

# Epidemiology of Erectile Dysfunction

Stanley G. Korenman

*Department of Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA*

**Following the landmark Massachusetts Male Aging Study (MMAS) that provided the first relatively unbiased study of the epidemiology of erectile dysfunction (ED), a number of additional studies were carried out in the U.S. and around the world. The studies vary in quality because they used different definitions of ED, different assessment instruments, different and sometimes biased sources of populations, inadequate response rates to questionnaires and interviews, cultural disparities in willingness to discuss sexual issues, and differing interpretations of the results. Nevertheless, the studies demonstrated similar levels of ED by age and an exponential rise with age. They also generally confirmed the conditions that correlated with ED in the MMAS, namely, diabetes, hypertension, coronary artery disease, prostate cancer therapy, and depression. These were exacerbated by cigaret smoking.**

**Key Words:** Erectile dysfunction; epidemiology; aging; diabetes; atherosclerosis; depression; hypertension; prostate cancer.

## Introduction

Over the course of the past decade, the epidemiology of erectile dysfunction (ED) has been studied in some detail. The investigations vary in quality because they used different definitions of ED, different assessment instruments, different and sometimes biased sources of populations, inadequate response rates to questionnaires and interviews, cultural disparities in willingness to discuss sexual issues, and differing interpretations of the results.

Variability notwithstanding, the results generally support most of the conclusions of the Massachusetts Male Aging Study (MMAS), first reported in 1994 (1), indicating that ED is a common affliction in men.

## Definitions and Instruments

The MMAS employed a nine-point scale for which an algorithm was developed, and men were divided into four ED categories: none, minimal, moderate, and complete. It is not widely understood that those with minimal ED had sex regularly with a full erection. Their complaint was the effort required to obtain an erection. By contrast, the National Institute of Health consensus document in 1993 (2,3) proposed the subjective definition “the inability to achieve or maintain an erection sufficient for satisfactory sexual performance,” which was adopted and became the standard.

From the MMAS study and the consensus development conference statement, it was agreed that there were indeed degrees of ED. These were further characterized in a number of validated instruments, the most popular of which was the International Index of Erectile Function (IIEF) (4). This instrument focused on the proportion of times sexual activity concluded successfully regarding both penetration and maintenance of an erection and global sexual satisfaction. Most of the studies of therapeutic agents used the questions about penetration and erection maintenance as their main end points. Reported epidemiologic studies have employed various end points that significantly affect the ability to compare studies.

## Epidemiological Issues

Comparisons among studies also fail because of differing sources of populations. The MMAS set the standard for a randomized study that was population based (i.e., non-medical), but it had only 5% African-Americans and essentially no Hispanic or Asian participants. Populations derived from medical or surgical practices have biases based on the medical conditions of the subjects. This is easily appreciated by reviewing studies in which the average age of subjects is under 50 whereas the vast majority of patients with ED are over age 60.

Other problems include a differential reluctance of populations to respond to inquiries, manifested by low response rates both to self and to professionally administered questionnaires. Generally, if one obtains much less than a 70% response rate, an epidemiologic study is suspect. For example, one cannot predict whether those with or without ED are more likely to be nonresponders.

By contrast, studies of ED in subjects with established medical disorders have problems in establishing rates in

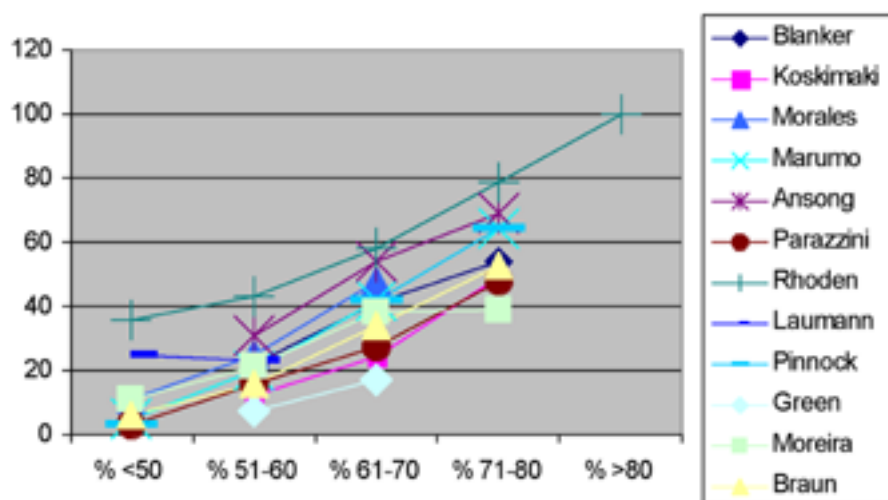
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Author to whom all correspondence and reprint requests should be addressed: Dr. Stanley Korenman, MD, Department of Medicine, David Geffen School of Medicine at UCLA, Los Angeles, CA. E-mail: skorenman@mednet.ucla.edu

**Table 1**  
Factors Associated with ED in the MMAS

Positive association	No association	Negative association
Age	Hypertension	High-density lipoprotein cholesterol
Smoking	Alcoholism	Dehydroepiandrosterone
Depression	Cortisol	Dominance
Diabetes, treated	Allergies	
Cardiovascular disease, treated	Dihydrotestosterone	
Anger, internalized or expressed		



**Fig. 1.** Prevalence of ED by age in international studies.

comparison to control subjects, because in the medical setting, control groups do not reflect the population at large. Given all these caveats, the actual agreement among studies regarding the major correlates of moderate or severe ED and the overall population prevalence of ED has been good.

