The Association of Exercise with Both Erectile and Sexual Function in Black and White Men

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ABSTRACT

Introduction. There is growing interest in using exercise to treat. Although many studies have highlighted the relationship between better erectile function and exercise, black men have been underrepresented in the literature.
Aims. This study aims to determine whether or not exercise is associated with better erectile as well as sexual function in black men and define a minimum exercise threshold for which better erectile/sexual function is seen in a cross-sectional study.
Methods. Our study population consisted of 295 healthy controls from a case-control study assessing risk factors for prostate cancer conducted at the Durham Veterans Affairs Medical Center, which contained a substantial proportion of black men (n = 93; 32%). Exercise and erectile/sexual function were both determined from self-reported questionnaires. Subjects were stratified into four exercise groups: <3 (sedentary), 3–8.9 (mildly active), 9–17.9 (moderately active), and ≥18 (highly active) metabolic equivalents (MET) hours/week. The association between exercise and erectile/sexual function was addressed utilizing multivariable linear regression analyses.
Main Outcome Measures. Erectile/sexual function was defined by the validated Expanded Prostate Cancer Index Composite sexual assessment, which was analyzed as a continuous variable (sexual function score). Clinically significant better function was defined as half a standard deviation (SD) (16.5 points).
Results. Median sexual function score was 53 (SD = 33). Higher exercise was associated with a better sexual function score ($P < 0.001$). Importantly, there was no interaction between black race and exercise (P-interaction = 0.772), meaning more exercise was linked with better erectile/sexual function regardless of race. Overall, exercise ≥18 MET hours/week predicted better erectile/sexual function ($P < 0.001$) with a clinically significant 17.3-point higher function. Exercise at lower levels was not statistically ($P \geq 0.147$) or clinically (≤8.14 points higher function) associated with erectile/sexual function.
Conclusions. In a racially diverse population, exercise ≥18 MET hours/week is highly associated with better erectile/sexual function regardless of race. **Simon RM, Howard L, Zapata D, Frank J, Freedland SJ, and Vidal AC. The association of exercise with both erectile and sexual function in black and white men. J Sex Med 2015;12:1202–1210.**

Key Words. Exercise; Exercise Therapy; Penile Erection; Erectile Dysfunction; Impotence

Introduction

Sexual dysfunction is a common problem among older men typically presenting as erectile dysfunction (ED) in 60% in men above the age of 65 [1]. In addition to increased age, other conditions such as obesity, diabetes, sedentary lifestyle, smoking, coronary artery disease, and lower socioeconomic status have also been highly associated with the presence and progression of ED [2–14]. Given the high prevalence of ED, multiple new pharmacologic options have been developed

for treating ED [15,16]. However, as these medications are not without side effects and are not 100% effective [16], there is growing interest in alternative ED treatments—specifically exercise [6,17–20].

Several large observational studies have highlighted the relationship between physical activity and erectile function [1,2,4,6,21]. Additionally, several randomized control trials have demonstrated improved erectile function with exercise [15,18,20,22,23]. Notably, a randomized trial conducted by Esposito et al. [20] demonstrated a significant increase in erectile function with increased exercise and decreased caloric intake in obese men ages 35–55 [20]. Consequently, several studies have attempted to determine a minimum amount of exercise needed to achieve an improvement in erectile function [6,17–19]. Importantly, a randomized trial conducted by Khoo et al. demonstrated sedentary obese Asian men had a significant increase in erectile function after 200–300 minutes of moderate intensity exercise (16.5–25 metabolic equivalents [MET] hours/week) [18]. However, in that study, men randomized to exercise of <11.5 MET hours/week did not demonstrate significant improvements in erectile function [18]. This suggests there may be a threshold below that exercise is not related to erectile function. Consistent with this, several observational studies found a similar threshold of minimal exercise to achieve better erectile function of approximately 16–40 MET hours/week [17,19,24].

