

RESEARCH

Open Access



Appropriate use of Doxy-PEP and inappropriate antibiotic self-medication for STI management: insights from a LGBTQIA+ survey in Italy

Ippazio C. Antonazzo^{1†}, Lorenzo Losa^{2†}, Davide Rozza², Ilenia Pennini³, Mirco Costacurta⁴, Ilaria Ulgharaita^{3,5}, Rodolfo Pessina⁶, Matteo Augello⁷, Lorenzo G. Mantovani^{2,8} and Pietro Ferrara^{2,8*}

Abstract

Background Doxycycline post-exposure prophylaxis (Doxy-PEP) has emerged as a promising strategy for preventing selected bacterial sexually transmitted infections (STIs). Nevertheless, concerns remain regarding unsupervised access and inappropriate antibiotic use, particularly in populations disproportionately affected by STIs. In Italy, evidence on real-life Doxy-PEP use and antibiotic self-medication for STI management is still limited.

Methods We conducted a nationwide cross-sectional survey among LGBTQIA+ individuals in Italy to estimate the prevalence of Doxy-PEP use and antibiotic self-medication involving antibiotics other than doxycycline, and to identify associated determinants. Data were collected through an anonymous, online questionnaire disseminated via community-based channels.

Results Among 211 respondents, 21.3% reported Doxy-PEP use, while 11.1% antibiotic self-medication for STI management. Doxy-PEP use was associated with HIV PrEP use (OR=6.10; 95% CI: 1.09–34.24) and at least one STI diagnosis in the previous 12 months (OR=6.33; 95% CI: 1.72–23.41), whereas it was inversely associated with antibiotic self-medication (OR=0.04; 95% CI: 0.00–0.56). Antibiotic self-medication was associated with a history of prior STIs (OR=4.82; 95% CI: 1.27–18.37) and younger age (OR=0.93 for year; 95% CI: 0.86–0.99). A non-negligible proportion of Doxy-PEP users obtained doxycycline through informal or non-prescribed channels.

Conclusions Two distinct patterns of antibiotic exposure coexist within the Italian LGBTQIA+ community: structured Doxy-PEP use embedded in prevention pathways and unsupervised antibiotic self-medication. Integrated strategies are needed to support appropriate Doxy-PEP implementation, reinforce antimicrobial stewardship, and reduce barriers to equitable sexual health care.

[†]Ippazio C. Antonazzo and Lorenzo Losa contributed equally to this work.

*Correspondence:
Pietro Ferrara
pietro.ferrara@unimib.it

Full list of author information is available at the end of the article



Key Points

- This survey provides the first Italian evidence distinguishing guideline-consistent Doxy-PEP use from inappropriate antibiotic self-medication for STI prevention and management within the LGBTQIA+ community.
- Doxy-PEP use was strongly associated with engagement in formal sexual health pathways, including HIV PrEP use and recent STI diagnoses, supporting its role as a structured secondary prevention strategy.
- Antibiotic self-medication emerged as a distinct and unsupervised practice, more common among younger individuals and those with prior STIs.
- High willingness to use Doxy-PEP if medically prescribed highlights a substantial unmet demand, likely constrained by limited clinical guidance and access rather than individual reluctance.
- Integrated public health strategies are needed to promote appropriate Doxy-PEP implementation, strengthen antimicrobial stewardship, and reduce informal antibiotic use outside medical oversight.

Keywords Doxycycline post-exposure prophylaxis, Sexually transmitted infections, Antimicrobial stewardship, LGBTQIA+ health, Sexual health, Italy

Introduction

Understanding the real-life patterns of antibiotic use is a priority in the control of sexually transmitted infections (STIs) [1]. In clinical practice, inappropriate antibiotic use may lead to suboptimal outcomes, delayed etiologic diagnosis, and increased risk of complications or onward transmission [2, 3]. From a public health standpoint, improper antibiotic use contributes to the spread of antimicrobial resistance, undermines surveillance systems based on diagnosed cases, and challenges the effectiveness of population-level prevention strategies [4]. Accurate knowledge of how, when, and why antibiotics are used—whether prescribed, shared, or self-administered—is therefore essential to inform evidence-based guidelines, optimize antimicrobial stewardship, and ensure that novel prevention approaches, such as doxycycline post-exposure prophylaxis (Doxy-PEP), are implemented safely and effectively [5, 6].

