follow-up in 2000. The analysis sample consisted of 428 (83.4%) of 513 men without ED at baseline. The men were interviewed in person, using a standardized questionnaire, and ED was assessed by a single global self-rating question.

Results. The crude incidence rate for ED was 65.6 cases per 1000 person-years (95% confidence interval 49.6 to 85.2). The incidence rate increased with age and was 33.3, 53.7, and 189.5 cases per 1000 person-years for men 40 to 49, 50 to 59, and 60 to 69 years old, respectively. The age-adjusted risk of developing new-onset ED was higher for men with lower education, diabetes, hypertension, and benign prostatic hyperplasia. Population projections for men 40 to 69 years old suggest that approximately 68,600 new cases of ED in Bahia and 1,025,600 in Brazil would be expected annually.

Conclusions. The incidence of ED in Brazilian men was 2.5-fold higher than that in the Massachusetts Male Aging Study (26/1000 person-years) and increased with age, lower education, diabetes, hypertension, and benign prostatic hyperplasia. UROLOGY 61: 431–436, 2003. © 2003, Elsevier Science Inc.

Erectile dysfunction (ED) is the consistent inability to achieve or maintain a penile erection adequate for satisfactory sexual performance.¹ ED is a widespread and common health problem affecting the well-being of middle-age and older men.^{1,2} The prevalence of ED in the United States

has been estimated to range from 10.4%³ to 52%,⁴ with nationwide projections from the Massachusetts Male Aging Study (MMAS) that ED could affect up to 18 million men.⁴ In Brazil, data from a large randomly sampled population-based survey indicated that 49% of men aged 40 to 69 years have ED.⁵ Despite the wealth of information on the prevalence of ED and its correlates, data on the incidence of ED are still scarce. Recently, the longitudinal results from the MMAS offered the first population-based estimates of ED incidence, as well as risk estimates for correlates of ED identified in previous cross-sectional studies.⁶ Nevertheless, knowledge of the epidemiology of ED is still incomplete and little is known regarding its incidence in relation to modifiable behaviors and selected medical conditions.

Estimates of ED prevalence, although useful to assess the burden of this condition in a population, cannot be used to estimate risk. We estimated the incidence of ED in a randomly sampled popula-

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TABLE I. Selected characteristics of the study cohort at baseline, Salvador, Bahia, Brazil, 1998–2000

Characteristic	Initial Cohort (n = 513)	Analysis Sample (n = 428)	Lost to Follow-up (n = 85)
Age (yr)			
40–49	274 (53.4)	225 (52.6)	49 (57.6)
50–59	154 (30.0)	131 (30.6)	23 (27.1)
60–70	85 (16.6)	72 (16.8)	13 (15.3)
Race			
White	109 (21.2)	81 (18.9)	28 (32.9)
Mixed	326 (63.5)	274 (64.0)	52 (61.2)
Black	78 (15.2)	73 (17.1)	5 (5.9)
Marital status			
Married or living with partner	431 (84.0)	362 (84.6)	69 (81.2)
Divorced, widowed, separated	57 (11.1)	47 (10.9)	10 (11.8)
Never married	25 (4.9)	19 (4.4)	6 (7.1)
Education (years of school attendance)			
≤4	159 (31.0)	136 (31.8)	23 (27.1)
5–11	176 (34.3)	152 (35.5)	24 (28.2)
≥12	178 (34.7)	140 (32.7)	38 (44.7)
Tobacco use			
No	152 (29.6)	133 (31.1)	19 (22.4)
Ever	193 (37.6)	161 (37.6)	32 (37.6)
Current	168 (32.7)	134 (31.3)	34 (40.0)
Medical conditions			
Diabetes	22 (4.3)	20 (4.7)	2 (2.4)
Hypertension	123 (24.0)	102 (23.8)	21 (24.7)
Heart disease	38 (7.4)	32 (7.5)	6 (7.1)
Ulcer	41 (8.0)	37 (8.6)	4 (4.7)
Depression	18 (3.5)	13 (3.0)	5 (5.9)
Benign prostatic hyperplasia	15 (2.9)	11 (2.6)	4 (4.7)

Data presented as number of respondents, with the percentage in parentheses.

tion-based cohort of aging men and sought to determine whether incidence varied with age, socioeconomic status (SES), and select chronic medical conditions.

MATERIAL AND METHODS

This was a prospective observational study of a population-based cohort of men conducted in Salvador, Bahia State, in northeastern Brazil. Salvador is the third largest city in Brazil, with a racially diverse population of 2.3 million.