Although numerous studies have highlighted the effect of exercise and erectile function, there has been minimal representation (<10%) of black men in these prior studies as well almost no analysis of other components of sexual function [4,6,15,17–22]. As such, the effect of exercise on both erectile and sexual function in this population is relatively unknown. Moreover, no study has ever addressed the minimal amount of exercise needed to improve erectile and sexual function in black men. Although it is debated whether black race is a risk factor for ED or not [11], several studies have demonstrated the increased prevalence of ED risk factors in the American black population including obesity, diabetes, sedentary lifestyle, and lower socioeconomic status [5,7–11,25]. As such, two key questions remain that we sought to address: Is exercise associated with erectile/sexual function in black men? If so, is there a minimum exercise threshold that is associated with better erectile/sexual function in black men? We hypothesized that (i) there would be a statistically and clinically significant association with exercise and better erectile/sexual function in black men and in our population overall, and (ii) there would be a minimum exercise threshold for which this association was observed. To test our hypotheses, we examined self-reported exercise and erectile/sexual function from a group of men who served as healthy controls for an ongoing case-control study of prostate cancer risk factors, which contained a substantial proportion (32%) of black men [26].

Materials and Methods

Study Population

Our accrual process for this study has been reported previously [26]. Briefly, our study population consisted of healthy controls from a case-control study assessing risk factors for prostate cancer conducted at the Durham Veterans Affairs Medical Center (DVAMC) in Durham, North Carolina. Subjects for this analysis were recruited from the DVAMC Internal Medicine, Dermatology, and Urology Clinics [26]. Eligibility criteria were age ≥18, no prior history of prostate cancer, and having a prostate-specific antigen (PSA) test conducted in the year prior to enrollment but not recommended to undergo biopsy. Questionnaires were administered to subjects to assess family, medical, and social history as well as questions to assess amount of exercise per week and erectile/sexual function. Participants were instructed to complete the questionnaire at home at their convenience and return it to study personnel in a provided, pre-addressed stamped envelope. Between 2007 and 2012, we identified 596 potential healthy controls of whom 498 signed written consent forms for this study (84% accrual rate). We excluded men that had missing data in our measures of weekly exercise (n = 158), erectile/sexual function (n = 35), waist circumference (n = 2), body fat percentage (n = 6), smoking status (n = 1), and coronary artery disease (n = 1). Thus, a total of 295 men were included in the analyses. We compared the two groups and found that except for fewer smokers (70.2% vs. 72.5%, $P = 0.043$), and more black men in the excluded group (47% vs. 32%, $P < 0.001$), there were no other differences between groups. Institutional Review Board approval was obtained at Duke University and at the DVAMC, and all subjects signed an informed consent prior to enrollment.

Exercise was assessed using the leisure score index of the Godin Leisure-Time Exercise Questionnaire [27]. The leisure score index contains

three questions that assess the average frequency of mild, moderate, and strenuous intensity exercise during free time in a typical week. There was also a corresponding question for each of the three exercise intensities on the average duration in minutes for a typical session of activity within that exercise intensity.

To calculate the metabolic equivalent of task (MET) hours of total current exercise, the frequency of exercise sessions per week in each intensity category was multiplied by the average reported duration in hours, weighted by an estimate of the MET for that intensity, summed across all intensities, and expressed as average total MET hours/week (Supplementary Table S1). The weighted values for each exercise intensity were mild (3 METs), moderate (5 METs), and strenuous (9 METs). For example, for a subject who reported mild activity for 1 hour 3 times a week (i.e., golfing) and moderate activity for 30 minutes twice a week (i.e., tennis), the calculation 3 MET × (1 hour × 3) + 5 MET × (0.5 hours × 2) = 14 MET hours/week would be used to compute total current MET hours/week of exercise.

The exercise categories were based on the 2007 joint recommendations of the American College of Sports Medicine and the American Heart Association, which states that 7.5–12.4 MET hours/week over and above routine activities of daily living is the minimal amount of activity recommended to achieve substantial health benefits in reducing the risk of chronic diseases and disabilities [28]. The exercise categories for this study, based on this recommendation and previous work done with women with breast cancer were: <3 (sedentary), 3–8.9 (mildly active), 9–17.9 (moderately active), and ≥18 (highly active) MET hours/week [29].