Recently, Doxy-PEP has emerged as an effective structured prevention strategy for selected bacterial STIs: syphilis, chlamydia, and to some extent, gonorrhea. Randomized clinical trials have demonstrated a substantial reduction in the incidence of these infections among key populations, particularly men who have sex with men (MSM) and transgender women (TGW) [7, 8]. Although these findings have positioned Doxy-PEP as a promising addition to the STI prevention toolbox, its expanding use outside clinical settings raises important concerns [9, 10]. In particular, even in the absence of formal national guidelines, appropriate use of Doxy-PEP should be grounded in a clear clinical indication, medical supervision, adherence to recommended dosing regimens, and integration within comprehensive STI prevention and care pathways. Conversely, unsupervised access and inappropriate use may lead to suboptimal clinical outcomes and potentially accelerate the emergence of tetracycline-resistant bacterial strains [11].

Emerging evidence from high-income countries indicates that a non-negligible proportion of individuals using Doxy-PEP obtain the medication through informal or non-prescribed channels, often in the absence of medical counselling, especially within the LGBTQIA+ community, which remains disproportionately affected by STIs and has historically experienced barriers to equitable access to sexual health services [11, 12].

Closely intertwined is the broader phenomenon of antibiotic self-medication—defined as the consumption of antimicrobial agents without medical supervision or a valid prescription—, for both the prevention and treatment of suspected STIs [13, 14]. In the context of STIs, this behavior is often driven by stigma, fear of disclosure, perceived barriers to accessing sexual health services, and misconceptions regarding the benefits of early or prophylactic antibiotic use. As a result, individuals may initiate antibiotic therapy in the absence of a confirmed diagnosis or standardized treatment protocols, with potential consequences for individual clinical outcomes, STI transmission dynamics, and the emergence of antimicrobial resistance [13].

To date, studies examining the prevalence of Doxy-PEP use have largely been conducted in localized clinical settings [15, 16], and no study has systematically evaluated antibiotic self-medication for STI management within the Italian LGBTQIA+ community. Generating robust evidence on these practices is essential to inform targeted public health interventions, strengthen antimicrobial stewardship, and support policy decisions regarding the appropriate integration of Doxy-PEP into prevention strategies. This study was designed to disentangle these two practices—which are frequently conflated in public debate but differ substantially in rationale, implementation, and clinical implications—by estimating the prevalence of Doxy-PEP use and antibiotic self-medication and identifying the sociodemographic and behavioral determinants associated with these practices among LGBTQIA+ individuals in Italy.

Methods

Study design and population

We conducted a nationwide, cross-sectional observational study in Italy to estimate the prevalence of Doxy-PEP use and antibiotic self-medication for STI management, and to identify factors associated with these practices within the LGBTQIA+ community. Antibiotic self-medication for STI management was defined, in line with the questionnaire wording, as the use of antibiotics other than doxycycline without medical prescription. This operational definition was adopted to distinguish this practice from Doxy-PEP use, which was assessed separately. The study was implemented through online questionnaire coordinated by the Center for Public Health Research (CESP) of the University of Milano-Bicocca, in collaboration with Arcigay APS, a national LGBTQIA+ association with experience in sexual health research and STI prevention among the LGBTQIA+ community.

The survey was disseminated online during from July to November 2025 through Arcigay's official Instagram channels via posts and stories. No paid advertisements or additional promotional activities were conducted. Participant recruitment was conducted exclusively via online outreach. Eligible participants were individuals aged 18 years or older who self-identified as members of the LGBTQIA+ community, had internet access, and provided consent to participate. No personal identifiers were collected, and participation was voluntary and without financial or other compensation. Ethical approval was obtained from the Ethics Committee of the University of Milan-Bicocca (protocol no. 955/2025), and data were analyzed anonymously. The study is reported in accordance with the CHERRIES (Checklist for Reporting Results of Internet E-Surveys) guidelines [17]. A completed checklist is provided in the Supplementary Material.

