

Prevalence of erectile dysfunction and associated factors among men without concomitant diseases: a population study

A Nicolosi^{1,2*}, DB Glasser³, ED Moreira⁴ and M Villa¹ for the Erectile Dysfunction Epidemiology Cross National Study Group

¹Department of Epidemiology, Institute of Biomedical Technologies, National Research Council, Milan, Italy; ²G. H. Sergievsky Center, School of Public Health, Columbia University, New York, New York, USA; ³Pfizer Inc, New York, New York, USA; and ⁴Gonçalo Moniz Research Center, Fiocruz, Salvador, Brazil

We interviewed a population sample of 2412 men aged 40–70 y in Brazil, Italy, Japan and Malaysia about medical history, lifestyle habits and sexual behavior. Men were classified as having moderate or complete erectile dysfunction (ED) if they reported to be sometimes or never able to achieve and maintain an erection satisfactory for sexual intercourse, respectively. There were 1335 men with no diagnosis of cardiovascular or prostate diseases, diabetes, ulcer or depression, nor taking hormones. The prevalence of ED was 16.1%. ED was associated with age (the risk increased 8% per y), moderate (odds ratio (OR) = 2.2) or severe (OR = 4.9) lower urinary tract symptoms and smoking (OR = 2.3 for >30 cigarettes/day). It was inversely associated with physical activity (OR = 0.5) and higher educational levels. Between the ages of 40 and 70 y, almost one in six ‘healthy’ men is affected by ED. Further research should look at preclinical disease stages and genetic factors. *International Journal of Impotence Research* (2003) 15, 253–257. doi:10.1038/sj.ijir.3901010

Keywords: erectile dysfunction; prevalence; risk factors; smoking; LUTS

Erectile dysfunction (ED) is a common problem in adult and elderly men.^{1–4} All the clinical or epidemiological studies carried out to date have tried to identify causal factors or predictors of ED: in addition to aging, cardiovascular diseases,⁵ diabetes,⁶ prostate disease,⁷ depression⁸ and a number of treatments⁹ (particularly with hormones, and antihypertensive and antiulcer drugs) have been associated with increased risk, but ED also affects men without any clinically apparent disease.

We conducted a crossnational survey on the prevalence of ED in population samples, and its association with concomitant medical, psychological and behavioral conditions.¹⁰ In this paper, we examine the prevalence of ED among men unaffected by the diseases known to be associated with ED.

Materials and methods

The ‘Cross National Study on the Epidemiology of Erectile Dysfunction and Its Correlates’ was carried out in Brazil, Italy, Japan and Malaysia; its methods have been described in detail elsewhere (Nicolosi *et al.*¹⁰). Briefly, in each country, different cities were identified as target populations, a random sample of 2700 households were contacted, and approximately 600 men aged 40–70 y were interviewed. The interviews were based on a standardized questionnaire, which was the same for each country. The questionnaire, which was designed on the basis of the results of two focus group meetings held in each country, was aimed at gathering data about the subjects’ demographic and social status, medical history, lifestyle habits and sexual behavior. The interviews were conducted between October 1997 and June 1998.

All of the subjects were asked whether they had ever been diagnosed as having heart disease, hypertension, diabetes, any prostate disease (or surgery), depression or gastric or duodenal ulcer, or were currently taking medications for any of these diseases. In addition, the presence of depressive symptoms was assessed using a shortened version of the Center for Epidemiologic Studies rating scale for measuring depressive mood in the community

*Correspondence: A Nicolosi, Department of Epidemiology, Institute of Biomedical Technologies, National Research Council, Via filicervi 93, 20090 Segrate (MI) Milan, Italy.

E-mail: alfredo.nicolosi@itb.cnr.it

Accepted 05 February 2003

(CES-D).¹¹ Lower urinary tract symptoms (LUTS) were assessed using the International Prostate Symptoms Score (IPSS) and classified as absent or mild (IPSS ≤ 7), moderate (8–19) or severe (20–35).¹² The degree of physical activity was classified as 'less than average', 'average' or 'more than average' depending on the answers concerning the amount and frequency of physical activity at work and during leisure time. The definition of smokers included the smoking of cigarettes, cigars or a pipe, and men were classified as former or current smokers. Tobacco use was analyzed on the basis of the number of tobacco units (cigarettes, cigars, pipes) consumed per day. The definition of alcohol drinkers included all of the men who reported drinking wine, beer or spirits. The number of alcoholic drinks per week was calculated on the basis of the reported number of drinks of beer, wine or spirit, weighted by the alcoholic content (beer $\times 0.4$ + wine + spirits $\times 2.5$). The body mass index (BMI) was calculated as weight (kg)/height (m)²; quartiles were used in the analysis. The men with no diagnosis of cardiovascular or prostate diseases, diabetes, ulcer or depression, and who were not taking hormones, were classified as healthy.