Erectile/sexual function was measured using the validated Expanded Prostate Cancer Index Composite sexual assessment [30]. This questionnaire comprises questions pertaining to both erectile function and overall sexual function. The questions addressed the ability to have erections overall, ability to have an orgasm, quality and frequency of erections, overall sexual function, as well as a rating of how big of a problem subjects thought their erections were. Most of these questions had a score from 1 to 5 (1 = very poor, 5 = very good). Quality of erections was measured from 1 to 4 (1 = none at all, 4 = firm enough for intercourse). To transform these scores into a continuous variable, each number was mapped to a score from 0 to 100, and then all scores were averaged together to create an overall sexual function score that ranged from 0 to 100. The variables were transformed differently if they were listed from 1–4 (1 = 0, 2 = 33, 3 = 66, 4 = 100), 1–5 (1 = 0, 2 = 25, 3 = 50, 4 = 75, 5 = 100) and reversed in the erection problem question. For example, if a man stated that he had a small problem with erections (three out of five), with good ability to achieve an erection (four out of five), with erections firm enough for intercourse (four out of four), with very good ability to reach orgasm (five out of five), and the ability to achieve erections more than half the time the man wanted (four out of five), this patient would have an overall sexual function score of 80/100 ([50 + 75 + 100 + 100 + 75]/5 = 80).

Statistical Analysis

Our exposure was MET hours/week and our primary outcome was erectile/sexual function measured by sexual function score. MET hours/week was used as a categorical variable. Subject demographic characteristics were grouped into four categories of MET hours/week (described above). Baseline characteristics and sexual function score comparisons between these four groups were performed using Kruskal–Wallis for continuous non-normally distributed variables and χ^2 tests for categorical data.

The associations between sexual function score (primary outcome), different sexual function indicators (secondary outcome), and MET hours/week were analyzed using linear and logistic regression, respectively. Multivariable models were adjusted for age (continuous), waist circumference (continuous), race (black vs. nonblack), self-reported diabetes (categorical), smoking status (current + former vs. never), and coronary artery disease (history of heart attack or chest pain vs. no history). We did not adjust for body mass index (BMI) as it was collinear with waist circumference (Spearman, $r = 0.88$), and waist circumference is an established risk factor for significant ED [4]. Sexual function indicators included: ability to have erections overall, ability to have an orgasm, quality and frequency of erections, and overall sexual function. These were assessed as binomial variables (good vs. poor) with good sexual function defined as a 4 or 5 (good/very good) for all questions except for quality of erections in which a value of 4 was used (4 = Firm enough for intercourse). To determine a *P*-trend, MET hours/week was examined as a continuous variable assigning all men the median value of their

respective MET hours/week category. To determine if there was an interaction between exercise and black race in predicting sexual function, a cross product of black race (yes/no) with MET hours/week (continuous; median of categories) was examined in linear regression analysis.

Statistical analysis was performed using Stata, version 11.2 (Stata Corp, College Station, TX, USA). Statistical significance was two-sided with $P < 0.05$. Clinically significant differences in erectile/sexual function were defined as half of a standard deviation in overall sexual function score. As standard deviation was 33 points, a change of 16.5 points in our population was considered clinically significant [31].

Results

Our study population had a median age of 62 years, with a substantial proportion (32%) of black men. Our population was predominantly obese with a median BMI of 30.5 kg/m^2 and a median waist to hip ratio of 0.98. Subjects had an overall modest level of erectile/sexual function with a median sexual function score of 53.4. Mean sexual function score was 50 (standard deviation = 33). The largest portion of men (44%) reported <3 MET hours/week with the second highest (26%) reporting ≥18 MET hours/week. There was also a substantial proportion (39%) of men with self-reported type II diabetes in our study as well as coronary artery disease (36%). There was no difference in subjects when stratified by MET hours/week in terms of age, BMI, race, diabetes, smoking status, coronary artery disease, waist circumference, body fat, or waist-to-hip ratio (Table 1).

Our primary outcome was determining the relationship between exercise and erectile/sexual function measured by sexual function score. Men who reported more frequent exercise also reported higher sexual function scores. Specifically, men with reported ≥18 MET hours/week of exercise had a median sexual function score of 70.0 (interquartile range [IQR]: 43.5–85.0) vs. a median sexual function score of 33.4 (IQR: 15.0–68.4) in men who reported exercising <3 MET hours/week (Table 1).