Research instrument

Data were collected using a structured, self-administered open online questionnaire specifically developed for this study (Appendix A, Supplementary Material). It was implemented using the Qualtrics platform, which allowed for adaptive questioning through conditional logic based on participants' responses. The questionnaire comprised four main sections. The first section assessed socio-demographic characteristics and lifestyle factors, including age, sex assigned at birth, gender identity, sexual orientation, educational level, geographic area of residence, and level of urbanization. The second section focused on sexual behavior, collecting information on sexual satisfaction, number of sexual partners, condom use, and substance use during sexual activity. The third section addressed general and sexual health history,

including perceived health status, concern about acquiring STIs, HIV testing history and status, use of HIV pre-exposure prophylaxis (PrEP) and PEP, prior access to STI services, and history of diagnosed STIs. The fourth section investigated knowledge, prescription, and use of Doxy-PEP, including sources of information, patterns of use, adherence to recommended regimens, and modalities of drug procurement. It also assessed participants' willingness to use Doxy-PEP in the future if prescribed by a healthcare professional. In addition, this section included items on antibiotic self-medication for STI management (antibiotics other than doxycycline), exploring frequency, motivations, barriers to healthcare access, and sources of non-prescribed antibiotics. Where applicable, questionnaire items included "Prefer not to answer", "Do not know/Do not remember", and/or "Other" response options, the latter allowing respondents to provide free-text responses. The questionnaire was developed through an iterative, multidisciplinary process involving public health researchers, sociologists, psychologists, and representatives of the national LGBTQIA+ association Arcigay APS, ensuring both scientific rigor and contextual relevance. Where appropriate, items were adapted from previously published instruments to enhance content validity [12, 18–23]. Prior to dissemination, the questionnaire underwent pilot testing involving members of the research team. Minor revisions were made accordingly. The final questionnaire was administered once during the study period and had not been previously used or published. Measures were implemented to minimize duplicate responses (i.e., manual screening of the dataset). The dataset was also screened for completeness and incomplete entries (> 50% missing responses) were excluded from the final analysis.

Statistical analysis

The minimum sample size was calculated using the Lemeshow formula for single-proportion estimation in cross-sectional studies [24], assuming an expected prevalence of 13% based on the literature [20], a 95% confidence level (95%CI; $\alpha = 0.05$), and a margin of error of 5%. Under these assumptions, a minimum of 174 participants was required. Categorical variables were described as frequencies and percentages, while continuous variables were described using means and standard deviations (SD) or medians and interquartile ranges (IQR), as appropriate. For inferential analyses, a two-stage model-building strategy was applied [25, 26]. First, univariable analyses were conducted to assess associations between each independent variable and the outcomes of interest—namely, Doxy-PEP use and antibiotic self-medication for STI management (antibiotics other than doxycycline)—using the Mann-Whitney U test, chi-square (χ^2) test, and Fisher's exact test, as appropriate. Subsequently, variables

with a p -value < 0.25 in univariable analyses were considered eligible for inclusion in multivariable logistic regression models. Multivariable model construction followed a stepwise approach, retaining variables with a p -value < 0.25 in the final models to avoid excluding potentially relevant predictors in an exploratory study with a limited sample size. Multicollinearity was assessed using

Table 1 Sociodemographic characteristics of the study population overall, and stratified by Doxy-PEP use and antibiotic self-medication