Definition of ED

Based on the US National Institutes of Health and American Urological Association criteria,¹³ ED is defined as 'the persistent inability to achieve and/or maintain an erection sufficient for sexual activity'. All of our subjects were invited to choose one of four possible answers to the question 'How would you describe yourself?': 'always, usually, sometimes or never able to get and keep an erection good enough for sexual intercourse'. The subjects answering 'always' were classified as normal, and those answering 'usually', 'sometimes' or 'never' were classified as having 'mild', 'moderate' or 'complete'

ED, respectively. In the analyses in which we dichotomized ED, the 'always' and 'usually' categories were used to indicate subjects without ED, and the 'sometimes' and 'never' categories to indicate subjects with ED.

Statistical analysis

The prevalence of ED was calculated by dividing the number of cases by the corresponding population. We estimated the strength of the associations between ED and possible risk factors using crude and age-standardized odds ratios (OR) and their 95% confidence intervals (CI); a logistic regression analysis was used to estimate the associations between ED and other variables, while adjusting for the simultaneous effect of all of the variables in the model.¹⁴

Results

Of the 2513 subjects interviewed, 2412 answered the ED question and gave their medical history: 200 (8.3%) reported heart disease, 540 (22.3%) hypertension, 223 (9.2%) diabetes, 183 (7.6%) prostate diseases or surgery, 164 (6.8%) depression, 295 (12.2%) gastric or duodenal ulcer and 29 (1.2%) hormonal treatment. A total of 1077 men reported one or more diagnoses of concomitant conditions; the remaining 1335 men were classified as healthy.

The crude prevalence of moderate or complete ED among the healthy men (16.1%) was about half that of the diseased men (31.5%) (Table 1). (The prevalence of ED standardized to the 2001 US male population aged 40–69 y was 18.1%.) Both healthy and diseased men presented a similar age trend, as indicated by the comparability of the age-specific ORs. The age-adjusted OR of ED in the diseased vs the healthy men was 1.64 (95% CI: 1.33–2.03).

Table 1 Prevalence of moderate or complete ED among diseased and healthy men by age group and risk of ED (OR)

Age group (y)	Diseased men				Healthy men			
	ED	% with ED	No ED	OR (95% CI)	ED	% with ED	No ED	OR (95% CI)
40–44	21	12.6	146	1	32	7.8	380	1
45–49	26	15.4	143	1.26 (0.68–2.35)	34	10.2	299	1.35 (0.81–2.24)
50–54	35	19.0	149	1.63 (0.91–2.94)	40	17.5	189	2.51 (1.53–4.13)
55–59	67	36.0	119	3.91 (2.27–6.76)	36	22.2	126	3.39 (2.02–5.69)
60–64	82	43.9	105	5.43 (3.16–9.33)	30	28.6	75	4.75 (2.72–8.28)
65–70	108	58.7	76	9.88 (5.74–17.01)	43	45.7	51	10.01 (5.82–17.23)
Total	339	31.5	738		215	16.1	1120	

Age-adjusted OR for ED diseased/healthy men=1.64 (95% CI: 1.33–2.03).

ED=erectile dysfunction; OR=odds ratio; CI=confidence intervals of the OR.

Turning to the results for the group of healthy men, Figure 1 demarcates the men by age group and level of ED (mild, moderate or complete), corresponding to the answers given to the original question asked in the interview. Almost 40% of the men complained of occasional insufficiencies in

