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Sexually transmitted diseases among users of erectile dysfunction drugs

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Abstract

Background—Pharmacologic treatments for erectile dysfunction (ED) have gained widespread popularity among middle-aged and older males in recent years. Increased sexual activity among users of these treatments raises concerns about sexually transmitted diseases(STDs).

Objective—To examine the association between STDs and ED drug s.

Design—Longitudinal analysis of users and non-users of ED drugs.

Data sources—Medical and drug claims from 1997 to 2006 of 1,410,806 male employees above the age of 40 with private insurance from 44 large companies.

Results—Users of ED drugs had higher baseline rates of STDs compared to non-users even prior to initiating ED drug therapy (288 v. 156 annually per 100,000 people, $p < 0.005$). Adjusting for these baseline rates, users of ED drugs had higher rates of STDs in the year after first ED drug use when compared to non-users in the same period (OR 2.06, $p < 0.05$). Within users of ED drugs, STD rates were higher in the year following first ED drug use compared to the year before (327 vs 289 annually per 100,000 people, $p < 0.05$).

Limitations—Selection bias precludes firm conclusions about whether use of ED treatments directly leads to increases in STDs.

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Conclusions—Compared to non-users, users of ED drugs have higher rates of STDs both prior to initiation of treatment and one year after. At a minimum, this relationship suggests that men using ED drugs may benefit from early discussions about safe sexual practices and closer monitoring for STDs. It is also possible that availability of ED drugs may increase STD rates.

Pharmacologic treatments for erectile dysfunction (ED) have gained widespread popularity among middle-aged and older males in recent years. Driven largely by the high prevalence of erectile difficulties in this population[1–8], rates of sildenafil use reportedly reached 1.4% in the commercially insured population by 2002.[9] This is perhaps not surprising, since nearly 40% of men aged 57 to 85 have some degree of erectile dysfunction.[8] While their clinical efficacy has been well documented, little is known about the relationship between ED treatments and the prevalence of sexually transmitted diseases (STDs). In light of growing evidence for rising STD cases, including AIDS cases, at older ages[10–14], ED drugs have received attention for their possible contribution to these trends.[13, 14] In fact, a recent study found that widowhood in older men, but not older women, was associated with higher rates of STDs, especially after the introduction of sildenafil (Viagra) in 1998.[15]

Although middle-aged and older adults generally take fewer risks with their health, their decreased need for contraception may imply less than optimal safe sexual practices compared to younger populations.[16] For example, prior research suggests that condom use declines with age[16, 17] and, among at-risk populations, individuals older than 50 years are one sixth as likely to use condoms during sex and one-fifth as likely to have been tested for HIV compared to individuals in their twenties.[18] Moreover, a survey of primary care physicians revealed that most physicians rarely or never discuss sexual risk factor reduction with their middle-age and older patients.[19] These facts are particularly important in light of the emergence of ED drugs, which have improved sexual function among older adult males.

Several small studies in the MSM (men who have sex with men) community have investigated the connection between pharmacologic ED treatments and STDs.[20–24] In this community, ED drug use is associated with high-risk sexual behavior, such as unprotected anal sex.[20–22] ED drug users also report a greater number of recent sex partners and higher rates of STDs than non-users.[21–23] While the measured outcomes of these studies likely reflect selection bias among users rather than the effect of ED drugs *per se*, these studies nonetheless highlight a group of individuals within the MSM community who are at high risk of contracting STDs.

In light of these findings and the growing use of pharmacologic treatments for ED, we investigated the relationship between STDs and ED drug use in a comprehensive, large sample of privately insured, middle-age and older adult male beneficiaries. Large datasets are required to examine STD patterns since in the general population itself, STDs are still quite rare, and even more so among middle-age and older adults.[15] For men above 40, we compared STD rates *between* users and non-users of ED drugs, adjusting for pre-existing STDs and other co-morbidities. We also compared STD rates *within users* before and after initiation of an ED drug. We hypothesized that users of ED drugs would have higher rates of STDs compared to non-users and that users of ED drugs would have higher rates of STDs in the months after initiating an ED drug compared to the months prior. A confirmation of this hypothesis would suggest two things. At a minimum, men requesting ED drugs would be at higher risk of contracting or already having sexually transmitted disease and may therefore benefit from closer monitoring of risky sexual behavior and renewed discussions about safe sexual practices. Second, the availability of ED drugs could in theory directly lead to higher rates of STDs by facilitating sexual activity among those previously less sexually active.