	Total cohort	Doxy-PEP users	Participant who reported antibiotic self-medication
Total	211	27	21
Characteristic	N (% column) *	N (% row) ^	N (% row) ^
Sex assigned at birth			
Female	35 (16.6)	0 (0.0)	1 (2.9)
Male	173 (82.0)	27 (15.6)	20 (11.6)
Intersex	0 (0.0)	0 (0.0)	0 (0.0)
Prefer not to answer	3 (1.4)	0 (0.0)	0 (0.0)
Age (median and IQR)	37 (32–44)	37 (31–47)	35 (29–43)
Gender identity			
Cisgender	188 (89.1)	27 (14.4)	19 (10.1)
Transgender	14 (6.6)	0 (0.0)	2 (14.3)
Gender-diverse (gender-fluid, genderqueer, others)	7 (3.3)	0 (0.0)	0 (0.0)
Prefer not to answer	2 (1.0)	0 (0.0)	0 (0.0)
Sexual orientation			
Homosexual (gay, lesbian)	160 (75.8)	25 (15.6)	16 (10.0)
Bisexual, bi+, pansexual	34 (16.1)	2 (5.9)	4 (11.8)
Heterosexual	10 (4.7)	0 (0.0)	1 (10.0)
Asexual, greysexual	4 (1.9)	0 (0.0)	0 (0.0)
Others	3 (1.4)	0 (0.0)	0 (0.0)
Prefer not to answer	0 (0.0)	0 (0.0)	0 (0.0)
Educational level			
Postgraduate education	34 (16.1)	4 (11.8)	4 (11.8)
Master's degree or equivalent	68 (32.2)	12 (17.6)	5 (7.4)
Bachelor's degree	45 (21.3)	6 (13.3)	8 (17.8)
Primary or secondary education	64 (30.3)	5 (7.8)	4 (6.3)
Geographic area of residence			
Northern Italy	142 (67.3)	14 (9.9)	14 (9.9)
Central Italy	38 (18.0)	7 (18.4)	2 (5.3)
Southern Italy and Islands	31 (14.7)	6 (19.4)	5 (16.1)
Level of urbanization			
Metropolitan	101 (47.9)	13 (12.9)	11 (10.9)
Suburban	65 (30.8)	9 (13.8)	5 (7.7)
Rural/peripheral	45 (21.3)	5 (11.1)	5 (11.1)

Abbreviations: IQR Interquartile range

* Percentages may not sum to 100 due to rounding

^ Percentages calculated using the total number of participants in each category as denominator. Column percentages are reported in Table S1 (Supplementary material)

variance inflation factors (VIF), and no evidence of significant collinearity was observed. In both models, age, sex at birth, sexual orientation, and the alternate outcome variable were included a priori as fixed covariates. Candidate variables for multivariable modeling included sociodemographic, behavioral, and health-related factors. Specifically, these comprised age (continuous); sex assigned at birth (female, male); gender identity (cisgender vs. transgender or gender-diverse); sexual orientation (homosexual, bisexual/bi+/pansexual, heterosexual, asexual/greysexual, other); educational level (master's degree or higher vs. bachelor's degree or lower); geographic area of residence (North, Center, South/Islands); and level of urbanization (rural/peripheral, suburban, metropolitan). Behavioral variables included sexual life satisfaction (10-point Likert-type scale); number of sexual partners in the past six months (none, from 1 to 5, from 6 to 10, over 10); condom use during sexual intercourse in the past six months (never/rarely, always/almost always); and substance use during sexual activity in the past 12 months (no vs. at least once). Health-related variables comprised perceived health status (positive vs. negative); concern about acquiring an STI (10-point Likert-type scale); HIV status at the last test (negative, positive, never tested); current use of HIV PrEP (yes vs. no); prior use of HIV PEP (never vs. at least once); prior access to an STI clinic (never vs. at least once); history of previous STIs (none vs. at least one confirmed lifetime diagnosis); STI diagnoses in the past 12 months (none vs. at least one). Results were reported as adjusted odds ratios (ORs) with corresponding 95% CIs. Statistical significance was set at a two-sided p -value < 0.05 . All analyses were performed using Stata 19.5 [27].

Results

Participant characteristics

A total of 211 participants were included in the analysis. Population characteristics are presented in Table 1 and Table S1. The median age was 37 years (IQR: 32–44), and most of them were assigned male sex at birth (82.0%). Most respondents identified as cisgender (89.1%), 6.6% as transgender, whereas 3.3% reported a different gender identity. Sexual orientation was predominantly reported as homosexual (gay or lesbian) (75.8%), followed by bisexual, bi+, or pansexual orientation (16.1%). Participants were geographically distributed across Italy, with the majority residing in Northern Italy (67.3%). In terms of urbanization, nearly half of the sample lived in metropolitan settings (47.9%).

