Erectile Dysfunction and Undiagnosed Diabetes, Hypertension, and Hypercholesterolemia

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ABSTRACT

PURPOSE We investigated whether erectile dysfunction, a marker for future cardiovascular disease, is associated with undiagnosed cardiometabolic risk factors among US men. Identifying the presence of these risk factors could lead to earlier initiation of treatment for primary prevention of cardiovascular disease.

METHODS We analyzed cross-sectional data from men aged 20 years and older who participated in the National Health and Nutrition Examination Survey during 2001-2004. Erectile dysfunction was determined by a single, validated survey question. We used logistic regression analyses to investigate the relationship between erectile dysfunction and undiagnosed hypertension, hypercholesterolemia, and diabetes.

RESULTS After multivariate adjustment, men with erectile dysfunction had more than double the odds of having undiagnosed diabetes (odds ratio = 2.20; 95% CI, 1.10-4.37), whereas no association was seen for undiagnosed hypertension or undiagnosed hypercholesterolemia. For the average man aged 40 to 59 years, the predicted probability of having undiagnosed diabetes increased from 1 in 50 in the absence of erectile dysfunction to 1 in 10 in the presence of erectile dysfunction.

CONCLUSIONS Our results underscore the importance of erectile dysfunction as a marker of undiagnosed diabetes. Erectile dysfunction should be a trigger to initiate diabetes screening, particularly among middle-aged men.

INTRODUCTION

One of every 3 deaths in the United States is attributable to cardiovascular disease (CVD).[1] With 45% of US adults having hypertension, hypercholesterolemia, or diabetes, early diagnosis and effective management of these cardiometabolic risk factors can markedly reduce the impact of CVD.[2] Unfortunately, in more than 15% of US adults, 1 or more of these 3 cardiometabolic risk factors is undiagnosed.[2] From a public health perspective, underdiagnosis is concerning as it limits the potential benefits of early recognition and risk reduction. This is particularly true for men, owing to their greater reluctance to use preventive care and significantly higher prevalence of CVD compared with women.[3,4] Identifying easily observable risk factors associated with undiagnosed cardiometabolic risk factors, particularly in men, may improve early diagnosis and subsequent treatment.

Over the past decade, evidence has suggested that erectile dysfunction is an early indicator for cardiovascular disease.[5] In light of this association, erectile dysfunction has been described as providing a "window of curability" for men at risk for future CVD. There is a lack of empirical evidence on whether erectile dysfunction is a risk factor for having underlying cardiometabolic risk factors, however. We studied the association between erectile dysfunction and undiagnosed hypertension, hypercholesterolemia, and diabetes mellitus in a nationally representative sample of men.

METHODS
Data Source
We analyzed data from the National Health and Nutrition Examination Survey (NHANES), a nationally representative survey of the resident civilian, noninstitutionalized US population conducted in 2-year cycles that has previously been described.[6] We pooled the 2001-2002 and 2003-2004 cycles of NHANES, as these survey waves were the most recent that asked questions regarding erectile dysfunction.

Measures
Erectile dysfunction was assessed in NHANES with the question: "Many men experience problems with sexual intercourse. How would you describe your ability to get and keep an erection adequate for satisfactory intercourse?" This single, self-reported question has previously been validated for clinical erectile dysfunction.[7] Using an approach similar to that used in previous studies,[8] we considered men who responded "never able" or "sometimes able" to have erectile dysfunction and considered those who responded "usually able" or "always or almost always able" to have normal erectile function.

We likewise determined the presence of previously diagnosed cardiometabolic risk factors using an approach similar to that used in prior studies.[9] For each risk factor, men were classified as already having the diagnosis if they responded that they had been told by a doctor or health professional that they had the condition or if they reported taking medications for it. In our statistical models, we also included potential confounding variables based on those used in earlier studies.[8] Our study used physical examination and laboratory measures to identify undiagnosed cardiometabolic risk factors, using the same diagnostic criteria as used by the National Center for Health Statistics.[2]

From the 21,161 respondents to NHANES for 2001-2004, we studied the 4,519 men aged 20 years or older who had completed both the interview and physical examination components. Men with prostate cancer or missing responses to the question on erectile function or the other covariates were excluded (Supplemental Figure, available at http://www.annfammed.org/content/13/4/331/suppl/DC1). Three study analytic subsamples were created, as described below.