When testing the interaction between black race and MET hours/week in predicting sexual function score, there was no interaction (P interaction = 0.772). As such we did not stratify by race in further analyses. Among all subjects, self-reported exercise of ≥18 MET hours/week was associated with a 17.32 point higher sexual

Table 1 Demographic characteristics of 295 men by MET hours/week

Variable	Cohort N = 295	MET hours/week <3 N = 129 (44%)	3–8.9 N = 49 (17%)	9–17.9 N = 38 (13%)	≥18 N = 79 (26%)	*P* value
Age	62 (58–65)	62 (59–67)	61 (58–64)	61 (58–64)	62 (58–65)	**0.024***
BMI (kg/m^2)	30.5 (26.5–33.8)	30.9 (21.0–34.1)	30.5 (27.1–33.3)	30.2 (25.9–33.8)	29.8 (26.3–33.2)	0.656*
Race (black)	93 (32%)	37 (29%)	15 (31%)	12 (32%)	29 (37%)	0.686†
Diabetes (self-reported)	114 (39%)	54 (42%)	17 (35%)	17 (45%)	26 (33%)	0.493†
Smoking (past or current)	214 (73%)	98 (76%)	36 (73%)	27 (71%)	53 (67%)	0.552†
CAD (history of heart attack or chest pain)	107 (36%)	53 (41%)	18 (37%)	10 (26%)	26 (33%)	0.346†
Waist circumference (inches)	43.0 (39.5–46.5)	43.3 (40.5–47.0)	43.5 (40.0–46.0)	42.5 (38.0–46.0)	42.0 (39.0–45.0)	0.124*
Body fat (percentage)	30.1 (25.9–33.3)	31.0 (26.6–34.3)	30.3 (27.3–33.9)	30.0 (22.7–32.1)	28.8 (25.3–32.6)	0.123*
Waist-to-hip ratio	0.98 (0.98–1.06)	0.98 (0.95–1.01)	0.98 (0.94–1.00)	0.97 (0.91–1.01)	0.96 (0.91–1.00)	0.251*
Sexual function score	53.4 (21.6–80.0)	33.4 (15.0–68.4)	55.0 (23.4–75.0)	59.2 (23.4–85.0)	70.0 (43.4–85.0)	**0.002***

*Kruskal–Wallis
†χ^2 test
All data are represented as medians with interquartile range (IQR) in parentheses or as a proportion for binomial variables.
Comparisons were made between MET/hours per week groups.
The bold values represent associations that were statistically significant.
BMI = body mass index; CAD = coronary artery disease

Table 2 Linear multivariable regression analysis of sexual function score

Variable	Change in (SF) score*	95% CI	*P* value
Age (continuous)	–0.93	–1.48 to –0.44	**<0.001**
Race (black vs. nonblack)	–1.36	–9.04 to 6.33	0.729
Diabetes (self-reported yes vs. no)	–11.06	–18.36 to –3.76	**0.003**
Smoking (past or current vs. never)	–5.07	–12.96 to 2.83	0.208
History of heart attack or chest pain (CAD) vs. no	–13.90	–21.17 to –6.62	**<0.001**
Waist circumference (continuous)	–0.30	–0.95 to 6.33	0.373
MET hours/week (vs. < 3)			
3–8.9	6.03	–3.93 to 16.00	0.235
9–17.9	8.14	–2.87 to 19.15	0.147
≥18	17.32	8.69 to 25.94	**<0.001**

*Change in SF score can be interpreted as the relative increase/decrease in SF score observed for each categorical variable (i.e., men who exercise ≥18 MET hours/week are likely to have an increase in sexual function score of 17.32 compared with those who exercise for <3 MET hours/week) or increase/decrease per unit increase in the continuous variable analyzed (i.e., for every 1 year increase in age a man is likely to have a 0.93 point decrease in sexual function score compared with a man 1 year younger). All models were mutually adjusted for age (continuous), race (black vs. nonblack), diabetes (categorical, self-reported yes vs. no), smoking status (past and current vs. never), coronary artery disease (history of heart attack or chest pain vs. no history), and waist circumference (continuous).
The bold values represent associations that were statistically significant.
CAD = coronary artery disease; SF = sexual function

