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Recreational Use of Erectile Dysfunction Medications in Undergraduate Men in the United States: Characteristics and Associated Risk Factors

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Abstract   Mounting evidence indicates that erectile dysfunction medications (EDMs) have become increasingly used as a sexual enhancement aid among men without a medical indication. Recreational EDM use has been associated with increased sexual risk behaviors, an increased risk for STIs, including incident HIV infection, and high rates of concomitant illicit drug use. The aim of the present study was to investigate the characteristics and associated risk factors for recreational EDM use among young, healthy, undergraduate men. A cross-sectional sample of 1,944 men were recruited from 497 undergraduate institutions within the Unites States between January 2006 and May 2007. The survey assessed patterns of EDM use, as well as demographic, substance use, and sexual behavior characteristics. Four percent of participants had recreationally used an EDM at some point in their lives, with 1.4% reporting current use. The majority of recreational EDM users reported mixing EDMs with illicit drugs and particularly during risky sexual behaviors. Recreational EDM use was independently associated with increased age, gay, or bisexual sexual orientation, drug abuse, lifetime number of sex partners, and lifetime number of "one-night stands." Recreational EDM users also reported a 2.5-fold rate of erectile difficulties compared to nonusers. Overall, recreational use of EDMs was associated with sexual risk behaviors and substance abuse; however, a relatively small proportion of undergraduates reported using EDMs. Results also suggest that a sizable portion of recreational EDM users are heterosexual men, and that use does not solely occur within the environments of venues that cater to men having sex with men.

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Introduction

There are currently three oral medications approved by the Food and Drug Administration (FDA) for the treatment of erectile dysfunction (ED): sildenafil (Viagra), tadalafil (Cialis), and vardenafil (Levitra). These erectile dysfunction medications (EDMs) are well tolerated and effective for treating ED of various etiologies (Goldstein et al., 1998; Rosen & Kostis, 2003) and it is estimated that over 25 million men worldwide have been prescribed sildenafil alone (Pfizer Inc.).

Although these EDMs have been FDA approved to treat ED, mounting evidence indicates that these drugs have become increasingly used as a sexual enhancement aid among men without a medical indication. This phenomenon has raised concern particularly with respect to its association with increased sexual risk behavior. Studies indicate that in samples of men who have sex with men (MSM), those who recreationally use sildenafil are between two and six times as likely as nonusers to engage in unprotected anal intercourse with a partner of unknown or serodiscordant HIV status (Swearingen & Klausner, 2005). Recreational EDM users also report a higher number of sex partners during the past 1–2 months (Cachey, Mar-Tang, & Mathews, 2004; Kim, Kent, & Klausner, 2002), and about a twofold rate in sexually transmitted infections (STIs), including HIV infection (Jackson, 2005; Kim et al., 2002).

In addition, studies report frequent use of illicit drugs taken concomitantly with EDMs such as, but not limited to, methamphetamines, methylenedioxymethamphetamine (MDMA, ecstasy), cocaine, alkyl nitrites (poppers), and ketamine (Chu et al., 2003; Fisher et al., 2006; Hirshfield, Remien, Humberstone, Walavalkar, & Chiasson, 2004; Kim et al., 2002). Concordant use

of EDMs and illicit drugs poses several serious health concerns. Use of nitrates and EDMs simultaneously is contraindicated as it can cause severe hypotension, cardiac complications, and even death (Ishikura et al., 2000). Furthermore, concurrent use of illicit drugs and EDMs may potentiate high-risk sexual behavior by increasing social disinhibition while simultaneously enhancing sexual performance (e.g., decreasing the post-orgasmic refractory period; Mondaini et al., 2003), thereby facilitating the ability to have more sexual partners in a short period of time (Loeb, 2004).

Prior studies have begun to provide much needed data on recreational EDM use; however, they are not without their limitations. The vast majority of studies have sampled from high-risk populations, such as patients at STI/HIV clinics and prevention programs, and MSM attending circuit parties and nightclubs, and therefore little data are available regarding EDM use among heterosexual men. Second, the preponderance of studies has used relatively small convenience samples recruited from specific geographic locales, which has limited the generalizability of these findings. Third, studies have not established an event-specific association between EDM use and increased sexual risk behavior. Although there appears to be a relationship between these behaviors, more data are needed with respect to the time of EDM use and the specific type(s) of sexual behavior. Finally, a paucity of studies has investigated EDM use in an undergraduate population. Examining EDM use in college-aged men may be advantageous for several reasons: (1) individuals would be relatively young and the prevalence of clinically significant ED would be quite low; and (2) college students report high rates of alcohol and drug abuse, as well as high rates of sexual risk taking (Cooper, 2002; Gledhill-Hoyt, Lee, Strote, & Wechsler, 2000), behaviors which may be associated with EDM use.