METHODS

We assembled a data set of pharmacy and medical claims at the monthly level from 1997 to 2006 for 44 large US employers. Because we were interested in STD rates among males most likely to use erectile dysfunction drugs, we restricted our sample to men above the age of 40.[9] Our final data included 1,410,806 male beneficiaries continuously enrolled for 2 years (n = 67,718,688 person-months). The data was de-identified and therefore exempt from review by the Institutional Review Board of the corresponding author's institution.

The pharmacy claims incorporated all prescription drug claims, each with information on the type of drug, drug name, national drug code, dosage, and days supplied. The medical claims included the date of service, diagnosis, and procedure code. These data have been used elsewhere to examine the impact of benefit design on pharmacy spending[25], use of medication by the chronically-ill[26, 27], and specialty drugs[28]. Although all types of health care encounters were captured - including inpatient, emergency, and outpatient services - our claims data excluded both the informal provision of prescription drugs by online or "black-market" suppliers, as well as prescriptions that were filled but not reported to the health plan. This is, of course, a possibility for drugs used to treat erectile dysfunction.

Our level of observation was an individual in one of four quarters of the year. In each quarter, we classified an individual as using an ED drug if they filled one or more prescriptions in that quarter for either sildenafil (Viagra), tadalafil (Cialis), or vardenafil (Levitra). Use of any of these drugs was identified by searching the pharmacy claims data for both the generic and branded names of these drugs, as well as the national drug codes associated with them.

We flagged individuals by quarter according to whether they had at least one claim for one of the following STDs: chlamydia, gonorrhea, herpes, HIV/AIDS, syphilis, or other (haemophilus ducreyi, human papilloma virus, lymphogranuloma venereum). Disease indicators for these STDs were identified in the medical claims according to International Classification of Disease, Ninth Revision (ICD-9) diagnoses. (Full list of ICD-9 codes used are available from the corresponding author).

We also constructed disease indicators for co-morbid conditions, some of which might be associated with the use of erectile dysfunction drugs and the likelihood of sexually transmitted disease. Separate disease indicators identified the following conditions: anxiety, asthma, cancer, cardiac disease, congestive heart failure, chronic obstructive pulmonary disease, depression, diabetes, hypercholesterolemia, hypertension, stroke, vascular disease. A beneficiary was determined to have one of these chronic conditions if their medical claims included 2 or more office visits with the corresponding ICD-9 code (available upon request).

Statistical Analysis

We analyzed the relationship between ED drug use and STDs in two ways. First, we compared rates of STDs between users and non-users of ED drugs. Specifically, for all users in our sample, we identified the first claim for an ED drug and calculated the average incidence of sexually transmitted disease 3, 6, 9, and 12 months after the first month a script was filled. We then compared these rates to a random sample of *non-users* for 3, 6, 9, and 12 months after the reference user filled their first ED script. We did this for each user and compared the 3-, 6-, 9-, and 12-month rate of STD between users and non-users of ED drugs. Because a simple comparison of means between individuals would not account for other important covariates, we estimated logistic models of STD incidence in which we accounted for age, other co-morbidities, existing STDs, and employer. We did this for each of several STDs (chlamydia, gonnorrhea, herpes, HIV, syphillis, other) and for all STDs

combined. In general, we prefer the specification combining all STDs since the relative infrequency of STDs, even in large samples such as ours, makes precise estimates difficult to obtain.