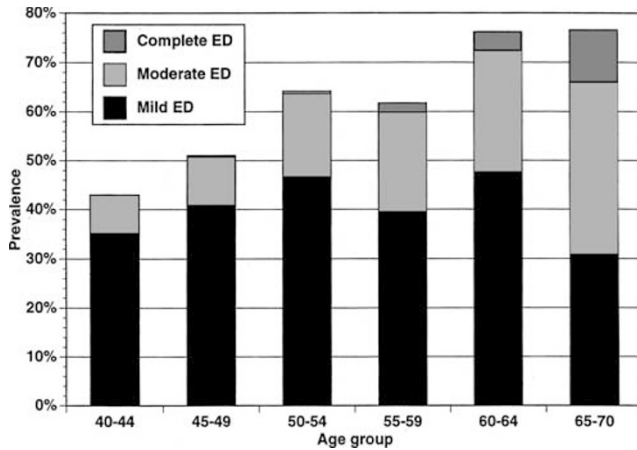


Figure 1 Prevalence of mild, moderate and complete ED by age group among men without concomitant diseases.

erectile function (mild ED); this proportion was quite stable across all age groups. Moderate ED was present in 17% of the men aged 50–54 y, and involved approximately one-third of the population aged between 60 and 70 y. The prevalence of complete ED became relevant after the age of 55 y.

A number of factors were associated with ED at univariate analysis (Table 2). An increasing degree of physical activity was inversely associated, with a 65% reduction in prevalence among the individuals with more than average physical activity. The BMI (population mean 24.3, range 12.8–64.5) showed a similar linear relationship with ED: individuals in the fourth quartile had a 43% reduction in the prevalence of ED in comparison with those in the first quartile. The association between ED and smoking was clear from the increase in the OR from nonsmokers to former smokers and current smokers, and was confirmed within the category of current smokers by the fact that the increase in the OR was dependent on the amount of tobacco consumed. The slight association between alcohol use and ED was not statistically significant. If anything, the lower OR for men who drank an average of between one and seven drinks per week might suggest a beneficial effect for moderate drinking.

Table 2 Factors associated with ED among healthy men (univariate analysis)

	Men without ED	Men with ED	Proportion with ED (%)	OR	95% CI
<i>Physical activity</i>					
Less than average	73	34	31.8	1	
Average	226	48	17.5	0.46	0.27–0.76
More than average	821	133	13.9	0.35	0.22–0.54
<i>BMI</i>					
First quartile	268	69	21.1	1	
Second quartile	275	52	16.3	0.73	0.49–1.09
Third quartile	287	51	14.1	0.69	0.46–1.03
Fourth quartile	288	42	11.7	0.57	0.37–0.86
<i>Smoking status</i>					
Never	362	56	13.4	1	
Former smoker	275	48	14.9	1.13	0.74–1.71
Current smoker	468	107	18.6	1.48	1.04–2.10
<i>Tobacco units per day (cigarettes, cigars, pipe)</i>					
None	642	107	14.3	1	
1–30	429	88	17.0	1.23	0.91–1.67
>30	44	19	30.2	2.59	1.46–4.61
<i>Weekly alcohol drinks</i>					
None	503	98	16.3	1	
1–7	294	51	14.8	0.89	0.62–1.29
8–21	191	38	16.6	1.02	0.68–1.54
>21	130	28	17.7	1.11	0.70–1.75
<i>LUTS</i>					
Absent or minor	1010	159	13.6	1	
Moderate	74	25	25.3	2.15	1.32–3.48
Severe	9	6	40.0	4.23	1.49–12.06
<i>Education</i>					
High school not completed	514	126	19.7	1	
High school completed	448	73	14.0	0.66	0.49–0.91
Degree	154	16	9.4	0.42	0.24–0.73
<i>Depressive symptoms</i>	180	54	23.1	2.11	1.48–3.02

ED=erectile dysfunction; OR=odds ratio; CI=confidence interval; LUTS=lower urinary tract symptoms.

Table 3 Factors associated with ED among healthy men (multivariate analysis)

<i>Factor</i>	<i>OR</i>	<i>Lower 95% CI</i>	<i>Higher 95% CI</i>
Age ^a (y)	1.08	1.06	1.11
LUTS			
Absent or minor	1		
Moderate	2.19	1.24	3.87
Severe	4.91	1.44	16.73
Physical activity			
Below average	1		
Average	0.54	0.30	0.98
More than average	0.48	0.29	0.82
Education			
High school not completed	1		
High school completed	0.66	0.45	0.97
Degree	0.41	0.22	0.77
Current smoking			
None	1		
1–30	1.26	0.88	1.80
>30	2.31	1.19	4.49

^aRisk (OR) pery between the ages of 40 and 70 y.

OR=odds ratio; CI=confidence interval; LUTS=lower urinary tract symptoms.