The present investigation was designed to provide the first national study conducted in the Unites States examining EDM use in heterosexual, bisexual, and gay undergraduate men. Our first aim was to assess the rates of recreational use of sildenafil, tadalafil, and vardenafil and explore descriptive characteristics related to their use, such as frequency and length of use, motivations for use, source(s) of acquisition, and concomitant illicit drug use. Second, we aimed to investigate associated risk factors for recreational EDM use, including demographic characteristics, as well as sexual behavior and substance abuse characteristics.

Method

Participants

Individuals participating in this study were part of a cross-sectional convenience sample and were recruited from colleges and universities within the Unites States between January 2006 and May 2007. Overall, 3,056 individuals activated the online survey. Of these men, 283 exited the survey without answering any items; 2,773 participated in the survey to various extents, to which

1,944 questionnaires were complete enough for statistical analysis. Participants resided in 43 states, as well as the District of Columbia, and represented 497 distinct undergraduate institutions. The sample had a mean age of 21.3 years ($SD = 4.12$; range, 18–51) with 78% of men being between the ages of 18 and 22. The sample was predominantly White (67%) and participants were evenly distributed across academic years. The majority of participants identified as being heterosexual (86%) with 12% and 2% identifying as gay and bisexual, respectively. Characteristics of the participant sample are presented in Table 1.

Measures

Demographics

Participants completed a general demographics questionnaire which included items about age, race/ethnicity, socioeconomic status, academic year, geographic residence, and sexual orientation as assessed with the Kinsey Sexual Orientation scale (Kinsey, Pomeroy, & Martin, 1948).

Erectile Dysfunction Medication Use

Men were assessed as to whether they had ever used an oral EDM and, if yes, the types used (sildenafil, tadalafil, and vardenafil) and purpose of use (e.g., to treat ED diagnosed by a physician or for recreational reasons). They also reported whether they currently used an EDM and, if yes, the frequency of use (past 4 weeks, 6 months, and 1 year), and the frequency by which participants typically knew the dosage of the EDM that they were using (1 = never, 2 = sometimes, 3 = about half the time, 4 = most times, 5 = always). Motivation for use was also assessed by having participants select all of the particular motives that applied to them; response options were: curiosity, increase erectile rigidity, decrease refractory phase, counteract effects of drugs/alcohol that may attenuate erection, increase erectile sensation, increase libido, enhance self-esteem, decrease performance anxiety, impress/satisfy sexual partner, other. Participants indicated whether they had ever combined an EDM with recreational drugs. If they responded affirmatively, they were asked to report on the following substances: methamphetamines/amphetamines, MDMA (ecstasy), alkyl nitrites (poppers), ketamine, GHB/GBL (gamma-hydroxybutyric acid/γ-butyrolactone), marijuana, cocaine, LSD, mushrooms (psilocybin), heroin, and alcohol. Participants also reported on the frequency of concomitant drug use (past 4 weeks, 6 months, and year) and whether they believed that mixing EDMs with illicit drugs enhanced their sexual experience (1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = agree somewhat, 5 = strongly agree). Finally, the primary source by which individuals acquired EDMs was assessed, as well as the facility by which participants acquire EDMs (measured by the following item, "I have easy access to acquire Viagra,

Table 1 Participant characteristics: national cross-sectional sample of undergraduate men within the United States, 2006–2007

Characteristic	n	%
Age (years)		
18–22	1,513	77.8
>22	431	22.2
Race/ethnicity		
European-American	1,274	67.2
African-American/Black	73	3.8
Latino/a	213	11.2
Asian	290	15.3
Native-American	9	0.5
Other	38	2.0
Missing	47	
Academic year		
Freshman	523	26.9
Sophomore	466	24.0
Junior	415	21.3
Senior	447	23.0
Other[a]	93	4.8
Missing	214	
Geographic residence[b]		
North East	320	16.5
South Atlantic	140	7.2
North Central	254	13.1
South Central	939	48.3
Mountain	81	4.2
Pacific	210	10.8
Sexual identity		
Heterosexual/straight	1,669	85.9
Homosexual/gay	233	12.0
Bisexual	41	2.1
Missing	1	
Sexually active[c]	1,138	58.6
Erectile dysfunction[d]	145	12.7
Ever acquired an STI	131	6.8
HIV positive	6	0.3

STI Sexually transmitted infection

[a] Represented students who did not identify with a formal academic year, the majority of which were students who either recently graduated or were in a post-baccalaureate program

[b] The following states within each region within the United States were those actually represented by participants: Northeast (CT, MA, ME, NH, NJ, NY, PA, RI, VT); South Atlantic (DC, DE, FL, GA, MD, NC, SC, VA); North Central (IA, IL, IN, KS, MI, MN, NE, WI); South Central (AL, AR, KY, LA, OH, OK, MS, TN, TX); Mountain (AZ, CO, ID, NM, NV, UT); Pacific (CA, HI, OR, WA)

[c] Engaging in sexual intercourse within the past 4 weeks. Data were missing for three participants

[d] Calculated for only the subset of individuals who reported being sexually active ($n = 1,138$). Erectile dysfunction denotes an IIEF erectile function subscore < 25

Cialis, or Levitra," scored as 1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = agree somewhat, 5 = strongly agree).