function score relative to men who exercise <3 MET hours/week (Table 2). This difference was both statistically ($P < 0.001$) and clinically significant (>16.5 point higher). In contrast, exercise of 9–17.9 MET hours/week was not associated with either a statistically ($P = 0.147$) or clinically significant (8.14 point higher) difference relative to <3 MET hours/week. Additionally, increased age, the presence of diabetes, and coronary artery disease (history of heart attack or chest pain) were all associated with a decreased sexual function score ($P = 0.001$, $P = 0.003$, and $P < 0.001$, respectively) (Table 2). Black race, smoking, and abdominal obesity (waist circumference) were unrelated to sexual function scores. In sensitivity analyses excluding outliers or men who reported either >30 MET hours/week or >90 MET hours/week, the association between sexual function score and ≥18 MET hours/week category became stronger (19.6 higher sexual function score, $P = 0.001$; 19.9 higher sexual function score, $P < 0.001$, respectively) (data not shown).

When examining dichotomous outcomes of "good" vs. "poor" erectile/sexual function, overall more exercise was associated with better function across all domains (all P trend ≤0.016). Specifically, ≥18 MET hours/week was an independent predictor of all five examined erectile/sexual function indicators: a good/very good ability to have an erection (odds ratio [OR] = 2.77, $P = 0.002$), good/very good ability to reach orgasm (OR = 2.29, $P = 0.008$), erections firm enough for intercourse (OR = 2.43, $P = 0.005$), ability to have erections more than half the time/whenever the subject wanted (OR = 3.06, $P = 0.001$) and good/very good ability to function sexually over the past 4 weeks (OR = 3.53, $P < 0.001$) relative to <3 MET hours/week (Table 3). Although exercising ≥18 MET hours/week was favorably associated with all outcome measures; this was not true for lesser levels of exercise. For example, though 9–17.9 and 3–8.9 MET hours/week were generally associated with better function for most outcomes, these associations did not always reach statistical significance, and some outcome measures did not even show a suggestion of association with exercise (i.e., erection ability and orgasm among men who reported 3–8.9 MET hours/week). Additionally, diabetes, older age, past or current smoking, and coronary artery disease, but not abdominal obesity (waist circumference), were negatively associated with all components of the sexual function score, though not all of these associations reached statistical significance. Although black race was associated with a worse outcome in several components, reaching statistical significance for poor frequency of erections, ability to have erections, and ability to function sexually over the past 4 weeks, it was associated with better scores in two outcomes including quality of erections (though this was not statistically significant).

Discussion

Multiple prior studies have shown that exercise is associated with better erectile function as well as some aspects of overall sexual function. Nonetheless, how much exercise is needed to see differences in erectile/sexual function remains unclear [15]. Moreover, it is also not well understood

Table 3 Logistic regression model by demographic characteristics and by MET hours/week for components of the sexual function score

	Erection ability†		Orgasm‡		Quality of erections§		Frequency of erections¶		Sexual function**	
Variable	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age (continuous)	0.94 (0.91–0.98)	**0.003**	0.97 (0.93–1.00)	0.056	0.96 (0.93–1.00)	0.052	0.94 (0.91–0.98)	**0.003**	0.94 (0.0–0.98)	**0.002**
Race (black vs. nonblack)	0.52 (0.28–0.95)	**0.033**	1.08 (0.63–1.86)	0.777	1.39 (0.80–2.41)	0.244	0.49 (0.27–0.88)	**0.018**	0.53 (0.29–0.96)	**0.037**
Diabetes (self-reported yes vs. no)	0.55 (0.31–0.98)	**0.044**	0.68 (0.40–1.15)	0.154	0.43 (0.25–0.73)	**0.002**	0.49 (0.28–0.84)	**0.010**	0.57 (0.32–0.99)	**0.049**
Smoking (past or current vs. never)	0.74 (0.41–1.35)	0.331	0.52 (0.30–0.91)	**0.022**	0.88 (0.50–1.56)	0.671	0.63 (0.35–1.13)	0.119	0.61 (0.34–1.09)	0.095
History of heart attack or chest pain (CAD) vs. no	0.56 (0.32–0.99)	**0.050**	0.49 (0.29–0.83)	**0.008**	0.43 (0.25–0.73)	**0.002**	0.44 (0.25–0.77)	**0.004**	0.47 (0.27–0.83)	**0.009**
Waist circumference (continuous)	0.99 (0.94–1.04)	0.640	1.01 (0.96–1.05)	0.783	0.99 (0.94–1.04)	0.644	0.99 (0.94–1.04)	0.578	1.01 (0.96–1.06)	0.748
MET hours/week (vs. < 3)										
3–8.9	0.94 (0.42–2.09)	0.872	1.00 (0.49–2.05)	0.993	2.59 (1.27–5.29)	**0.009**	2.41 (1.17–4.97)	**0.017**	1.74 (0.82–3.66)	0.146
9–17.9	2.02 (0.90–4.56)	0.089	1.13 (0.52–2.45)	0.758	2.45 (1.13–5.34)	**0.024**	1.78 (0.80–3.97)	0.160	2.02 (0.90–4.56)	0.088
≥18	2.77 (1.45–5.29)	**0.002**	2.29 (1.25–4.20)	**0.008**	2.43 (1.31–4.50)	**0.005**	3.06 (1.62–5.80)	**0.001**	3.53 (1.84–6.76)	**<0.001**
P trend*		**0.001**		**0.005**		**0.016**		**0.002**		**<0.001**