### MMAS Findings

Table 1 indicates those factors that are increased, decreased, or did not affect the risk of ED in the main MMAS study. The most powerful associations with ED on initial interview are age and depression. Moderate to severe ED rose from 22% from ages 40 to 50 to 49% from ages 60 to 70. Other studies (Fig. 1) also demonstrate that the risk of ED continues to rise with increasing age. This result persisted throughout multiple regression analyses.

Analysis of the MMAS follow-up data 9 yr later (5) demonstrated that the factors predicting a significantly increased incidence of ED on follow-up are age and the inverse of education. In treated diabetes and treated heart disease, there was a doubling, and with treated hypertension, a 50% increase in the age-adjusted incidence of ED. The baseline incidence was 26 per thousand patient years.

Although psychologic problems were prominent in the initial study, on follow-up about 9 yr later (6), depressed

subjects with normal erectile function without diabetes or cardiovascular disease demonstrated no increased prevalence of ED. However, dominance as measured by the instrument remained strongly inversely correlated to the development of ED. The investigators concluded that a submissive personality predisposed to ED.

The follow-up incidence data (7) allowed investigators, using age-based population data, to calculate 617,000 new cases of ED in white males in the United States annually. They also estimated that in 1995 there were more than 152 million men with ED worldwide. The number was estimated to increase to 322 million by the year 2025. The consequences for health care delivery systems if treatment were offered could be immense.

### Worldwide Epidemiological Studies

Given the results of the MMAS, what more light have additional epidemiologic studies carried out worldwide shed on ED? Table 2 describes epidemiologic studies from around the world reported since 1998 that examined ED prevalence and factors correlated with ED. While the absolute prevalence varied with age distribution and type of query instrument employed, the related factors closely followed the findings of the MMAS, with increased ED associated

**Table 2**  
Findings of Worldwide Epidemiological Studies of ED

Reference	Response/ no. polled	Ethnic group	Definition of ED	Principal findings
8	1688/3924	Dutch	Severely reduced rigidity or no erections	3% age 50–54 to 20% age 70–78
9	1983/3143	Finnish	Achieve and maintain MMAS-like	17–28% sexually active men had no erection
10	1857/2476	Spanish	IIEF	14 and 12% had moderate to severe ED; increased with age; decrease in intercourse moderate and severe
11	1071	Brazilian	IIEF (5) (ques)	18.9% age 25–70, usual comorbidities
12	1244/1574	North American	One relevant question in large survey	32.3% > minimal increase with age etc.; no relation to seven tests
13	2287/5198	New York rural	Self-administered survey	5% (sexual days)
14	1286	Brazilian	Single-frequency question	Prevalence: 21.3–46% increases with age socio-economic status, perceived health
15	4489/8000	German	New questionnaire	14.7% moderate to severe increase with age; lots of association factors pids a young population
16	2311/1517	Japanese	IIEF	31–44% dissatisfied with sex lives; 19.2% ED with steep age curve; usual comorbidities
17	2002/4060	Welsh	Always/sometimes/never able to get erection	Usual % in relation to age; usual risk factors
18	427/612	South Australian	UCLA questionnaire multiple factors	Average 13.2%, age related and usual comorbidities
19	2010	Italian	Always/sometimes/never able to have satisfactory sex	Usual comorbidities; high rates after noncancer pelvic surgery
20	1494/2460	Danish	Both sexes, a few ED questions	12.8% prevalence; 2% of 18-yr-olds to 48% in those age >70; usual causes increase risk; increased blood pressure and diabetes and both
				57.5% men satisfied with sex life; 5.4 of total have ED, others premature ejaculation, decreased desire

with age, diabetes, cardiovascular disease, and pelvic surgical interventions. The relationship to emotional problems was not often assessed. Thus, age is the most positive determinant of ED, wherever and however it has been studied.

To medical practitioners, epidemiologic studies of the population provide an incentive to query about ED, especially in older men, but that does not necessarily alert them to ED in patients already under treatment for one or more clinical conditions. Thus, practitioners may ask about the prevalence of ED in specific medical conditions. Numerous studies of this type have been reported, but as noted, rarely is a comparable, age-matched control group found, and the population invariably shows a biased selection process intrinsic to the selectivity of medical populations.