In addition to analyzing STD rates *between* users and non-users of ED drugs, we compared STD rates before and after initiation of an ED drug *within* users as well. Specifically, we identified the first claim for an ED drug and calculated the average incidence of STD 3, 6, 9, and 12 months before and after initiation of treatment. Those individuals whose first claim occurred when a plan entered our data were omitted since we could not identify the presence of a STD in the months prior to initiating treatment. In addition to a descriptive analysis, we estimated linear regression models in which we accounted for the hierarchical longitudinal structure of our data by including random effects at the individual and employer levels. These models included age and disease covariates as well and were computed separately for each STD and for all STDs combined.

STATA version 10 (STATA Corp, College Station, Texas) was used for statistical analyses and the 95% CI reflects .025 in each tail or $P \leq .05$.

Role of the funding source

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RESULTS

Sildenafil was approved for use in erectile dysfunction by the FDA in March 1998. From 1998 to 2003, sildenafil use among men above 40 increased from 4.3 percent to 6.3 percent in our sample. Vardenafil and tadalafil were approved by the FDA in September 2003 and December 2003, respectively. With the arrival of these competing drugs, sildenafil use dropped to 3.7 percent in 2006, as vardenafil and tadalafil steadily gained market share. In 2006, the last year of our data set, sildenafil still remained the market leader of erectile dysfunction drugs; 3.6 percent of men above 40 used sildenafil, 1.0 percent of men used vardenafil, and 1.7 percent of men used tadalafil.

Table 1 presents descriptive statistics of users and non-users of ED drugs in our data, including average age, rates of medical co-morbidities, and rates of STDs in the reference year prior to first ED drug fill.

Table 1 demonstrates that in general and not surprisingly, users of ED drugs were older and had higher rates of chronic disease. Overall rates of STDs in the year prior to the reference start date were substantially higher among those who ended up taking an ED drug. Note that HIV is significantly more prevalent than other diseases; this is because HIV is not curable and therefore the prevalence is high. Although differences in individual STDs (except for chlamydia and HIV) are not statistically significant due to low power, after pooling together all STDs and excluding HIV, users still have higher rates of STD prior to initiating ED drugs compared to non-users prior in the same period.

Table 2 extends our descriptive comparison of users and non-users of ED drugs by presenting average rates of sexually transmitted disease among users of ED drugs in the year after initiating therapy compared to non-users in that same period. STD rates are presented

per 100,000 beneficiaries and are calculated as rates in the first 3, 6, 9, or 12 months after users initiated treatment; a random sample of non-users were followed from the same calendar date forwards as well.

Table 2 shows that users of ED drugs had higher rates of chlamydia, herpes, HIV, syphilis, and other STDs in the 12 months after initiating treatment compared to a random sample of non-users in that same time period. Only Chlamydia, HIV, and all STDs combined were significant, however, at the $p < 0.05$ level. As before, the seemingly high HIV rate reflects the fact that the disease is incurable which raises the prevalence at any given point in time. Although Table 2 shows a higher prevalence of STDs among users of ED drugs in the year after first ED drug use (compared to non-users), it does not account for the higher baseline rate of sexually transmitted disease among users in the year before starting an ED drug. We address this in Table 3.

Table 3 presents the results of an estimated logistic model comparing STD rates between users and non-users, accounting for other covariates such as age, pre-existing STDs, other medical conditions, and employer. We employed random effects at the employer level.

Age and other medical conditions (not shown in table) were associated with higher STD rates in the following year. Adjusting for the prevalence of STDs prior to starting any ED drug, Table 3 shows that the prevalence of STDs was raised by more among users of ED drugs in the following year than among non-users. For example, the odds-ratio of users having an STD within 12 months after initiating an ED drug compared to non-users in that same period was 2.06 (95% CI 1.56 – 2.74), adjusting for prevalence of STD in the year prior. While it may appear that HIV drives the result for overall STDs, in a separate analysis where we excluded HIV and focused on all other STDs combined, the 1-year odds-ratio of any STD between users and non-users was 1.61 (95% CI 1.10 – 2.38).