STUDY POPULATION AND SAMPLING FRAME

In the baseline assessment (January to June 1998), we conducted a population-based survey in a cluster sample of men 40 to 70 years old, selected from a random list of census tracts representing all 16 administrative zones in the city of Salvador. Of the 654 men in the appropriate age groups identified, 52 men refused to participate. Thus, the study population at baseline was 602 men, and the initial response rate was 92%. The study design and the results of the baseline phase have been described in detail elsewhere.⁷

The follow-up assessment was performed from March to August 2000. Of the initial 602 respondents to the baseline survey, 501 (83%) completed the follow-up interview. Of the 101 excluded men, 19 were confirmed dead, 8 were seriously ill, 22 refused to participate, and 52 were lost to follow-up.

STUDY INSTRUMENT

A 40-item structured questionnaire was administered by a trained interviewer in person to each subject. All study participants provided written informed consent. The interview took 25 to 30 minutes to complete. All data were collected by self-report only. ED was assessed by a single previously validated question⁸ derived directly from the National Institutes of Health Consensus Conference¹ definition: "Using the following categories, how would you describe yourself? Always/usually/sometimes/never able to get and keep an erection adequate for satisfactory sexual intercourse." Responses were considered to represent "no," "mild," "moderate," and "complete" ED, respectively. For analysis, ED status was dichotomized into the absence or presence of moderate/complete ED.

The questionnaire also included potential sociodemographic and health-related determinants of ED. Men were classified as having a specific disease if they reported receiving a physician's diagnosis of that disease or if they were taking medications for the disease of interest.

STATISTICAL ANALYSIS

Of the 602 men at baseline, 89 reported moderate to complete ED (14.8%), leaving 513 at risk during follow-up. The analysis sample consisted of 428 (83.4%) of the 513 at-risk men available at follow-up.

Incidence density rates for ED were calculated as the number of new cases (defined as cases of moderate/complete ED at

TABLE II. Incidence rates and crude and age-adjusted relative risks for erectile dysfunction according to sociodemographic, medical, and lifestyle characteristics in 428 men, 1998–2000

Characteristic	Incidence/1000 person-years	Crude RR (95% CI)	Age-Adjusted RR (95% CI)
Age (yr)			
40–49	33.3	1 (referent)	
50–59	53.7	1.61 (0.79–3.29)	
60–70	189.5	5.69 (3.06–10.59)*	
Race			
White	61.7	1 (referent)	1 (referent)
Mixed	60.7	0.98 (0.49–1.97)	0.97 (0.48–1.97)
Black	89.0	1.44 (0.65–3.22)	1.41 (0.61–3.22)
Education (yr)			
≥12	36.9	1 (referent)	1 (referent)
5–11	66.2	1.79 (0.88–3.66)	1.83 (0.88–3.80)
≤4	100.8	2.73 (1.36–5.50)†	2.10 (1.01–4.39)‡
Monthly income [§]			
≥\$1100	43.6	1 (referent)	1 (referent)
\$500–\$1099	60.1	1.38 (0.63–3.03)	1.55 (0.69–3.49)
\$260–\$499	75.2	1.73 (0.81–3.66)	2.07 (0.95–4.49)
≤\$259	120.7	2.77 (1.07–7.17)‡	2.08 (0.77–5.64)
Medical conditions			
Diabetes			
No	61.4	1 (referent)	1 (referent)
Yes	153.0	2.49 (1.09–5.68)‡	2.87 (1.21–6.80)‡
Hypertension			
No	49.1	1 (referent)	1 (referent)
Yes	118.9	2.42 (1.43–4.08)†	2.42 (1.42–4.13)†
Heart disease			
No	63.2	1 (referent)	1 (referent)
Yes	96.6	1.53 (0.67–3.48)	1.98 (0.84–4.64)
Depression			
No	64.1	1 (referent)	1 (referent)
Yes	114.5	1.79 (0.59–5.40)	1.94 (0.60–6.26)
Benign prostatic hyperplasia			
No	62.5	1 (referent)	1 (referent)
Yes	185.9	2.98 (1.12–7.91)‡	1.83 (0.65–5.20)
Tobacco use			
Never	56.8	1 (referent)	1 (referent)
Ever	71.4	1.26 (0.66–2.38)	0.93 (0.49–1.80)
Current	67.7	1.19 (0.61–2.33)	1.11 (0.56–2.21)

KEY: RR = relative risk; CI = confidence interval.

* $P < 0.001$.

† $P < 0.01$.

‡ $P < 0.05$.