The OR for ED in men with a high depression score was double that of those who had no or few symptoms of depression.

Although all of the men with a diagnosis of prostate disease were excluded from the analysis, 7.6% of the interviewees reported moderate and 1.1% severe LUTS. The risk for ED was, respectively, 2.15 and 4.2 in comparison with men with no or minor LUTS.

Educational level inversely correlated with the prevalence of ED.

When we used a multivariate model to estimate the associations between ED and the possible risk factors, older age, the presence of LUTS, the degree of physical activity, current smoking and educational level were all statistically significant predictors (Table 3). In particular, the risk increased almost 10% pery of age (between the ages of 40 and 70 y), and LUTS, physical activity, tobacco consumption and educational level all had a linear relationship with ED that was dependent on the severity or intensity of the exposure.

Discussion

This study, based on a random crossnational population sample, focuses on the prevalence of ED and its risk factors among men not diagnosed with concomitant diseases that usually predict it. Age, LUTS, smoking, physical activity and education were all associated with ED.

All the studies conducted so far have found that increasing age correlates with an increasing overall prevalence of ED and increasing severity, after controlling for all other correlates.^{1–4} Our results show that increasing age acts almost independently of the presence of diseases, as shown by the similarity of the age-specific ORs separately calculated for the diseased and healthy men. However, ED cannot be defined as a necessary consequence of aging, because 54% of the healthy and 41% of the diseased men in the oldest age group did not complain of moderate or severe dysfunction.

The presence of at least one of the considered diseases was associated with a 64% increased risk of moderate or severe ED, after adjusting by age. However, this should be viewed as a conservative estimate. We identified healthy men by excluding those who reported a diagnosis of, or a treatment for, at least one of the diseases most frequently associated with ED, and this definition suffers from two major limitations. The first is the lack of other diseases—such as chronic respiratory or neurologic disease and cancer—which are important causes of disability and can potentially influence the onset of ED (also indirectly) by reducing physical activity levels. The second limitation relates to the fact that some diseases, such as diabetes, hypertension and benign prostatic hyperplasia (BPH), are often undiagnosed in a considerable proportion of apparently healthy men. In this respect, the inverse association between education and ED may reflect the fact that men with a lower educational (and, consequently, socioeconomic) level have reduced access to medical services and may therefore include a subgroup with higher prevalence of undiagnosed disease. As an example of this possible bias, we found that approximately 70% of the men with moderate or severe LUTS in the ‘healthy’ population belonged to the lowest educational level (high school not completed).

The presence and severity of LUTS (as measured by IPSS scores) were the strongest predictors of ED in healthy men. It is possible that some of the men with severe LUTS had undiagnosed BPH, since the correlation between the IPSS, the BPH Impact Index and sexual dysfunction is known.¹⁵ An association between LUTS and sexual function was found in a French community study involving 2011 men aged between 50 and 80 y,¹⁶ and then replicated in a United Kingdom study of 423 men sampled from a community and 1271 urology clinic outpatients.¹⁷

Current smoking was associated with ED in our population of healthy men, and the risk was dependent on the amount of tobacco consumption. The Massachusetts Male Aging Study prevalence study¹ did not find any association between ED and smoking, but smoking was associated with an increased risk of ED in the prospective part of the study.¹⁸ Cigarette smoking was also found to be an independent risk factor for ED in a cross-sectional

study of 4462 US Army Vietnam-era veterans aged 31–49 y,¹⁹ and in the Health Professionals Follow-up Study.²⁰

Both moderately active and active men had a lower prevalence of ED in our study and in the Health Professionals Follow-up Study.²¹ It has been shown that physical activity has a beneficial effect on men's sexual behavior and, in the MMAS prospective study, a decreased risk of ED was observed in men who remained active or initiated physical activity.¹⁸

Some of the factors we studied did not show any association with ED, and others were associated with ED at univariate but not at multivariate analyses. Alcohol consumption did not correlate with ED in our study. The Health Professionals Follow-up Study found that moderate drinkers (one or two drinks per day) had a lower prevalence of ED than either nondrinkers or heavy drinkers.²¹ However, the MMAS¹ found a slightly high prevalence of ED with alcohol consumption. Men with diagnosed depression were excluded from our healthy population, so we could only study the association between ED and depressive symptoms: although an association was present at univariate analysis, it lost its statistical significance at multivariate analysis when controlling for other factors. The same thing happened in the case of the association between ED and the BMI.