Tables 4 and 5 analyze rates of STDs before and after first ED drug fill *within* users alone. Specifically, Table 4 displays average rates of STDs (per 100,000 people) among the users of ED drugs in both the 12 months before and after the first documented ED drug use.

Table 4 shows that within users, annual rates of overall STD increased from 289 to 327 per 100,000 men, a statistically significant difference at the 0.05 confidence level. This effect was mainly driven by increases in HIV, with all remaining STDs exhibiting no change on average.

Table 5 presents the estimated “within-effect” of the first ED drug fill on rates (per 100,000 people) of sexually transmitted disease within users, accounting for other covariates. This specification compares STD rates within users in the months following first ED drug fill compared to the equivalent number of months prior. For example, the rate of STD (per 100,000 people) at 6 months after an ED drug fill would be compared to the rate in the 6 months prior. STD rates are adjusted for covariates such as age and disease co-morbidities, and the model includes random effects at the user and employer level to account for the hierarchal structure of the data.

As Table 5 shows, our analysis generally lacks enough power to separately estimate the effect of ED drug use within users, by individual STD. For all STDs combined, however, the year after initiating ED drug therapy was associated with significantly higher rates of STD compared to the year before, the effect driven mainly by an increasing prevalence of HIV within users. Unlike our earlier analyses comparing users of ED drugs to non-users, when we excluded HIV from the within-analysis and combined all remaining STDs, we found no significant change in STD rates among users before and after starting an ED drug.

Sensitivity Analysis

We conducted a simple misspecification analysis to examine how misclassification of ED drug exposure would impact our results. For example, individuals using ED drugs may not have claims for these medications and could be incorrectly misclassified as non-users. Similarly, actual non-users of ED drugs could be incorrectly classified as users. Varying each of these probabilities, we found that the adjusted odds of STD at one year between users and non-users was relatively unchanged (analysis available from authors upon request). For example, if 10 percent of actual users of ED drugs were misclassified as being non-users and 20 percent of non-users were incorrectly classified as being users, our calculated adjusted odds of STD at one year between users and non-users would be still be 1.79 (compared to the baseline OR of 2.06).

DISCUSSION

Since the introduction of sildenafil (Viagra) in 1998, pharmacologic treatments for erectile dysfunction have gained increased popularity among middle-aged and older males. We investigated the relationship between ED drug use and STDs in a comprehensive, large sample of privately insured, middle-age and older adult male beneficiaries. Generally, we found that users of ED drugs had higher rates of sexually transmitted disease compared to non-users. In addition, among users of ED drugs, the months following first ED drug use were associated with higher rates of STDs than the months preceding initiation of therapy.

We interpret these results in two ways. At a minimum, use of ED drugs appears to be correlated with higher risk sexual behavior, either in the number or type of sexual encounters (neither of which we can observe in our data). Compared to non-users, users of ED drugs have a higher baseline prevalence of STDs prior to first ED drug use. After first use, rates of STDs are higher among users as well, even after adjusting for higher baseline prevalence. The simple fact that STD rates are higher among users of ED drugs at the very least suggests a particular subset of men who are at higher risk for STDs and who may benefit from renewed physician conversations about safe sexual practices. This is particularly relevant since most primary care physicians rarely discuss sexual risk factor reduction with their middle-age and older patients,[19] and only 9% of adults aged 40–80 years report that a doctor asked them about their sexual health during a routine doctor visit in the past three years.[29] Put differently, use of ED drugs by middle-aged and older patients may serve as a simple screening tool for physicians to use in identifying those patients who may benefit from reminders about safe sexual practice. This finding coincides with other researchers' recommendations that physicians should include discussions about sexual health in conversations with older patients.[30] Importantly, while conversations about safe sexual practices may be warranted, routine STD testing of men requesting ED drugs may, of course, not be. Although the relative difference between users and non-users of ED drugs is substantial, STD prevalence in older adults remains low and broad STD testing of those requesting ED drugs from their physician would likely not be cost-effective. For example, with annual average rates of STDs prevalence among users and non-users of 327 and 166 per 100,000 men, respectively, nearly 620 men requesting ED drugs would need to be screened to identify a single STD case.