Statistical Analysis
We used logistic regression analysis to investigate the relationships of erectile dysfunction with undiagnosed hypertension, undiagnosed hypercholesterolemia, and undiagnosed diabetes in each of the corresponding analytic samples: men having a blood pressure measurement, a cholesterol measurement, and a fasting glucose measurement, respectively. Adjusted odds ratios (ORs) and their 95% CIs were then estimated using multivariate logistic regression analysis as described in the NHANES analytic guidelines.[10] We performed an additional post hoc analysis to test for interactions between erectile dysfunction and age. The predicted probability of each outcome in the average man was then determined using the regression coefficients from each model. Because of missing data, we adjusted the original sampling weights for nonresponse as described by Lohr[11] and recommended in the NHANES analytic guidelines.[10] We used SAS version 9.3 (SAS Institute) for all analyses.

RESULTS
We assessed the association of erectile dysfunction with undiagnosed hypertension among 2,224 men with a blood pressure reading; with undiagnosed hypercholesterolemia among 2,287 men with a cholesterol sample, and with undiagnosed diabetes among 1,417 men with a fasting glucose measurement. Characteristics of these analytic samples are shown in Table 1.

In the blood pressure analytic sample, 19.4% of men with erectile dysfunction had undiagnosed hypertension compared with 9.3% of men without erectile dysfunction. Before statistical adjustment, the odds of having undiagnosed hypertension were higher among men with erectile dysfunction (OR = 2.35; 95% CI, 1.78-3.11) compared to those without erectile dysfunction (Table 2). After we adjusted for potential confounders, however, the association was attenuated and was no longer statistically significant (OR = 1.27; 95% CI, 0.87-1.85).

In the cholesterol analytic sample, we found no statistically significant association between erectile dysfunction and undiagnosed hypercholesterolemia in either the unadjusted or adjusted analysis (Table 2).

In the fasting glucose analytic sample, we found the prevalence of undiagnosed diabetes was 11.5% in men with erectile dysfunction compared with 2.8% in men without erectile dysfunction. The difference was most pronounced in middle-aged men (those 40 to 59 years old), in whom the prevalence of undiagnosed diabetes was 19.1% among men with erectile dysfunction compared with 3.3% among men without the condition. We found that erectile dysfunction was strongly associated with undiagnosed diabetes in both the unadjusted analysis (OR = 4.58; 95% CI, 2.54-8.24) and the adjusted analysis (OR = 2.20; 95% CI, 1.10-4.37) (Table 2).

Our post hoc analysis found a significant interaction between erectile dysfunction and age in the fasting glucose sample (*P* <.001), but not in the blood pressure or cholesterol samples. In short, this interac-

Table 1. Characteristics of Analytic Study Samples

Characteristic	Blood Pressure Sample, No. (%) (n = 2,224)	Cholesterol Sample, No. (%) (n = 2,287)	Fasting Glucose Sample, No. (%) (n = 1,417)
Erectile dysfunction			
No	1,874 (89.1)	1,813 (87.3)	1,090 (83.8)
Yes	350 (10.9)	474 (12.7)	327 (16.2)
Age-group, y			
20-39	1,029 (49.8)	1,027 (51.5)	539 (43.6)
40-59	789 (40.3)	732 (37.1)	487 (40.5)
≥60	350 (9.9)	528 (11.5)	391 (15.9)
Ethnicity			
White	1,142 (71.4)	1,158 (70.4)	788 (72.6)
Black	391 (9.1)	441 (10.2)	242 (9.8)
Mexican American	539 (10.2)	542 (10.1)	297 (8.5)
Other	152 (9.3)	146 (9.3)	90 (9.1)
Physically active[a]			
No	1,267 (58.1)	1,329 (59.4)	834 (61.2)
Yes	957 (41.9)	958 (40.6)	583 (38.8)
Alcohol use			
Never	159 (7.1)	164 (7.3)	97 (6.8)
Former	195 (8.2)	209 (8.8)	130 (9.1)
Current	1,870 (84.6)	1,914 (83.8)	1,190 (84.1)
Current smoker			
No	1,559 (69.8)	1,596 (68.6)	1,043 (72.5)
Yes	665 (30.2)	691 (31.4)	374 (27.5)
History of hypertension			
No	2,224 (100.0)	1,799 (82.4)	1,042 (75.6)
Yes	0 (0.0)	488 (17.6)	375 (24.4)
History of high cholesterol			
No	1,779 (79.5)	2,287 (100.0)	1,025 (72.2)
Yes	445 (20.5)	0 (0.0)	392 (27.8)
History of diabetes			
No	2,130 (96.9)	2,159 (96.8)	1,417 (100.0)
Yes	94 (3.1)	128 (3.2)	0 (0.0)
History of cardiovascular disease[b]			
No	2,154 (97.7)	2,160 (96.8)	1,282 (93.4)
Yes	70 (2.3)	127 (3.2)	135 (6.6)
Family history of hypertension/stroke[c]			
No	1,668 (72.8)	1,669 (70.5)	1,028 (69.6)
Yes	556 (27.2)	618 (29.5)	389 (30.4)
Family history of angina/heart attack[c]			
No	1,985 (87.0)	2,043 (87.0)	1,263 (86.6)
Yes	239 (13.0)	244 (13.0)	154 (13.4)
Family history of diabetes			
No	1,217 (54.3)	1,262 (55.3)	779 (54.8)
Yes	1,007 (45.7)	1,025 (44.7)	638 (45.2)
Weight status[d]			
Normal weight/underweight	681 (30.8)	689 (30.8)	364 (25.4)
Overweight	760 (33.6)	727 (31.3)	476 (33.2)
Obese	783 (35.7)	871 (37.9)	577 (41.5)
Undiagnosed disease			
No	1,933 (89.3)	2,017 (87.9)	1,352 (95.8)
Yes[e]	291 (10.4)	270 (12.1)	65 (4.2)