Erectile Function

Sexual functioning was assessed by the International Index of Erectile Function (IIEF) (Rosen et al., 1997) which is a 15-item well validated self-report questionnaire assessing five domains of male sexual functioning: erectile function (six items), orgasmic function (two items), sexual desire (two items), intercourse satisfaction (three items), and overall satisfaction (two items). Because many of the items on the IIEF are related to sexual intercourse within the past 4 weeks, only sexually active individuals completed this questionnaire.

Sexual Behavior

Participants were asked whether they had ever engaged in sexual intercourse and, if yes, the age (in years) at which participants had experienced their first intercourse, and whether participants were currently sexually active (engaging in intercourse within the past 4 weeks). In order to evaluate sexual risk behaviors, participants completed items that assessed their number of sexual partners during the past 4 weeks, 6 months, and 1 year. Response options were 0–1, 2–5, and more than 5. Also assessed were the lifetime number of sexual partners (0–10, 11–50, >50), and the number of different partners with whom participants have had sexual intercourse on one and only one occasion (one-night stands; 0, 1–5, >5). Types of sexual contact (oral, vaginal, anal insertive, anal receptive), as well as whether participants used condoms and/or EDMs during these types of sexual contact, and participants' knowledge of partners' HIV status, was also examined. Response options to these items were measured as dichotomous (yes/no) responses. Finally, participants reported whether they have ever contracted an STI during their lifetime. Those reporting yes were asked to indicate which type(s) and whether they had ever engaged in unprotected oral-genital sex or unprotected intercourse while showing symptoms of an STI.

Substance Use

Participants were asked to report the number of times they had used particular illicit substances within the past year. They also reported on their frequency of alcohol use and patterns of use (frequency of inebriation), as well as tobacco use (number of cigarettes smoked daily).

Procedure

Male participants aged 18 and older were recruited via online classified advertisements as well as through online social

networking sites (e.g., LiveJournal, Xanga) and were asked to participate in a survey about "sexual behavior and recreational drug use." Individuals were also recruited via an undergraduate psychology subject pool at the University of Texas at Austin. All participants were required to read an online consent form before gaining access to the anonymous survey. The survey did not use cookies and did not collect user IP addresses. No personally identifying information was collected with the exception of the participant's academic institution in which he was enrolled, as well as the city and state of his residence. After completion of the 30-min survey, each participant was debriefed and given a random identification number that served as a confirmation that he had completed the survey. Participants were asked to email these identification numbers to the principal investigator such that they could be entered into a monthly raffle, upon which one participant was randomly selected each month and mailed a check for $50. Participants within the psychology subject pool at the authors' affiliated university received credit toward their psychology research requirement. The protocol was approved by the University of Texas at Austin Institutional Review Board.

Statistical Analysis

Participants reporting an erectile function score of <25 were considered to be experiencing erectile dysfunction of a clinical nature. This cutoff value has been demonstrated to have a sensitivity of 0.97 and a specificity of 0.88 to detect individuals with and without erectile dysfunction (Cappelleri, Rosen, Smith, Mishra, & Osterloh, 1999). Sexual orientation was categorized on the basis of participants' scores on the Kinsey Sexual Orientation Scale, whereby scores of 0, 1, or 2 denote heterosexual sexual identity, scores of 4, 5, or 6 denote homosexual sexual identity, and a score of 3 denotes bisexual sexual identity. Illicit drug use was categorized into the number of different drug types (with the exception of EDMs) used within the past year (0, 1, 2–4, >4), as well as total number of drug use occasions (regardless of drug type; 0, 1–50, >50). Alcohol use was examined as the average number of incidents that a participant was drunk during the past week (0, 1–3, >3), as well as the total number of alcoholic beverages consumed during the past month (0–50, 51–100, >100). Additional analyses using alternative cutpoints for illicit drug use and alcohol use did not change the results. Current smokers were categorized on the basis of number of cigarettes smoked per day ($\geq$10 cigarettes/day).