The second interpretation of our results is that increased availability of ED treatments (perhaps through more generous insurance coverage or generic entry in the future) may directly lead to increases in STDs. Although within users, rates of total STDs appear to rise after initiating therapy, even this may still reflect selection bias if those using ED drugs anticipate (and ultimately realize) increased sexual activity in the future regardless of ED drug utilization. More generally, users of ED drugs are likely to be different than non-users, even after adjusting for age and other diseases. Users may be more adventuresome, may be

recently married, may have more sexual partners, and so forth. To address this, future research might use the introduction of sildenafil in 1998 to analyze whether individuals with medical conditions predisposing to ED witnessed higher growth in STDs between the months before and after the introduction of sildenafil. This was not possible in our data since most individuals entered our sample after the introduction of sildenafil so that pre-sildenafil STD rates could not be calculated. In the event that such a direct effect between ED drug use and STD risk exists, a natural question is what steps, if any, should be taken to ensure responsible utilization of these treatments. For example, health plans may consider increasing co-pays for these treatments, or manufacturers may consider including information about safe sexual practices as part of package inserts or direct to consumer advertising. Physicians may also remind their older adult patients about responsible utilization of these drugs.

In addition to the limitations raised above, our analysis has several others. First, we did not conduct a randomized control trial, which would be ideal in assessing the direct link between ED drug use and STD risk. Second, we identified users of pharmacologic ED treatments and rates of STDs from insurance claims data. Measured ED drug utilization may not capture drugs purchased outside of a patient's health plan and measured STD rates may miss visits to anonymous clinics. For example, one study showed that sildenafil is readily available over the internet without the need for a physician visit.[31] Third, although our claims data includes information on many covered lives, the prevalence of sexually transmitted disease is still quite low and precludes analysis at the individual STD level; a more refined analysis would more precisely target those diseases that screening efforts would be best targeted towards. More generally, further work may better characterize those users of ED drugs who are at highest risk of STD. Screening, whether in the form of brief conversations or formal STD testing, would be most effective if targeted towards those at highest risk.

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References

1. Laumann EO, Nicolosi A, Glasser DB, et al. Sexual problems among women and men aged 40–80 y: prevalence and correlates identified in the Global Study of Sexual Attitudes and Behaviors. Int J Impot Res. Jan-Feb;2005 17(1):39–57. [PubMed: 15215881]
2. Nicolosi A, Laumann EO, Glasser DB, Moreira ED Jr, Paik A, Gingell C. Sexual behavior and sexual dysfunctions after age 40: the global study of sexual attitudes and behaviors. Urology. Nov; 2004 64(5):991–997. [PubMed: 15533492]
3. Laumann EO, Paik A, Rosen RC. Sexual dysfunction in the United States: prevalence and predictors. Jama. Feb 10; 1999 281(6):537–544. [PubMed: 10022110]
4. Bacon CG, Mittleman MA, Kawachi I, Giovannucci E, Glasser DB, Rimm EB. Sexual function in men older than 50 years of age: results from the health professionals follow-up study. Ann Intern Med. Aug 5; 2003 139(3):161–168. [PubMed: 12899583]
5. Araujo AB, Mohr BA, McKinlay JB. Changes in sexual function in middle-aged and older men: longitudinal data from the Massachusetts Male Aging Study. J Am Geriatr Soc. Sep; 2004 52(9): 1502–1509. [PubMed: 15341552]
6. Enzlin P, Mak R, Kittel F, Demyttenaere K. Sexual functioning in a population-based study of men aged 40–69 years: the good news. Int J Impot Res. Dec; 2004 16(6):512–520. [PubMed: 15085171]