§ Monthly income in American dollars.

follow-up among men who were free of ED at baseline) divided by the number of person-years of follow-up. Person-years were defined as the number of years between the baseline and follow-up interviews multiplied by the number of men at risk of ED. Age-adjusted estimates of the relative risk of ED were computed using Cox regression analysis.⁹ In addition to the age-adjusted models, full multivariate models were also fitted, and nonsignificant ($P > 0.1$) variables were eliminated in a stepwise backward elimination algorithm, least significant first, to determine the final model. Exceptions were made for the medical variables, which were forced into the model because they were of primary interest in the study.

The annual number of new cases of ED expected in men 40 to 70 years old was estimated separately for Bahia State and Brazil. Data on age-specific prevalence estimates from the baseline survey were used to determine the proportion of men

free of ED for each decade of age. This proportion was then multiplied, for each age category, by the number of men in the population obtained from the 2000 national census data.¹⁰ The product represented the estimated number of men at risk of ED within each age decade. The number of men at risk was then multiplied by the study age-specific incidence rates to yield the expected number of new ED cases by age decade.

RESULTS

Selected characteristics of men in the baseline cohort, in the analysis sample, and in the lost to follow-up group are shown in Table I. This allows comparison of variable distributions from baseline to follow-up and assessment of how attrition and

TABLE III. Results of multivariate analysis, adjusted relative risks for erectile dysfunction in 428 men (1998–2000)

Characteristic	RR (95% CI)
Age (each year increment)	1.07 (1.04–1.11)*
Race	
White or mixed	1 (referent)
Black	1.14 (0.59–2.20)
Education (yr)	
≥12	1 (referent)
<12	1.94 (0.93–4.03)
Medical condition	
Diabetes	2.49 (1.01–6.14)†
Hypertension	1.89 (1.07–3.37)†
Heart disease	1.48 (0.58–3.77)
Depression	1.16 (0.33–4.07)
Benign prostatic hyperplasia	3.67 (1.17–11.48)†

Abbreviations as in Table II.

* $P < 0.001$.

† $P < 0.05$.

exclusion of selected groups might have affected the analysis sample. Men in the analysis sample were similar to those lost to follow-up.

The mean follow-up was 2.0 years (range 1.7 to 2.3). Overall, 56 new cases of ED were identified in 853 person-years of follow-up, for a crude incidence rate of 65.6 cases per 1000 person-years (95% confidence interval 49.6 to 85.2). The risk of ED increased with age; it was almost sixfold higher for men 60 to 69 years than for those 40 to 49 years old (Table II). The crude incidence of ED was also higher for men with less education (100.8 cases per 1000 person-years), lower monthly income (120.7), self-reported diabetes (153.0), hypertension (118.9), or benign prostatic hyperplasia (185.9).

Because age was so strongly related to ED, we examined the age-adjusted associations between baseline potential risk factors and incident ED. The adjusted relative risk of ED for men with low educational attainment (primary school or less) compared with those with high school or more was 2.10 (95% confidence interval 1.01 to 4.39). Subjects with self-reported diabetes and hypertension had a significant increase in risk of ED compared with those without these conditions at baseline (Table II).

The results of the full multivariate model analysis are displayed in Table III. Age was the strongest predictor of incident ED in the final model. Self-report of diabetes, hypertension, and benign prostatic hyperplasia were also found to increase the risk of ED significantly after controlling for other baseline variables.

When we applied the incidence estimates yielded by this study to the population of men 40 to 69

years old at risk in Bahia State, we found that approximately 68,600 new cases of ED are expected to occur annually. The corresponding estimate for Brazilian men 40 to 69 years old was approximately 1,025,600 new cases (Table IV).

COMMENT

Despite the wealth of information on the prevalence and correlates of ED, data on the incidence of ED are still sparse. To our knowledge, our study is second only to the MMAS follow-up study⁶ to provide population-based estimates of the incidence of ED from a randomly selected sample of aging men. Our study, however, includes a more racially diverse population than the MMAS. Consistent with previous cross-sectional studies on ED prevalence in Brazil^{5,11} and elsewhere,^{4,12–14} incident ED was strongly associated with age, inversely related to education, and increased in men with self-reported diabetes and hypertension. The relationship we found between ED and benign prostatic hyperplasia, however, is less well recognized.