*To determine a *P*-trend, MET hours/week was examined as a continuous variable assigning all men the median value of their respective MET hours/week category. Reference group was comprised of the median of the <3 MET hours/week category and had a value of 0. Analyzed in separate model adjusted for age (continuous), race (black vs. nonblack), diabetes (categorical), smoking status (past and current vs. never), coronary artery disease (history of heart attack or chest pain), and waist circumference (continuous)

†Question: Your ability to have an erection? (Good/Very Good vs. Very Poor/Poor/Fair)

‡Question: Your ability to reach orgasm (climax)? (Good/Very Good vs. Very Poor/Poor/Fair)

§Question: How would you describe the quality of your erections? (Firm enough for intercourse vs. None at all/Not firm enough for any sexual activity/Firm enough for masturbation only)

¶Question: How would you describe the frequency of your erections? (More than half the time I wanted/Whenever I wanted vs. Never had an erection when I wanted one/Less than half the time/Half the time)

**Question: Overall, how would you rate your ability to function sexually during the last 4 weeks? (Good/Very Good vs. Very Poor/Poor/Fair)

All models were mutually adjusted for age (continuous), race (black vs. nonblack), diabetes (categorical), smoking status (past and current vs. never), coronary artery disease (history of heart attack or chest pain), and waist circumference (continuous).

The bold values represent associations that were statistically significant.

CAD = coronary artery disease

whether these associations apply to black men. To examine these two issues, we assessed a group of men who served as healthy controls for an ongoing case-control study of prostate cancer risk factors, which contained a substantial proportion of black men. After testing for the interaction between race and MET hours/week, we determined that regardless of race, exercise of ≥18 MET hours/week was associated with both statistically and clinically better erectile/sexual function, as well as better ability to have erections, ability to reach climax, quality of erections, frequency of erections, and overall ability to function sexually in the past 4 weeks. On the contrary, although exercising <18 MET hours/week was suggestively linked with better erectile/sexual function, these associations were not statistically significant and more importantly were not of a clinically significant magnitude. Therefore, our data suggest that exercising ≥18 MET hours/week is associated with clinically significant better erectile/sexual function regardless of race, whereas exercising less was not associated with better erectile/sexual function. These data support future randomized trials to test the use of high levels of exercise (≥18 MET hours/week) to improve erectile and sexual function.

As sedentary lifestyle is associated with ED, there has been considerable interest in exercise as a form of ED treatment [2,4]. Although many observational and several randomized trials have demonstrated the benefits of exercise in improving ED [6,15,20,21,23], few have determined a minimum threshold for which this benefit occurs [17–19,24]. This is an important point, as knowledge of this threshold could potentially aid the design of future guidelines or trials for treating patients with ED. A randomized trial conducted by Khoo et al. [18] determined that exercising 16.5–25 MET hours/week lead to improved erectile function, which was in line with our findings. A key distinction in that study, however, was its inclusion criteria of only abdominally obese Asian men [18]. Observational studies with varying inclusion criteria have identified other thresholds of minimal exercise to be associated with better erectile function such as the Androx Vienna Municipality study among nondiabetic healthy controls (~40 MET hours/week) [24], a study conducted by Hsaio et al. among men under the age of 40 (~20 MET hours/week) [17], and a study conducted by Bacon et al. in the Health Professionals Follow-up Study (16.6–32.6 MET hours/week) [19]. In our study, although exercising 3–18 MET hours/week was associated with better scores on