Conclusions

Clinically apparent disease explains only a portion of the ED prevalence in the population. Between the ages of 40 and 70 y, almost one in six healthy men is affected by moderate or complete ED. The prevalence of ED increases with age, but is not a necessary consequence. Although aging, diseases and lifestyle habits all play a role in the etiology of ED, further research is needed to understand this disorder better, possibly by looking at preclinical disease stages and genetic factors.

Acknowledgements

This work was partially funded by Pfizer Inc., New York, NY, USA.

References

- 1 Feldman HA *et al.* Impotence and its medical and psychosocial correlates: results of the Massachusetts Male Aging Study. *J Urol* 1994; **151**: 54–61.
- 2 Panser LA *et al.* Sexual function of men aged 40 to 79 years: the Olmsted County Study of Urinary Symptoms and Health Status Among Men. *J Am Geriatr Soc* 1995; **43**: 1107–1111.
- 3 Koskimäki J, Hakama M, Huhtala H, Tammela TLJ. Effect of erectile dysfunction on frequency of intercourse: a population based prevalence study in Finland. *J Urol* 2000; **164**: 367–380.
- 4 Blanker MH *et al.* Erectile and ejaculatory dysfunction in a community-based sample of men 50 to 78 years old: prevalence, concern, and relation to sexual activity. *Urology* 2001; **57**: 763–768.
- 5 Sullivan ME, Keoghane SR, Miller MA. Vascular risk factors and erectile dysfunction. *BJU Int* 2001; **87**: 838.
- 6 Bacon C *et al.* Duration of diabetes and risk of erectile dysfunction among older men. *Diabetes* 2001; **50**(Suppl 2): A456.
- 7 Burger B, Weidner W, Altwein JE. Prostate and sexuality: an overview. *Eur Urol* 1999; **35**: 177–184.
- 8 Mathew RJ, Weiman ML. Sexual dysfunctions in depression. *Arch Sex Behav* 1982; **11**: 323–328.
- 9 Wein AJ, Van Arsdalen K. Drug induced male sexual dysfunction. *Urol Clin N Am* 1988; **15**: 23–31.
- 10 Nicolosi A *et al.* The epidemiology of erectile dysfunction in four countries: Cross-National Study of the Prevalence and Correlates of Erectile Dysfunction. *Urology* 2003; **61**: 201–206.
- 11 Weissman MM *et al.* Assessing depressive symptoms in five psychiatric populations: a validation study. *Am J Epidemiol* 1977; **106**: 203–214.
- 12 Barry MJ *et al.* for the Measurement Committee of the American Urological Association. The American Urological Association symptom index for benign prostatic hyperplasia. *J Urol* 1992; **148**: 1549–1557.
- 13 NIH Consensus Conference. Impotence. NIH Consensus Development Panel on Impotence. *JAMA* 1993; **270**: 83–90.
- 14 Schlesselman JJ. *Case-Control Studies: Design, Conduct, Analysis*. Oxford University Press: New York, 1982, pp 227–290.
- 15 Namasivayam S *et al.* The evaluation of sexual function in men presenting with symptomatic benign prostatic hyperplasia. *Br J Urol* 1998; **82**: 842–846.
- 16 Macfarlane GJ *et al.* The relationship between sexual life and urinary condition in the French community. *J Clin Epidemiol* 1996; **49**: 1171–1176.
- 17 Frankel SJ *et al.* Sexual dysfunction in men with lower urinary tract symptoms. *J Clin Epidemiol* 1998; **51**: 677–685.
- 18 Derby CA *et al.* Modifiable risk factors and erectile dysfunction: can lifestyle changes modify risk? *Urology* 2000; **56**: 302–306.
- 19 Mannino DM, Kleven RM, Flanders WD. Cigarette smoking: an independent risk factor for impotence? *Am J Epidemiol* 1994; **140**: 1003–1008.
- 20 Bacon CG, Mittleman MA, Glasser DB, Rimm EB. A large prospective study of risk factors for change in erectile function among men over age 50. *J Urol* 2001; **165**(Suppl): 219.
- 21 Rimm EB, Bacon CG, Giovannucci EL, Kawachi I. Body weight, physical activity, and alcohol consumption in relation to erectile dysfunction among U.S. male health professionals free of major chronic diseases. *J Urol* 2000; **163**(Suppl): 241.