7. Johannes CB, Araujo AB, Feldman HA, Derby CA, Kleinman KP, McKinlay JB. Incidence of erectile dysfunction in men 40 to 69 years old: longitudinal results from the Massachusetts male aging study. J Urol. Feb; 2000 163(2):460–463. [PubMed: 10647654]
8. Lindau ST, Schumm LP, Laumann EO, Levinson W, O'Muircheartaigh CA, Waite LJ. A study of sexuality and health among older adults in the United States. N Engl J Med. Aug 23; 2007 357(8): 762–774. [PubMed: 17715410]
9. Delate T, Simmons VA, Motheral BR. Patterns of use of sildenafil among commercially insured adults in the United States: 1998–2002. Int J Impot Res. Aug; 2004 16(4):313–318. [PubMed: 14973524]
10. Ory M, Mack K. Middle-Aged and Older People with AIDS: Trends in National Surveillance Rates, Transmission Routes, and Risk Factors. Research on Aging. 1998; 20(6):11.
11. Bodley-Tickell AT, Olowokure B, Bhaduri S, et al. Trends in sexually transmitted infections (other than HIV) in older people: analysis of data from an enhanced surveillance system. Sex Transm Infect. Aug; 2008 84(4):312–317. [PubMed: 18586861]
12. Karlovsky M, Lebed B, Mydlo JH. Increasing incidence and importance of HIV/AIDS and gonorrhea among men aged >/= 50 years in the US in the era of erectile dysfunctiontherapy. Scand J Urol Nephrol. 2004; 38(3):247–252. [PubMed: 15204381]
13. Sharples T. More Midlife (and Older) STDS. Time Magazine. 2008
14. Schmid G. The unexplained story of HIV and ageing. WHO Bulletin. 2009; 87(3):1.
15. Smith KP, Christakis NA. Association between widowhood and risk of diagnosis with a sexually transmitted infection in older adults. Am J Public Health. Nov; 2009 99(11):2055–2062. [PubMed: 19762656]
16. Lindau ST, Leitsch SA, Lundberg KL, Jerome J. Older women's attitudes, behavior, and communication about sex and HIV: a community-based study. J Womens Health (Larchmt). Jul-Aug;2006 15(6):747–753. [PubMed: 16910906]
17. Patel D, Gillespie B, Foxman B. Sexual behavior of older women: results of a random-digit-dialing survey of 2,000 women in the United States. Sex Transm Dis. Mar; 2003 30(3):216–220. [PubMed: 12616139]
18. Stall R, Catania J. AIDS risk behaviors among late middle-aged and elderly Americans. The National AIDS Behavioral Surveys. Arch Intern Med. Jan 10; 1994 154(1):57–63. [PubMed: 8267490]
19. Skiest DJ, Keiser P. Human immunodeficiency virus infection in patients older than 50 years. A survey of primary care physicians' beliefs, practices, and knowledge. Arch Fam Med. May-Jun; 1997 6(3):289–294. [PubMed: 9161358]
20. Chu PL, McFarland W, Gibson S, et al. Viagra use in a community-recruited sample of men who have sex with men, San Francisco. J Acquir Immune Defic Syndr. Jun 1; 2003 33(2):191–193. [PubMed: 12794553]
21. Paul JP, Pollack L, Osmond D, Catania JA. Viagra (sildenafil) use in a population-based sample of U.S. men who have sex with men. Sex Transm Dis. Sep; 2005 32(9):531–533. [PubMed: 16118600]
22. Swearingen SG, Klausner JD. Sildenafil use, sexual risk behavior, and risk for sexually transmitted diseases, including HIV infection. Am J Med. Jun; 2005 118(6):571–577. [PubMed: 15922685]
23. Kim AA, Kent CK, Klausner JD. Increased risk of HIV and sexually transmitted disease transmission among gay or bisexual men who use Viagra, San Francisco 2000–2001. AIDS. Jul 5; 2002 16(10):1425–1428. [PubMed: 12131222]
24. Cachay E, Mar-Tang M, Mathews WC. Screening for potentially transmitting sexual risk behaviors, urethral sexually transmitted infection, and sildenafil use among males entering care for HIV infection. AIDS Patient Care STDS. Jun; 2004 18(6):349–354. [PubMed: 15294085]
25. Joyce GF, Escarce JJ, Solomon MD, Goldman DP. Employer drug benefit plans and spending on prescription drugs. JAMA. Oct 9; 2002 288(14):1733–1739. [PubMed: 12365957]
26. Goldman DP, Joyce GF, Escarce JJ, et al. Pharmacy benefits and the use of drugs by the chronically ill. JAMA. May 19; 2004 291(19):2344–2350. [PubMed: 15150206]