## ED in Medical Conditions

### *Diabetes Mellitus*

ED has received the most study in diabetes. The high prevalence of diabetes in men presenting with ED (1,21–23) suggested that ED would be highly prevalent in diabetic populations. Kaiser and Korenman (24) in reviewing

the older literature and their own data indicated that ED occurred in type 1 diabetes patients by 15 or 20 yr after diagnosis and in more than half of type 2 diabetes patients, increasing steadily with age. Those with type 2 diabetes had a high prevalence of macrovascular disease including established coronary artery disease (CAD) (18%), hypertension (40% plus), and CVA (15%). There was a degree of hypogonadism comparable with that in nondiabetic men. Other studies demonstrated that patients with diabetes had microvascular disease in the penis that included disruption of sinusoidal smooth muscle, perisinusoidal fibrosis (25), and diminished nitric oxide synthase activity (26). Recent international epidemiologic studies have confirmed the high prevalence of ED in diabetes (27,28) and related prevalence to the control, complications, and duration of the diabetes (29).

### *Prostate Disease*

Prostate disease including prostatitis and prostate surgery, primarily for prostate carcinoma (30,31), is associated with ED. In Finland, a cross-sectional survey showed that men with prostatitis had increased rates of ED and decreased libido associated with depressive personality characteristics (32).

Nerve-sparing resection of the prostate and adjacent tissues, developed by Walsh and Eggleston (33), was designed to reduce the incidence of postoperative ED, which previously had been nearly universal. Litwin et al. (34) demonstrated a high degree of ED during the first year after radical prostatectomy or radiation therapy followed by 1 yr of improvement and then a recurrent decline especially for those treated with radiotherapy. Recovery after surgery occurred more commonly in those who received a nerve-sparing procedure. Schover et al. (35) did a more comprehensive study of patients with localized prostate cancers from the Cleveland clinic's prostate cancer registry. Forty-nine percent of the questionnaire instruments were returned, and they seem to be from those men who were more interested in sexual function. The study demonstrated that 85% of the men returning the questionnaire had ED. Many were also greatly bothered by the loss of ejaculatory function and the effects of hypogonadism caused by further treatment. They found a high degree of partner sexual dysfunction, and better sexual outcomes in younger and healthier men and in those with a sexually functional partner. Neither study remarked on the effectiveness of ED treatments including sildenafil, intracorporeal injection, and vacuum tumescence devices in maintaining erectile capacity in these patients, but such treatments are quite helpful, especially when introduced shortly after surgery. Stock et al. (31) studied 416 patients who received brachytherapy and found that erectile function was preserved in >50% of those with good to excellent sexual function at the time of the procedure. Since in all of these studies selection of patients for each therapeutic mode was not randomized, we cannot conclude that one or another modality is more protective against erectile function. Nerve-sparing radical prostatectomy seems to be more conservative than conventional radical prostatectomy.

### Chronic Renal Failure

Patients with chronic renal failure on hemodialysis have a high prevalence of ED. Using IIEF scores, Rosas et al. (36) demonstrated that 82% of community hemodialysis patients had some degree of ED, with severe ED in 45%. Subjects under age 50 had an overall ED rate of 63%. Of all those over age 50, the condition was present in 90%. Use of angiotensin-converting enzyme inhibitors was somewhat protective. However, renal transplantation does not resolve the problem (37). Of 323 consecutive male kidney transplant recipients queried using the IIEF, 271 replied. Of the 221 patients who were sexually active in the previous 4 wk, 55.7% had ED using the domains of the IIEF. As might be expected, age, time on dialysis, and repeated transplantations were negatively associated with erectile function. It would have been valuable to know the number and rate of ED in those with diabetes in this group. Among those not having sexual activity a substantial number must have had ED. In that regard, 54 renal transplant patients were studied extensively (38), and venoocclusive dysfunction was pre-

dominant in 68% and arterial occlusive disease in 43% of the subjects. As expected, hypertension, diabetes, and hypercholesterolemia correlated with ED. Thus, the investigators confirmed the hypothesis that ligation of one internal iliac artery compromises penile circulation.

The relation of psychiatric problems to ED remains to some degree a chicken-or-egg phenomenon. If one employs a risk factor approach to ED, the question of the relation becomes moot. In a review, Seidman (39) concludes that sometimes depression is causal and sometimes an effect of ED. In my clinical experience, ED in a younger and otherwise healthy man usually predicts substantial depression. A recent study (40) of 152 depressed men, average age 56, with ED demonstrated substantial improvement in depression with amelioration of ED, suggesting that a substantial portion of depression in some men is owing to poor sexual function.

A number of conditions appear to be associated with an increased incidence of ED, and that seems to be consistent with their physiology. These include multiple sclerosis (41), paraparesis (42), and human immunodeficiency virus (43).

The role of cigarette smoking, which was first implicated in ED in the MMAS, was further studied and demonstrated to approximately double the rate of ED in CAD, hypertension, and atherosclerosis (44). This effect declines with duration of smoking cessation, suggesting that smoking may be the most important modifiable behavior affecting sexual function.

### Conclusion

ED is common in men worldwide over the age of 50 independently of their clinical state. ED is progressively common with age in all studied populations. However, certain conditions including diabetes, hypertension, CAD, prostate cancer therapy, and depression are associated with increased rates of ED for age, and these are exacerbated by cigarette smoking. Many other risk factors have been proposed, for which there are variable degrees of evidence. From a heuristic point of view, a man's claim of ED should trigger a therapeutic response from his clinician regardless of his or her specialty.

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