some outcome measures when the sexual function score was broken down into its component questions, overall this level of exercise was not associated with statistically nor clinically significant differences in overall erectile/sexual function. However, exercising ≥18 MET hours/week was associated with both statistically and clinically significant better overall erectile/sexual function as well as better function on all components of the sexual function score. Collectively, our study along with the prior studies provide support that a minimum level of exercise is needed to be associated with better erectile/sexual function and that threshold is around 18 MET hours/week.

Although our results are in line with prior studies, it is notable that prior studies demonstrated a paucity of black men (<10%) in their populations [17–19,24]. To overcome this limitation in the prior literature, we assessed a population that included a substantial proportion of black men with considerable ED risk factors such as increased age and a high prevalence of obesity and type II diabetes. Importantly, we found no interaction between race and exercise for predicting erectile/sexual function. In other words, the association between more exercise and better erectile/sexual function was seen in both black and nonblack men. As such, these data suggest that trials focused on exercise as a means to improve erectile/sexual function should include a racially diverse population with significant ED risk factors.

It has been shown previously that increased age, obesity, coronary artery disease, and type II diabetes are negatively associated with ED [1–4,12–14]. Although we found similar associations with age, type II diabetes, and coronary artery disease, we did not find any links between erectile/sexual dysfunction and obesity. However, as our population was comprised of predominately obese subjects (median waist circumference = 43, median BMI = 30.5), it is plausible that this effect was underestimated as prior studies that reported this association had considerably lower proportions of obese men [2,4]. Nevertheless, diabetes, coronary artery disease, and increased age still proved to be additional risk factors for erectile/sexual dysfunction in our predominately obese population.

One strength of our study is that we utilized a racially diverse cohort with significant ED risk factors. The major limitation of our study was its cross-sectional design and lack of long-term follow-up. As such, we cannot test whether a man who increases his exercise will see an improvement in his erectile/sexual function. Importantly, as this was not a randomized trial, we cannot conclude that more exercise caused better erectile/sexual function. Though we controlled for major confounders (age, diabetes, coronary artery disease, waist circumference, and smoking) we cannot exclude residual confounding (i.e., socioeconomic status). As our data were derived from a self-reported questionnaire, it is susceptible to recall bias or patients' inaccurately reporting. For example, the magnitude of the positive association between exercise and erectile/sexual function here reported may have been biased by including men who overreported MET hours. However, after excluding outliers (men who reported >30 and >90 MET hours/week) from the analysis, the association between exercise and sexual function became stronger. We also excluded from our analysis a substantial proportion of men that had missing data. Given that this excluded population was less likely to smoke and more likely to be black, inclusion of these men could have altered our findings, as smoking and black race are both risk factors for ED. Finally, we did not account for cumulative effects of exercise over time as the questionnaire only referred to current exercise. Thus, we cannot conclude whether or not increased levels of exercise over time affect erectile/sexual function. Additionally, we did not control for medications such as those that affect ED positively (i.e., phosphodiesterase type 5 inhibitors) or medications that would affect ED negatively (i.e., beta-blockers). As such we cannot definitely say that exercise does in fact lead to improved erectile function and could in fact be attributed to more prevalent medication use in a population that exercises more. Also, as patients were recruited from Veterans Affair's clinics and they may have a higher percentage of comorbidities when compared with the general population, our findings should be confirmed outside of the clinical/hospital setting. Finally, more exercise could be a surrogate for higher socioeconomic status that has also been demonstrated to be protective for ED. Although these factors limit the interpretation of our results, the level of exercise associated with better erectile/sexual function is comparable with that of previous population studies examining the association between exercise and ED [17,18].

In conclusion, in a racially diverse cohort with significant ED risk factors, exercise ≥18 MET hours/week was highly associated with better erectile/sexual function. Importantly, similar results were seen in both black and nonblack men. Although our study demonstrates an association

between better erectile/sexual function and highly active exercise, future clinical trials are needed to confirm these findings.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Table S1 Godin leisure-time exercise questionnaire.