27. Goldman DP, Joyce GF, Karaca-Mandic P. Varying pharmacy benefits with clinical status: the case of cholesterol-lowering therapy. American Journal of Managed Care. Jan; 2006 12(1):21–28. [PubMed: 16402885]

28. Goldman DP, Joyce GF, Lawless G, Crown WH, Willey V. Benefit design and specialty drug use. Health Aff (Millwood). Sep-Oct;2006 25(5):1319–1331. [PubMed: 16966729]

29. Moreira ED Jr, Brock G, Glasser DB, et al. Help-seeking behaviour for sexual problems: the global study of sexual attitudes and behaviors. Int J Clin Pract. Jan; 2005 59(1):6–16. [PubMed: 15707457]

30. Kuehn BM. Time for “the talk”--again: seniors need information on sexual health. Jama. Sep 17; 2008 300(11):1285–1287. [PubMed: 18799432]

31. Armstrong K, Schwartz JS, Asch DA. Direct sale of sildenafil (Viagra) to consumers over the Internet. N Engl J Med. Oct 28; 1999 341(18):1389–1392. [PubMed: 10536133]

Table 1

Characteristics of users and non-users of erectile dysfunction drugs among men aged 40 and older with employer-provided health insurance

	Non-users	Users
N	1,376,838	33,968
Average age	58.6	62.2
Medical co-morbidities (%)		
Cancer	4.6	10.6
COPD	0.9	1.4
Heart disease	10.3	14.7
Depression	1.9	4.14
Diabetes	7.5	15.0
Hypercholesterolemia	6.0	12.7
Hypertension	14.7	29.9
STD rate in prior year (per 100,000 men)		
Chlamydia	15.0	41.2
Gonorrhea*	7.9	11.8
Herpes*	8.1	8.8
HIV	115.3	217.9
Syphilis*	7.3	14.7
Other*	8.4	5.9
All STDs	156.8	288.5
All STDs but HIV	45.9	79.5

Notes: Users and non-users were defined according to whether they filled one or more claims for either sildenafil, vardenafil, or tadalafil. All comparisons between users and non-users, except those specified by asterisk, are significant at the $p<0.005$ level. Those specified by asterisk all had p-values > 0.10.

Table 2

Rates of STD among users of ED drugs in the year after initiating therapy compared to non-users in that period (per 100,000 men)

	Rates per 100,000 non-users, by month				Rates per 100,000 users, by month after first ED drug fill			
	3 mo.	**6 mo.**	**9 mo.**	**12 mo.**	**3 mo.**	**6 mo.**	**9 mo.**	**12 mo.**
Chlamydia	4	9	13	18	15†	18†	26†	26†
Gonorrhea	3	5	7	9	3	6	6	9
Herpes	1	3	5	7	0	0	3	12
HIV	26	72	104	120	59†	165†	218†	262†
Syphilis	2	4	6	9	3	3	12	18
Other	3	5	7	8	3	12	12	18
All	38	96	139	166	82†	200†	265†	327†

Notes: STD rates were computed for users (n = 33,968) by quarter for one year after first ED drug fill; a control group of randomly selected non-users (n = 1,376,838) was followed during this same period.

† $p < 0.05$ in a comparison of mean STD rates between users and non-users.