Behavioral and health-related characteristics

Behavioral and health-related characteristics of the study population are presented in Table S2. Overall, participants reported a favorable perceived health status, with

the vast majority rating their health as good (57.5%) or very good (28.0%). Sexual life satisfaction was relatively high, with a median score of 7 (IQR: 5–8) on a 10-point Likert-type scale.

The median number of sexual partners in the past six months was 5 (IQR: 1–10), with half of participants reporting having between 1 and 5 partners during this period. Substance use during sexual activity in the past 12 months was reported by nearly one quarter of participants, with most indicating occasional or infrequent use. Concern about acquiring a STI was moderate to high, with a median score of 7/10 (IQR: 5–9).

Almost one in ten participants who responded to this item (9.3%) were living with HIV (PLWH) for a mean duration of 12.3 years ($SD \pm 7.0$), while 10.9% had never been tested for HIV. Among the remaining 154 participants, 45.8% indicated current use of HIV PrEP. Overall, 71.4% of respondents had at least one previous access to STI services, and more than half (55.2%) had received at least one STI diagnosis over their lifetime. The median number of STI diagnoses in the past 12 months was 3 (IQR: 3–4). Regarding the distribution of STIs preventable by Doxy-PEP, more than three quarters of respondents (77.4%) had experienced at least one diagnosis over their lifetime, with gonorrhea having affected more than half of the study population. Additionally, 17.0% ($n=18$) had contracted all three infections, while 23.6% had experienced at least two (12 chlamydia and gonorrhea, 1 chlamydia and syphilis, and 12 gonorrhea and syphilis).

Doxy-PEP use, access patterns, and willingness to use

Details on Doxy-PEP use, access patterns, and willingness to use are reported in Table 2; Fig. 1 illustrates individual-level patterns among participants reporting Doxy-PEP use, stratified by physician prescription status. Overall, approximately 33.0% of participants were unaware of Doxy-PEP, including five PLWH. Twenty-seven (21.3%) respondents, including two PLWH, reported having ever used Doxy-PEP, with most indicating fewer than three intake episodes in the previous 12 months. In 14 out of 27 (51.9%) users, Doxy-PEP followed a physician's prescription. Sources of doxycycline included pharmacies without a medical prescription (18.5%), but also health-care-sector acquaintances, sexual partners, and online purchases, indicating mixed access pathways. Among participants who had never used Doxy-PEP, willingness to use it in the future if prescribed by a physician was high, including three PLWH. Half of respondents reported that they would be willing to use Doxy-PEP, and a further 24.2% indicated that they would do so, while uncertainty was reported by nearly another quarter of participants and unwillingness by only a small minority.

In univariable analyses, Doxy-PEP use was significantly associated ($p < 0.05$) with an increasing number

of sexual partners in the past six months, current use of HIV PrEP, and a history of at least one previous STI, both over the lifetime and in the past 12 months. In multivariable logistic regression analysis (Table 3, Model 1), participants with higher education level (OR = 5.21; 95% CI: 1.23–22.12), those with a history of at least one STI diagnosis in the previous 12 months (OR = 6.33; 95% CI: 1.72–23.41), and who reported current use of HIV PrEP (OR = 6.10; 95% CI: 1.09–34.24) showed significantly higher odds of Doxy-PEP use. Participants reporting a negative perceived health status were significantly less likely to use Doxy-PEP (OR = 0.06; 95% CI: 0.00–0.85). Similarly, participants reporting ever having self-medicated with antibiotics other than doxycycline had substantially lower odds of Doxy-PEP use (OR = 0.04; 95% CI: 0.00–0.56).