Key demographic variables as well as other variables previously shown to be associated with EDM use were examined using Pearson χ^2 tests. Fisher's Exact tests were used in cases with low cell counts. In the initial logistic regression analyses, variables were examined using the Wald test and unadjusted odds ratios with their 95% confidence intervals (CIs) were calculated. Significant risk factors identified in the simple logistic regression analyses were considered for the multivariable logistic regression by performing forward and backward stepwise selection and

calculating the χ^2 from the difference in -2 log likelihood estimates for each subsequent model. All variables that significantly improved the model fit ($p < .05$) were retained. A Pearson product moment correlation coefficient was used to quantify the relation between age and erectile functioning. All statistical tests were two-sided and an alpha <.05 was considered statistically significant. All analyses were performed using SPSS statistical software version 14.0 (SPSS Inc., Chicago, IL, USA).

Results

Erectile Dysfunction Medication Use Characteristics

The total sample of men had a mean IIEF erectile function score of 27.7 ($SD = 4.03$) and 13% of these participants had ED according to IIEF established standards. Mean scores for other domains of sexual functioning as per the IIEF were as follows: orgasmic function ($M = 9.0$; $SD = 1.77$), sexual desire ($M = 8.1$; $SD = 1.56$), intercourse satisfaction ($M = 11.5$; $SD = 2.99$), and overall satisfaction ($M = 7.8$; $SD = 1.96$). In concert with well established findings (Laumann, Paik, & Rosen, 1999; Selvin, Burnett, & Platz, 2007), age was significantly negatively correlated with erectile functioning, $r(1112) = -0.11, p < .001$. Approximately 7% of the total sample reported acquiring an STI, and six individuals (0.3%) reported being HIV positive.

Of the total sample, 5% reported using an EDM at some point in their lives. Of these individuals, 74% (4% of total sample) reported that their EDM use was for recreational purposes and 26% (1% of total sample) reported being prescribed an EDM by a physician to treat ED. Overall, 2% reported current use, with 1.4% of the total sample comprising recreational EDM users (see Table 2).

The following results pertain to only those participants reporting recreational EDM use and these are also shown in Table 2. Although these individuals had a mean IIEF erectile function score that was well within the nonclinical range ($M = 26.3$; $SD = 0.63$), approximately 27% of these participants had ED as per IIEF standards, compared with 11% of nonusers. Sildenafil was the most commonly used EDM (89%), compared to 24% and 23% of participants reporting the use of tadalafil and vardenafil, respectively. Among current recreational EDM users, the mean frequencies of use are as follows: 1.2 times during the prior month ($SD = 1.4$; range, 0–5), 2.8 times during the past 6 months ($SD = 2.87$; range, 0–10), and 5.8 times throughout the past year ($SD = 8.97$; range, 0–38). Among all recreational EDM users (past and current), the majority (61%) reported that they did not always know the dose, with 36% reporting never knowing the dose. The most common motive for initial use was curiosity, endorsed by 75% of men, followed by the aim to counteract substances that decreased erectile functioning, a motive endorsed by 29%. The primary reason for current use was to increase erectile rigidity (24%).

Table 2 Characteristics of erectile dysfunction medication use: national cross-sectional sample of undergraduate men within the United States, 2006–2007

Characteristic	n	%
EDM use (lifetime)	104	5.3
EDM use (current)	42	2.2
Purpose of EDM use		
Physician prescribed to treat ED	27	1.3
Recreational	77	4.0
Among recreational EDM users		
Motives for use (n = 77)		
Curiosity	56	74.7
Counteract drugs that decrease erectile capacity	22	29.3
Increase erectile rigidity	20	26.7
Impress sexual partner	17	22.7
Enhance self-esteem	13	17.3
Increase sex drive	12	16.0
Decrease refractory phase	10	13.3
Improve sensation	9	12.0
Other	4	5.3
Combined EDM with illicit drugs (n = 75)[a]	33	44.0
Among recreational EDM users who concomitantly use illicit drugs		
Substances most often involved (n = 33)		
Marijuana	20	60.6
Alcohol	15	45.5
Ecstasy	14	42.4
Methamphetamines/amphetamines	12	36.4
Cocaine	10	30.3
GHB/GBL	6	18.2
Alkyl nitrites (poppers)	5	15.2
Ketamine	3	9.1
Primary source of acquisition (n = 77)		
Friend	44	66.7
Internet	8	12.1
Dealer	4	6
OTC pharmacy outside of the United States	1	1.5
Other	9	13.6
Missing	11	

ED Erectile dysfunction, *EDM* Erectile dysfunction medication, *OTC* over the counter

[a] Data were missing for two participants

Forty-four percent of men reported that they had combined illicit drugs and/or alcohol with an EDM. Among these men, the most commonly reported were marijuana (61%), alcohol (46%), ecstasy (42%), methamphetamines (36%), and cocaine (30%). Of men reporting concomitant use, mean frequencies were as follows: 1.1 times during the past month ($SD = 3.63$; range, 0–20), 3.8 times during the past 6 months ($SD = 8.39$; range, 0–36), and 7.7 times during the past year ($SD = 19.03$, range, 0–100). Of men who reported mixing EDMs with illicit drugs, a substantial proportion reported doing so during sexual activity: 58% during vag-

inal intercourse, 62% during insertive anal intercourse, 38% during receptive anal intercourse, and 87% during oral sex. The majority of men reported that mixing EDMs with illicit drugs enhanced the sexual experience (67%). With respect to the primary source of acquisition, the majority (67%) of men reported obtaining EDMs from friends. As far as the facility by which men acquired EDMs, 50% reported easy access, 35% reported difficult access, and 15% reported a neutral attitude.