Table 3

Adjusted odds-ratios of STD between users and non-users of erectile dysfunction drugs

	Months after first ED drug fill			
	3 mo.	**6 mo.**	**9 mo.**	**12 mo.**
Chlamydia (%)	5.01† (1.92 – 13.02)	1.99 (0.85 – 4.64)	2.11† (1.06 – 4.18)	1.60 (0.81 – 3.84)
Gonorrhea (%)	1.04 (0.13 – 7.99)	1.42 (0.34 – 5.86)	0.99 (0.24 – 4.27)	1.13 (0.35 – 3.56)
Herpes (%)	0.97 (0.43 – 4.21)	0.84 (0.36 – 4.02)	0.64 (0.87 – 4.63)	1.74 (0.63 – 4.77)
HIV (%)	1.97† (1.08 – 3.59)	2.33† (1.52 – 3.57)	2.37† (1.50 – 3.37)	4.27† (2.73 – 6.65)
Syphilis (%)	1.18 (0.16 – 9.01)	0.57 (0.08 – 4.23)	1.56 (0.54 – 4.47)	1.84 (0.76 – 4.14)
Other (%)	0.87 (0.11 – 7.19)	2.55 (0.88 – 7.36)	1.88 (0.67 – 5.29)	2.23 (0.97 – 5.27)
All (%)	1.83† (1.15 – 2.90)	1.83† (1.31 – 2.56)	1.72† (1.26 – 2.34)	2.06† (1.56 – 2.74)

Notes:

† $p < 0.05$. 95% confidence intervals in parentheses. STD rates were computed for users by quarter after first ED drug fill and compared to a control group of randomly selected non-users during this same period. Odds-ratios were adjusted for age, pre-existing STDs, and other co-morbidities (results not shown in table).

Table 4

Rates of STDs among users before and after starting an ED drug (per 100,000 men)

	Months before first ED drug fill				Months after first ED drug fill			
	−12 mo.	−9 mo.	−6 mo.	−3 mo.	+3 mo.	+6 mo.	+9 mo.	+12 mo.
Chlamydia (%)	41	38	29	15	15	18	26	26
Gonorrhea (%)	12	9	3	3	3	6	6	9
Herpes (%)	9	6	3	0	0	0	3	12
HIV (%)	218	206	168	79	59	165	218	262†
Syphilis (%)	15	12	12	9	3	3	12	18
Other (%)	6	6	6	3	3	12	12	18
All (%)	289	265	212	103	82	200	265	327†
N	33,968	33,968	33,968	33,968	33,968	33,968	33,968	33,968

Notes:

† $p < 0.05$. STD rates were computed for users by quarter for one year before and after first ED drug fill.

Table 5

Change in adjusted STD rates within users before and after starting an ED drug (rate per 100,000 users)

	Change in adjusted STD rates within users by month after first ED drug fill			
	3 mo.	**6 mo.**	**9 mo.**	**12 mo.**
Chlamydia (%)	0	−10	−8	−12
	(−19 – 18)	(−33 – 14)	(−36 – 19)	(−40 – 16)
Gonorrhea (%)	−1	3	−3	−3
	(−9 – 8)	(−7 – 14)	(−16 – 11)	(−19 – 12)
Herpes (%)	0	−3	−5	3
	(−7 – 8)	(−9 – 3)	(−15 – 5)	(−13 – 18)
HIV (%)	−3	42†	62†	102†
	(−34 – 29)	(5 − 79)	(31 − 93)	(72 − 131)
Syphilis (%)	−6	−8	2	7
	(−17 – 6)	(−21 – 5)	(−15 – 18)	(−11 – 24)
Other (%)	0	6	6	14
	(−1 – 2)	(−6 – 18)	(−6 – 18)	(−1 – 29)
All (%)	−3	34	49†	99†
	(−41 – 34)	(−14 – 81)	(2 – 96)	(49 – 149)

Notes:

† $p < 0.05$. Reported coefficients reflect the change in adjusted STD rates (per 100,000 people) within users in the months following first ED drug fill compared to the equivalent number of months prior. For example, adjusted STD rates in the entire 6 months after initiating ED treatment are compared to the 6 months prior.