Antibiotic self-medication for STI management involving antibiotics other than doxycycline

Overall, 11.1% of respondents, including two PLWH, reported antibiotic self-medication, most limited to one to four episodes. The main reasons were symptoms suggestive of an STI (47.6%), partner notification of an STI (33.3%), preventive use after unprotected intercourse (23.8%), and reassurance after sexual activity (14.3%). Non-prescribed antibiotics were obtained through multiple channels: the most common sources were leftover medications from previous prescriptions (57.1) and pharmacies without a prescription (28.6%). Patterns of antibiotic self-medication are summarized in Table 2. This practice, in univariable analyses, was significantly associated ($p < 0.05$) with the increasing number of sexual partners in the past six months, a lifetime history of STI diagnosis, and a history of at least one STI preventable by doxycycline. Results from the multivariable logistic regression model (Table 3, Model 2) found that increasing age was independently associated with lower odds of antibiotic self-medication, with a 7% reduction in odds per additional year of age (OR = 0.93; 95% CI: 0.86–0.99). Participants with a previous STI diagnosis had more than fourfold higher odds of reporting self-medication compared with those without such history (OR = 4.82; 95% CI: 1.27–18.37).

Discussion

Principal findings

In this survey among LGBTQIA+ individuals in Italy, we provide novel evidence on the real-life use of Doxy-PEP, and on the prevalence and determinants of antibiotic self-medication for STI prevention and management. Our findings highlight a complex and heterogeneous landscape, characterized by emerging uptake of Doxy-PEP, high willingness to use it if medically prescribed, and a non-negligible prevalence of unsupervised antibiotic use.

Table 2 Doxy-PEP use and antibiotic self-medication

Characteristic	N (%) [*]
Awareness of Doxy-PEP	
No	63 (33.0)
Yes, from healthcare professionals (e.g., staff at a healthcare facility or checkpoint)	28 (14.7)
Yes, from friends, acquaintances, or sexual partners	26 (13.6)
Yes, in community-based or associative settings	31 (16.2)
Yes, I am a healthcare professional	12 (6.3)
Yes, from websites or social media	29 (15.2)
Others	2 (1.0)
Physician prescription of Doxy-PEP	
No	113 (89.0)
Yes	14 (11.0)
Ever use of Doxy-PEP	
No	100 (78.7)
Yes (adherent)	25 (19.7)
Yes (non-adherent)	2 (1.6)
Source of Doxy-PEP	
Pharmacy with a medical prescription	14 (51.9)
Pharmacy without a prescription	5 (18.5)
I already had the medication at home (e.g., leftover from a previous prescription for another condition)	6 (22.2)
Medication provided by acquaintances working in the healthcare sector	1 (3.7)
Medication obtained from a sexual partner	2 (7.4)
Medication obtained from other acquaintances or family members (non-healthcare)	0 (0.0)
Purchased online	1 (3.7)
Others	1 (3.7)
Frequency of Doxy-PEP use (past 12 months)	
1	8 (29.6)
2–3	13 (48.1)
4–5	1 (3.7)
6–7	3 (11.1)
8–9	0 (0.0)
10 or more	2 (7.4)
Willingness to use Doxy-PEP if prescribed	
Definitely no	0 (0.0)
No	1 (1.6)
Yes	31 (50.0)
Definitely yes	15 (24.2)
Do not know	15 (24.2)
Ever antibiotic self-medication for STIs (antibiotics other than doxycycline)	
No	165 (87.3)
Yes	21 (11.1)
Do not remember	3 (1.6)
Frequency of antibiotic self-medication (antibiotics other than doxycycline)	
1–4	18 (94.7)
5–9	0 (0.0)
10 or more	1 (5.3)
Reasons for antibiotic self-medication [†]	
A sexual partner informed me that they had a STI	7 (33.3)
For prevention, after unprotected sexual intercourse with one or more partners	5 (23.8)
Presence of symptoms that made me suspect a STI	10 (47.6)
To feel more reassured after sexual intercourse	3 (14.3)
To avoid being diagnosed with a STI	1 (4.8)
Others	0 (0.0)
Reasons for not seeking medical care [‡]	

Table 2 (continued)