Men who recreationally used EDMs reported high rates of unprotected intercourse with individuals of serodiscordant or unknown HIV status. Specifically, of men reporting unprotected receptive anal intercourse with a partner of serodiscordant or unknown HIV status, 73% reported that they had concurrently used EDMs. Rates of event-specific EDM use for men reporting unprotected penetrative anal intercourse and unprotected vaginal intercourse with a partner of serodiscordant or unknown HIV status were 63% and 35%, respectively.

Associated Risk Factors for Recreational Erectile Dysfunction Medication Use

In the univariate analyses, recreational EDM use was found to be significantly associated with age ($\chi^2 = 43.42$, $df = 1$, $p < .001$) and sexual orientation ($\chi^2 = 38.88$, $df = 2$, $p < .001$; see Table 3). The use of EDMs was also associated with several substance use characteristics, such as the number of drug use occasions ($\chi^2 = 47.63$, $df = 3$, $p < .001$) and the number of different drug types used ($\chi^2 = 39.46$, $df = 3$, $p < .001$) within the past year, as well as the number of instances an individual was drunk during the past week, $\chi^2 = 7.25$, $df = 2$, $p < .03$. No association was found between EDM use and ethnicity, household income, relationship status, total number of drinks consumed during the prior month, and tobacco consumption.

Recreational EDM use was also found to be significantly associated with a number of sexual behavior characteristics (Table 4). As per univariate logistic analyses, significant correlates included number of sex partners during the past month ($\chi^2 = 41.06$, $df = 3$, $p < .001$), lifetime number of sex partners ($\chi^2 = 137.34$, $df = 3$, $p < .001$), lifetime number of one-night stands ($\chi^2 = 98.67$, $df = 2$, $p < .001$), STI status ($\chi^2 = 40.52$, $df = 1$, $p < .001$), erectile functioning ($\chi^2 = 13.05$, $df = 1$, $p < .001$), and risky sexual behaviors, such as unprotected receptive anal intercourse ($\chi^2 = 12.20$, $df = 1$, $p < .001$), unprotected penetrative anal intercourse ($\chi^2 = 21.07$, $df = 1$, $p < .001$), and unprotected vaginal intercourse ($\chi^2 = 8.78$, $df = 1$, $p < .01$), all with individuals of serodiscordant or unknown HIV status.

In the multivariate analyses (see Table 3), age remained a significant factor after adjusting for demographic characteristics, substance use, and sexual behavior variables, with individuals 23 years and older being significantly more likely to use an EDM compared to men aged 18–22 years (adjusted OR [AOR] = 2.73; 95% CI = 1.59, 4.70). Both gay (AOR = 2.83; 95% CI = 1.54, 5.18) and bisexual (AOR = 3.46; 95% CI =

Table 3 Association between demographic and substance use characteristics and recreational EDM use in a national cross-sectional sample of undergraduate men within the United States, 2006–2007

Characteristic	Recreational EDM use				Unadjusted OR	95% CI	Multivariate adjusted[a] OR	95% CI
	Yes		No					
	n	*%*	*n*	*%*				
Age (years)								
18–22 (referent)	37	2.5	1,465	97.5	1.00			
>22	40	9.6	375	90.4	4.22***	2.66–6.70	2.73***	1.59–4.70
Sexual orientation								
Heterosexual/straight (referent)	48	2.9	1,606	97.1	1.00			
Homosexual/gay	25	11.1	200	88.9	4.18***	2.52–6.93	2.83***	1.54–5.18
Bisexual	4	10.5	34	89.5	3.94**	1.34–11.53	3.46*	1.11–10.86
Drug use (past year)								
Drug types used[b]								
0 (referent)	15	1.6	904	98.4	1.00			
1	15	3.2	455	96.8	1.99	0.96–4.10	1.90	0.86–4.19
2–4	31	8.3	344	91.7	5.43***	2.90–10.19	4.23***	2.10–8.53
>4	13	10.9	106	89.1	7.39***	3.42–15.96	4.41***	1.77–11.01
Drug use occasions[b]								
0 (referent)	15	1.6	907	98.4	1.00			
1–50	29	4.6	599	95.4	2.93***	1.56–5.51	2.62**	1.31–5.24
>50	30	9.0	303	91.0	5.99***	3.18–11.28	3.23**	1.27–8.23
Alcohol use								
Days drunk (past week)[c]								
0 (referent)	26	2.7	923	97.3	1.00			
1–3	42	4.8	838	95.2	1.78*	1.08–2.93	1.64	0.93–2.87
>3	5	7.1	65	92.9	2.73*	1.02–7.35	1.44	0.45–4.66
Drinks consumed (past month)								
0–50 (referent)	45	3.5	1,244	96.5	1.00			
51–100	19	5.2	345	94.8	1.52	0.88–2.64	1.18	0.63–2.22
>100	13	4.9	251	95.1	1.43	0.76–2.69	0.97	0.46–2.06
Cigarette use (*n* smoked/day)								
<10 (referent)	70	3.9	1,742	96.1	1.00			
10 or more	7	6.7	98	93.3	1.78	0.80–3.97	0.55	0.20–1.51