Our estimate of ED incidence (65.6/1000 person-years) was 2.5-fold that of the MMAS longitudinal study (26/1000 person-years).⁶ Although men from the MMAS sample were in the same age range (40 to 69) and had a mean age similar to those in our sample (52.2 versus 50.9), subjects in the MMAS sample were different from the men in our analysis sample in respect to important characteristics that could have underestimated the incidence rates from that study.⁶ The MMAS population was healthier than our analysis sample, as suggested by fewer smokers (24% versus 31%) and fewer men with heart disease (4.0% versus 7.5%) and hypertension (12.3% versus 23.8%).⁶ All these factors have been implicated in ED in previous research.^{15–20}

Moreover, the 450 men excluded from the analysis in the MMAS incidence study were older and presented characteristics that would have put them at higher risk of ED than those remaining in the cohort.⁶ Thus, differential losses to follow-up might have occurred and biased the estimates in the MMAS sample. In addition, the longer mean follow-up time in the MMAS compared with our sample (8.8 years versus 2.0) might have led to an analysis cohort predominantly comprised of survivors, healthier than the excluded men, and therefore at lower risk of ED.⁶ Although the overall incidence rate estimates were different in the two studies, both indicated a strong association with age and also agreed that low education and selected medical conditions increase the risk of ED. The results from our sample were less affected by attrition and exclusion of selected groups, and there-

TABLE IV. Estimated number of new cases of erectile dysfunction annually in Bahia and Brazil, men 40 to 69 years old

Age Range (yr)	Men* (n)	Study Prevalence Erectile Dysfunction	Proportion Without Erectile Dysfunction	Men at Risk† (n)	Age-Specific Incidence Rate for Erectile Dysfunction‡	Expected New Erectile Dysfunction Cases (n)
Bahia men						
40–49	593,001	0.0930	0.9070	537,852	0.0333	17,914
50–59	408,169	0.1307	0.8693	354,821	0.0537	19,046
60–69	241,699	0.3083	0.6917	167,183	0.1895	31,675
Total	1,242,869			1,059,856		68,635
Brazil men						
40–49	9,416,000	0.0930	0.9070	8,540,312	0.0333	284,452
50–59	5,977,000	0.1307	0.8693	5,195,806	0.0537	278,906
60–69	3,527,000	0.3083	0.6917	2,439,626	0.1895	462,212
Total	18,920,000			16,175,744		1,025,570

* Based on 2000 census population data for men 40 to 69 years old in Bahia and Brazil.

† Calculated by multiplying the proportion without erectile dysfunction by the number of men in each age group.

‡ Estimated from our study data.

fore are more likely to have external validity (ie, to be more easily generalized to the population).

We found that new cases of ED are more likely to occur among men with lower income, particularly those with a lower level of education. Laumann *et al.*²¹ reported that a decrease in household income was associated with a twofold increase in the prevalence of ED. In the MMAS longitudinal study,⁶ the age-adjusted risk of developing ED was greater among less educated men (odds ratio 1.46; 95% confidence interval 1.02 to 2.08). Education is probably a surrogate for SES, other health behaviors, and social disparities, which could explain the higher incidence of ED in men with lower educational attainment. Despite the recognition of the association between low SES and a broad range of health issues, the relationship between SES and ED has not been well established. In a recent study, Aytac *et al.*²⁰ suggested that the effect of SES on ED might be, in part, mediated by its influence on lifestyle factors and medical conditions.

METHODOLOGIC MERITS AND LIMITATIONS

The present study was conducted during a 2-year mean interval in a randomly sampled population-based cohort of men, closely resembling the Brazilian male population aged 40 to 70 years. The response rate (92% at baseline, 83% at follow-up) was much higher than those typically achieved in comparable epidemiologic studies. The assessment of the presence of ED was based on the subject's response to a validated single global question, rather than on a physician's designation or physiologic test as typically used in clinical studies.

Because all interviews took place at the subjects' home, we avoided artifactual biases that commonly arise from the interaction of subjects with the med-

ical system. However, in interpreting the study findings, one limitation should be noted, illness at baseline was ascertained by self-report rather than a physician's diagnosis, and no attempt was made to validate respondents' answers with medical records. Commonly asymptomatic or oligosymptomatic medical conditions are often unknown by the subject and may be consequently underreported, which is likely to result in nondifferential misclassification and attenuation of the associations measured. Alternatively, if more severe illnesses were more likely to be reported, the relationships described here might be limited to more serious medical conditions.

CONCLUSIONS

The results of this study contribute information to the otherwise limited knowledge on the incidence of ED. The overall incidence rate of ED in Brazilian men was 65.6 cases per 1000 person-years. Our longitudinal data confirm that although incident ED is associated with age, it is not an inevitable outcome of the aging process. The identification of medical and behavioral risk factors for ED is essential to determine which factors could be modified for prevention efforts. The projection of one million new cases annually in Brazil adds to the public health importance of this condition.

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