Characteristic	N (%) [*]
Because I had previously felt discriminated against by a healthcare professional	0 (0.0)
Distance from the nearest healthcare facility / clinic / hospital	2 (9.5)
I did not consider it necessary	4 (19.0)
I was away from home / traveling	3 (14.4)
To act more quickly	15 (71.4)
To avoid feeling judged	7 (33.3)
Others	0 (0.0)
Source of non-prescribed antibiotics [‡]	
Pharmacy with an old prescription	2 (9.5)
Pharmacy without a prescription	6 (28.6)
I already had the medication at home (e.g., leftover from a previous prescription for another condition)	12 (57.1)
Obtained from a sexual partner	1 (4.8)
Obtained from other acquaintances or family members (non-healthcare)	1 (4.8)
Provided by acquaintances working in the healthcare sector	2 (9.5)
Purchased online	0 (0.0)
Others	0 (0.0)

Abbreviations: IQR, interquartile range; Doxy-PEP, doxycycline post-exposure prophylaxis; STI, sexually transmitted infection

^{*} Percentages may not sum to 100 due to rounding

[‡] Interviewees could choose more than one item

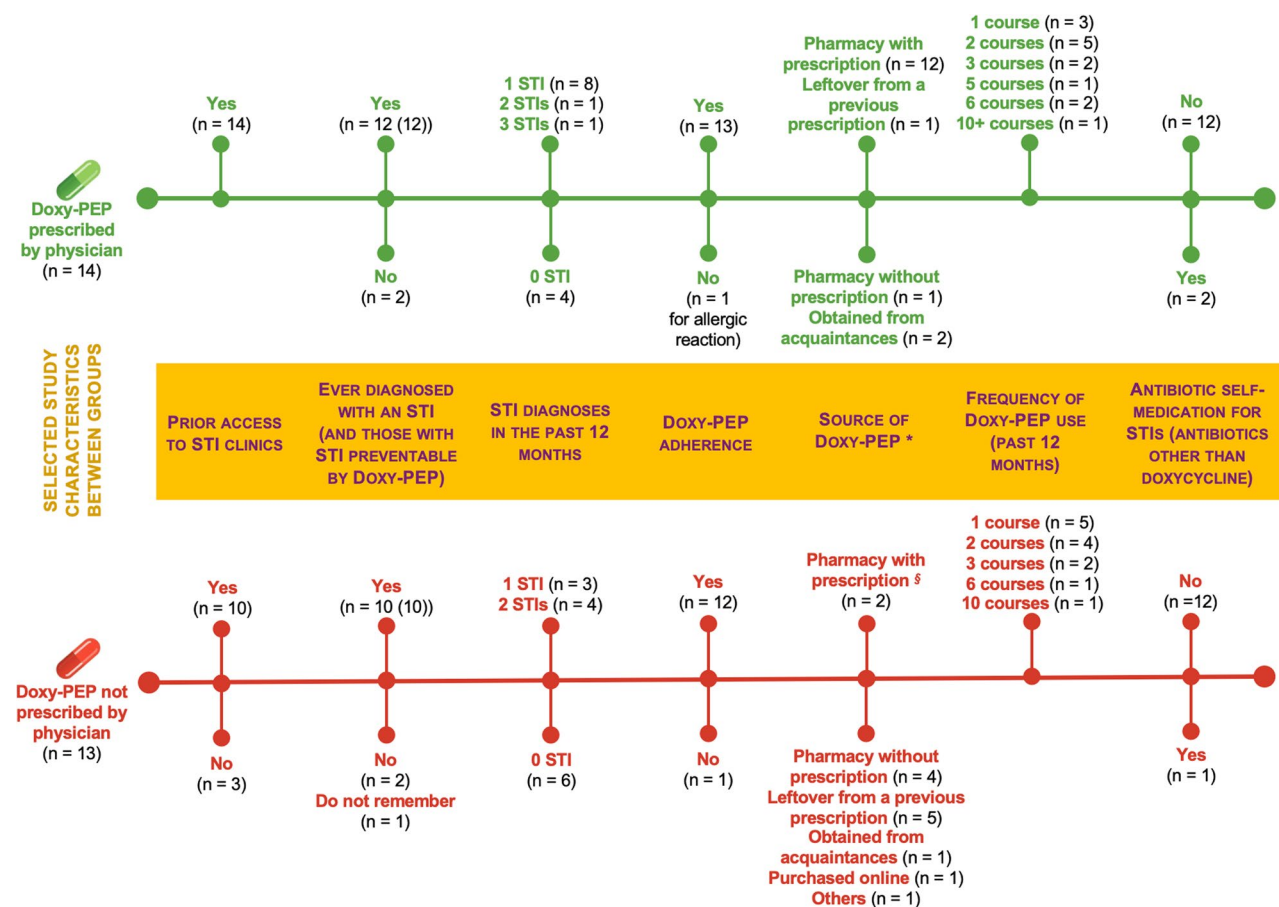


Fig. 1 Patterns of Doxy-PEP use, access pathways, and related sexual health characteristics among users, stratified according to self-reported physician prescription status. Numbers indicate the count of participants reporting each characteristic; multiple responses were allowed where applicable. [§] The origin of the prescription was not clearly identifiable. Abbreviations: Doxy-PEP, doxycycline post-exposure prophylaxis; STI, sexually transmitted infection

Table 3 Predictors of Doxy-PEP use: multivariable logistic regression analysis

Model 1: Predictors of Doxy-PEP use			
Variable *	Odds Ratio	95%CI	p-value
Log likelihood = -35.13; $\chi^2 = 32.63$ (6 df); p-value < 0.0001			
Educational level			
Bachelor's degree or lower	Ref.	1.23–	0.025
Master's degree or higher	5.21	22.12	
Perceived health status			
Positive	Ref.	0.00–	0.037
Negative	0.06	0.85	
Condom use during sexual intercourse in the past six months			
Never/rarely	Ref.	0.07–	0.151
Always/almost always	0.33	1.50	
STI diagnoses in the past 12 months			
None	Ref.	1.72–	0.006
At least one	6.33	23.41	
Current HIV PrEP use			
No	Ref.	1.09–	0.040
Yes	6.10	34.24	
Ever use of antibiotic self-medication for STI management (antibiotics other than doxycycline)			