Note: All percentages are probability weighted to account for the National Health and Nutrition Examination Survey sampling design.

[a] Men responding "more active" to the question "Compared with most men your age, would you say that you are ..." were considered to be physically active; those responding "less active" or "about the same" were considered not physically active.

[b] Included angina, heart attack, coronary heart disease, congestive heart failure, or stroke.

[c] Before the age of 50.

[d] Using World Health Organization classification: obese (body mass index [BMI] ≥30 kg/m² or waist circumference [WC] ≥102 cm), overweight (BMI ≥25 kg/m² but <30 kg/m² or WC ≥94 cm but <102 cm), or normal weight or underweight (BMI <25 kg/m² or WC <94 cm).

[e] Undiagnosed hypertension: average systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg; undiagnosed hypercholesterolemia: total cholesterol ≥6.21 mmol/L (≥240 mg/dL); undiagnosed diabetes: fasting plasma glucose level ≥126 mg/dL (≥7.0 mmol/L).

Table 2. Odds Ratios (95% CIs) for Association of Erectile Dysfunction With Undiagnosed Hypertension, Hypercholesterolemia, and Diabetes Among Men Aged ≥20 Years in NHANES 2001-2004

Characteristic	Undiagnosed Hypertension (n = 2,224)		Undiagnosed Hypercholesterolemia (n = 2,287)	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Erectile dysfunction	2.35 (1.78-3.11)	1.27 (0.87-1.85)	0.73 (0.47-1.15)	0.67 (0.42-1.07)
Age-group, y				
20-39 (ref)	1.00	1.00	1.00	1.00
40-59	2.47 (1.69-3.61)	2.38 (1.55-3.66)[a]	1.88 (1.25-2.84)	1.84 (1.24-2.75)[a]
≥60	7.29 (4.90-10.84)	7.41 (4.43-12.37)[a]	1.12 (0.76-1.65)	1.45 (0.87-2.43)
Ethnicity				
Non-Hispanic white (ref)	1.00	1.00	1.00	1.00
Non-Hispanic black	1.47 (1.07-2.02)	1.99 (1.34-2.97)[a]	0.76 (0.47-1.23)	0.87 (0.54-1.40)
Mexican American	0.64 (0.41-0.98)	0.90 (0.60-1.35)	0.92 (0.64-1.31)	0.97 (0.65-1.46)
Other	0.66 (0.34-1.30)	0.92 (0.46-1.85)	1.13 (0.64-1.99)	1.37 (0.77-2.44)
Physically active	0.99 (0.77-1.28)	0.84 (0.62-1.13)	0.82 (0.59-1.14)	0.84 (0.60-1.18)
Alcohol use				
Never (ref)	1.00	1.00	1.00	1.00
Former	1.57 (0.78-3.17)	1.31 (0.53-3.25)	1.28 (0.54-3.04)	0.90 (0.36-2.26)
Current	0.85 (0.47-1.51)	0.95 (0.44-2.06)	3.12 (1.57-6.21)	2.48 (1.20-5.10)[a]
Current smoker	0.65 (0.43-0.98)	0.82 (0.50-1.32)	1.59 (1.16-2.18)	1.65 (1.17-2.32)[a]
History of hypertension	n/a[b]	n/a[b]	1.10 (0.72-1.68)	0.95 (0.56-1.61)
History of high cholesterol	1.21 (0.87-1.68)	0.71 (0.48-1.05)	n/a[b]	n/a[b]
History of diabetes	0.96 (0.46-1.98)	0.56 (0.28-1.14)	0.54 (0.27-1.08)	0.45 (0.21-0.97)[a]
History of cardiovascular disease	1.11 (0.45-2.74)	0.59 (0.20-1.76)	1.20 (0.62-2.33)	1.24 (0.60-2.59)
Family history of hypertension/stroke	0.90 (0.60-1.35)	1.22 (0.76-1.95)	0.75 (0.53-1.06)	0.68 (0.47-0.99)[a]
Family history of angina/heart attack	0.59 (0.38-0.92)	0.68 (0.41-1.13)	1.12 (0.71-1.78)	1.18 (0.74-1.90)
Family history of diabetes	0.93 (0.74-1.18)	1.02 (0.78-1.32)	1.33 (0.95-1.87)	1.30 (0.92-1.84)
Weight status				
Normal weight/underweight (ref)	1.00	1.00	1.00	1.00
Overweight	2.10 (1.45-3.04)	1.75 (1.15-2.67)[a]	2.23 (1.51-3.30)	2.17 (1.46-3.23)[a]
Obese	3.11 (2.18-4.46)	2.37 (1.64-3.43)[a]	2.79 (1.70-4.58)	2.74 (1.68-4.47)[a]