CI Confidence interval, *EDM* erectile dysfunction medication, *OR* odds ratio

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Multivariate model adjusted for age, sexual orientation, number of drug types used within the past year, number of one-night stands (lifetime), presence of a sexually transmitted disease, and ever engaging in unprotected vaginal intercourse with someone of serodiscordant or unknown HIV status

[b] For 34 men, information on drug use was missing

[c] For 18 men, information on alcohol use was missing

1.11, 10.86) men were more likely to recreationally use EDMs compared to heterosexual men, and these former groups did not differ significantly from each other. Number of drug use occasions retained significance as an independent risk factor for recreational EDM use, and the association was strengthened as the number of drug use occasions increased. Compared with men who reported no drug use during the prior year, adjusted

odds ratios for EDM use were 2.62 (95% CI = 1.31, 5.24) for those reporting 1–50 drug use occasions, and 3.23 (95% CI = 1.27, 8.23) for those reporting >50 drug use occasions. Number of drug types used within the past year and likelihood of EDM use also displayed a dose response, with those using two to four drug types and those using greater than four drug types exhibiting adjusted odds ratios of 4.23 (95% CI = 2.10, 8.53) and 4.41

Table 4 Association between sexual behavior characteristics and recreational EDM use in a national cross-sectional sample of undergraduate men within the United States, 2006–2007

Characteristic	Recreational EDM use				Unadjusted OR	95% CI	Multivariate adjusted[a] OR	95% CI
	Yes		No					
	n	%	n	%				
Sexual partners								
Past month								
0–1 (referent)	54	3.2	1,655	96.8	1.00			
2–5	18	9.7	167	90.3	3.30***	1.89–5.67	1.91	1.00–3.63
>5	5	21.7	18	78.3	8.51***	3.05–23.78	2.29	0.57–9.27
Lifetime[b]								
0–10 (referent)	33	2.1	1,550	97.9	1.00			
11–50	22	8.7	231	91.3	4.47***	2.56–7.81	1.98	1.13–4.81
>50	17	30.4	39	69.6	20.47***	10.52–39.85	9.99***	3.16–31.54
One-night stands (lifetime)[c]								
0 (referent)	9	0.9	943	99.1	1.00			
1–5	27	3.9	672	96.1	4.21***	1.97–9.01	3.10**	1.39–3.25
>5	33	16.5	167	83.5	20.71***	9.73–44.06	7.25***	2.93–17.92
Have ever acquired an STI	18	14.2	109	85.8	5.28***	2.99–9.32	1.68	0.84–3.36
Erectile functioning[d]								
IIEF-EF ≥ 25 (referent)	47	4.8	931	95.2	1.00			
IIEF-EF < 25	17	12.5	119	87.5	2.83***	1.57–5.09	2.09*	1.05–4.17
Risky sexual behavior[e]								
Unprotected receptive anal intercourse	7	12.7	48	87.3	3.95***	1.72–9.06	0.56	0.17–1.86
Unprotected penetrative anal intercourse	10	14.1	61	85.9	4.61***	2.26–9.43	1.04	0.41–2.67
Unprotected vaginal intercourse	14	7.9	163	92.1	2.43**	1.33–4.44	1.70	0.85–3.41

CI Confidence interval, *EDM* erectile dysfunction medication, *IIEF-EF* Erectile Function subscore of the International Index of Erectile Function, *OR* odds ratio; *STI* sexually transmitted infection

* $p < .05$, ** $p < .01$, *** $p < .001$

[a] Multivariate model adjusted for age, sexual orientation, number of drug types used within the past year, number of one-night stands (lifetime), presence of a sexually transmitted disease, and ever engaging in unprotected vaginal intercourse with someone of serodiscordant or unknown HIV status

[b] For 25 men, information on lifetime number of sex partners was missing

[c] For 66 men, data on lifetime number of one-night stands was missing

[d] Calculated only for the subset of individuals who reported being sexually active ($n = 1,138$); for 24 men, information on erectile functioning was missing

[e] With individuals of serodiscordant or unknown HIV status

(95% CI = 1.77, 11.01), respectively. Men using only one drug type were more likely to use an EDM; however, this association did not reach statistical significance.

Multivariate analyses examining the association between recreational EDM use and sexual behavior characteristics are shown in Table 4. Number of lifetime sexual partners retained significance, with those reporting >50 partners being nearly ten times as likely to report recreational EDM use compared to those reporting 0–10 partners (AOR = 9.99; 95% CI = 3.16, 31.54). Men reporting an intermediate number of sex partners (11–50) reported a marginally significantly higher adjusted odds ratio compared to the reference group. A dose response was seen with the association between EDM use and the lifetime number of one-night stands, with men reporting 1–5 and >5 one-night stands having

adjusted odds ratios of 3.10 (95% CI = 1.39, 3.25) and 7.25 (95% CI = 2.93, 17.92), respectively. Finally, erectile functioning remained a significant factor after adjusting for age and other variables, with individuals scoring within the range suggestive of clinically significant erectile difficulties being significantly more likely to use an EDM compared to men without erectile problems (AOR = 2.09; 95% CI = 1.05, 4.17).

Discussion

The current study examined patterns of and associated risk factors for recreational EDM use in a large geographically diverse sample of undergraduate men in the United States.

Results indicated that 4% of participants had recreationally used an EDM at some point in their lives, with 1.4% reporting current use. The lifetime rate of use reported herein was similar to that of a young population-based sample in Finland (3%) (Santtila et al., 2007), as well as a small sample of undergraduate men in the United States (6%) (Musacchio, Hartrich, & Garofalo, 2006). These rates of recreational EDM use were in contrast to much higher rates reported in South American undergraduate (de Freitas, de Menezes, Antonialli, & Nascimento, 2008) and graduate (Korkes, Costa-Matos, Gasperini, Reginato, & Perez, 2008) samples (9–15%), most likely owing to the fact that prescriptions for EDMs in these countries are not required.

Frequency and breadth of substance use were both independently associated with recreational EDM use. Descriptive data revealed similar results, with nearly half of the sample of recreational EDM users reporting concomitantly mixing EDMs with alcohol and/or illicit substances, the most common of which were marijuana, alcohol, ecstasy, methamphetamines, and cocaine. These findings were similar to other studies examining patterns of recreational drug and EDM use in young men (Chu et al., 2003; Kim et al., 2002; Musacchio et al., 2006). A worrisome finding was that a sizable proportion (15%) of the sample reported mixing alkyl nitrites (poppers) with EDMs, a practice which is medically contraindicated as it may increase the risk of potentially fatal cardiovascular complications (Ishikura et al., 2000). Another point of concern is that the majority of men who mixed EDMs with recreational substances did so during sexual activity. EDMs in combination with illicit drugs may permit men in altered states to engage in unsafe sexual behaviors, creating concern for STI and HIV transmission, as well as unwanted pregnancy.

Men who recreationally used EDMs reported high rates of unprotected intercourse with individuals of serodiscordant or unknown HIV status. Although these rates varied according to sexual activity, they were all high (penetrative anal intercourse = 63%, receptive anal intercourse = 73%, vaginal intercourse = 35%). Studies examining rates of unprotected anal sex with a partner of unknown or differing HIV serostatus in men have reported similar results. These studies found an increase in unprotected anal sex with a partner of unknown or serodiscordant HIV status among sildenafil users, with recreational users between two and six times as likely to engage in this risk behavior (Chu et al., 2003; Colfax et al., 2001; Kim et al., 2002; Sherr, Bolding, Maguire, & Elford, 2000). However, it is important to note that, after we controlled for demographic, substance use, and sexual behavior covariates, these sexual risk taking behaviors were not independently associated with EDM use. Furthermore, recreational EDM use was not independently associated with negative health outcomes such as STIs (including HIV infection), as reported in other studies (Jackson, 2005; Kim et al., 2002).

In our study, men reporting a gay or bisexual sexual identity were approximately 3 to 3.5 times as likely to report EDM use, compared to heterosexual men. This is in line with a study that recruited men seeking public STI services in San Francisco, whereby gay and bisexual men were four times as likely to report recreational EDM use. Another study assessing recreational EDM use in the United Kingdom found similar results (McCambridge, Mitcheson, Hunt, & Winstock, 2006). Additionally, older age was associated with recreational EDM use. This is in accord with other studies reporting increasing EDM rates with increasing age, even in samples of young men with relatively small age ranges (Benotsch et al., 2006; Chu et al., 2003; Musacchio et al., 2006; Santtila et al., 2007). Recreational EDM users were also more sexually unrestricted compared to non-users. Specifically, men who recreationally use EDMs reported significantly higher numbers of lifetime sexual partners as well as higher numbers of one-night stands. In fact, men reporting more than 50 sex and more than 5 one-night were approximately 10 and 7 times as likely to recreationally use EDMs, respectively.