n/a = not applicable; NHANES = National Health and Nutrition Examination Survey; OR = odds ratio; ref = reference group.

[a] Statistically significant (*P* <.05).

[b] Men with previous history excluded.

tion further suggested that the relationship between erectile dysfunction and undiagnosed diabetes was strongest in the 40 to 59 age-group. For the average man between 40 and 59 years of age, the predicted probability of having undiagnosed diabetes increased from 1 in 50 (2.04% of men) without erectile dysfunction to 1 in 10 (10.4%) with erectile dysfunction.

DISCUSSION

Our results provide evidence of the importance of erectile dysfunction as a marker of undiagnosed diabetes, particularly in middle-aged men. They support previous studies suggesting that the prognostic value of erectile dysfunction for CVD is strongest in middle-aged men younger than 60.[5] Erectile dysfunction can act as an important tool to trigger both patients and physicians to screen for diabetes mellitus. Although we

observed significant associations between undiagnosed diabetes and more traditional cardiovascular risk factors, erectile dysfunction is unique because of its common symptomatology and available treatment options. As such, it can act as a useful incentive for men to access the health care system and be readily screened.

A number of study limitations should be addressed. First, although the question on erectile dysfunction was asked in a private room through a computer-assisted self-interview, because of the sensitive nature of the condition, it is possible that erectile dysfunction was underreported. This misclassification would have diluted the observed effect size. As a result, the estimates reported may in fact underestimate the association between erectile dysfunction and undiagnosed cardiometabolic risk factors. Second, increased recognition of the relationship between erectile dysfunction and cardiovascular disease may have altered screening

Undiagnosed Diabetes (n = 1,417)	
Unadjusted OR (95% CI)	Adjusted OR (95% CI)
4.58 (2.54-8.24)	2.20 (1.10-4.37)[a]
1.00	1.00
8.24 (2.49-27.19)	5.56 (1.78-17.35)[a]
14.83 (5.19-42.34)	8.70 (2.91-26.03)[a]
1.00	1.00
0.78 (0.39-1.56)	1.25 (0.57-2.71)
0.25 (0.11-0.58)	0.53 (0.21-1.33)
1.21 (0.46-3.15)	2.39 (0.87-6.55)
0.70 (0.33-1.47)	0.73 (0.35-1.55)
1.00	1.00
1.73 (0.56-5.36)	1.42 (0.47-4.30)
0.62 (0.23-1.68)	0.67 (0.29-1.55)
0.57 (0.25-1.34)	1.00 (0.41-2.41)
3.88 (2.16-6.96)	1.83 (0.92-3.65)
2.89 (1.68-4.98)	1.55 (0.81-2.99)
n/a[b]	n/a[b]
1.48 (0.71-3.07)	0.46 (0.18-1.17)
0.93 (0.54-1.62)	0.96 (0.54-1.72)
1.36 (0.65-2.86)	1.26 (0.50-3.14)
2.24 (1.40-3.59)	2.35 (1.50-3.68)[a]
1.00	1.00
2.83 (0.74-10.81)	2.28 (0.74-6.99)
5.98 (1.69-21.10)	3.60 (1.30-9.93)[a]

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practices of physicians. As such, the prevalence of undiagnosed cardiometabolic risk factors may in fact be lower now. Finally, as this study was cross-sectional, it was not possible to determine the temporal relationship between erectile dysfunction and the undiagnosed risk factors. This shortcoming does not, however, affect the importance of erectile dysfunction as a marker of undiagnosed cardiovascular risk factors for early intervention.

In conclusion, men with erectile dysfunction, particularly those who are middle-aged, should be made aware of their potential for having underlying diabetes and be encouraged to obtain screening. In the same vein, physicians should be vigilant in obtaining sexual histories in middle-aged men and screening those with erectile dysfunction for diabetes.