An important point to note is that the presence of clinically significant self-reported erectile difficulties was independently associated with EDM use. Although the mean IIEF erectile function score of recreational EDM users was well within the nonclinical range, 27% of these men had ED, compared to 11% of nonusers. The 2.5-fold rate of ED in recreational EDM users may be explained by recent data detailing the relationship between nonprescription EDM use and confidence in erectile abilities. Santtila et al. (2007) found that young recreational EDM users demonstrated significantly less confidence in their ability to gain and maintain erections compared to nonusers, and the frequency of EDM use was significantly negatively correlated with erectile confidence. Considering that lack of confidence in one's ability to initiate and hold erections has been identified as an important psychogenic risk factor for ED (Rosen, Cappelleri, Smith, Lipsky, & Pena, 1999), men who use EDMs recreationally may be vulnerable to becoming psychologically dependent on erections that are pharmacologically induced. This is an important consideration considering that the largest increase in sildenafil use among commercially insured adults in the U.S. is among younger men aged 18–45 years, who had an increase in use of 312% from 1998 to 2002 (Delate, Simmons, & Motheral, 2004). That being said, one cannot rule out the possibility that frequent substance use (which can independently cause erectile difficulties) may be etiologically responsible for the increased rate of self-reported ED. Unfortunately, this cannot be ascertained by our data, given the cross-sectional nature of our study design, as well as the fact that we did not specifically assess this relationship.

Strengths of the present study include: (1) the recruitment of a large, geographically diverse sample of men; (2) assessing rate of use and associated risk factors in a relatively low-risk population (compared to men recruited from STI/HIV clinics and MSM recruited from circuit parties) in order to attenuate overestimation biases; (3) recruitment of a large proportion of heterosexual men; (4) assessment of use of all three FDA-approved phosphodiesterase inhibitors; (5) the use of an anonymous survey conducted via the internet, thereby decreasing social desir-

ability bias and underreporting; (6) the establishment of event-specific associations between both EDM use and illicit drugs, and EDM use and sexual risk behavior, as well as time-sensitive data regarding all three of these characteristics; and (7) the use if rigorous statistical methods to control for associated risk factors such as age, and sexual orientation, as well as substance abuse and sexual behavior characteristics.

Several limitations of this study warrant mention. As a result of the cross-sectional nature of this study, we acknowledge the need to exercise caution in making direct casual inferences of any kind. The association between recreational EDM use and sexual risk behaviors warrants further investigation, in the form of prospective studies in multiple populations, in order to establish temporality of EDM use preceding sexual risk behaviors, as well as a potential causal link between recreational EDM use and increased risk of psychogenic ED.

Additionally, the sample of undergraduate men may not generalize to the population of young men in the United States for several reasons. First, nearly one-third of the entire participant sample was recruited from the authors' institution, and therefore the distribution of participants by geographic area is not representative of U.S. census data. Second, it is likely that this population of college men has an unintentional over-sampling of individuals who are relatively wealthy and educated. Third, our data indicate that African-American individuals were under-sampled while Asian-Americans were over-represented (U.S. Bureau of the Census, 2000). Fourth, considering that this survey was sexual in nature, biases among participants participating in sexuality research should also be considered (e.g., more sexual experiences, less traditional sexual attitudes, greater sexual sensation seeking, etc.; see Wiederman, 1999).

Another limitation is with respect to the method of data collection. Participants provided their responses via self-report on the Internet, thereby making it impossible to verify the validity of their data. However, collecting data online may also serve as an advantage in that it involves greater anonymity which may facilitate participants in disclosing intimate information. A final limitation was that there was no way to ascertain whether EDMs used by participants were in fact genuine (pharmacologically active), and therefore it is impossible to discount the possibility that some EDMs were inert, particularly those acquired from online pharmacies.

In conclusion, data from this national cross-sectional sample of undergraduates in the Unites States indicated that a relatively small portion of men recreationally used EDMs. Among those that did report use, EDMs were associated with sexual risk behaviors and substance abuse. These data were in line with the growing body of literature supporting the link between recreational EDM use and risky sexual behaviors and/or illicit drug use in samples of male high-risk populations. Results also suggest that a sizable portion of recreational EDM users were heterosexual men, and that use does not solely occur within the environments of venues that cater to MSM.

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