No	Ref.	0.00–	0.016
Yes	0.04	0.56	
Model 2. Predictors of antibiotic self-medication involving antibiotics other than doxycycline			
Variable **	Odds Ratio	95%CI	p-value
Log likelihood = -46.12; $\chi^2 = 9.85$ (3 df); p-value = 0.02			
Age (continuous, in years)			
	0.93	0.86– 0.99	0.036
History of previous STIs			
None	Ref.	1.27–	0.021
At least one confirmed lifetime diagnosis	4.82	18.37	
Doxy-PEP use			
No	Ref.	0.05–	0.115
Yes	0.27	1.37	

Abbreviations: Doxy-PEP Doxycycline post-exposure prophylaxis, HIV PrEP HIV pre-exposure prophylaxis, STI Sexually transmitted infection, 95%CI 95% confidence interval

* Categories of the sex at birth variable were automatically omitted due to estimability issues; age, sexual orientation, PEP use, and history of previous STIs (ever) variables were omitted for ≥ 0.25

** Sex at birth, sexual orientation, educational level, substance use, and STI diagnoses in the past 12 months variables were omitted for ≥ 0.25

A key contribution of this study is the explicit separation between Doxy-PEP use as a preventive intervention and antibiotic self-medication as an inappropriate practice. While both involve antibiotic exposure, they reflect fundamentally different behaviors, levels of medical oversight, and implications for patient care and antimicrobial stewardship. Our analytical approach intentionally

treated these phenomena as distinct outcomes, allowing their determinants to be characterized separately and avoiding the misattribution of risks associated with self-medication to Doxy-PEP itself.

Of note, the fact that nearly one in two participants in our sample reported current HIV PrEP use provides insight into the underlying characteristics of the study population, suggesting a subgroup more engaged in sexual health prevention pathways and likely at higher risk of STI exposure. In this context, PrEP use can be interpreted as a proxy indicator of increased sexual health awareness and risk profile, which is particularly relevant for the study of Doxy-PEP use and antibiotic-related behaviors.

Doxy-PEP use: comparison with existing evidence and interpretation of multivariable results

The proportion of participants reporting prior use of Doxy-PEP in our study is broadly consistent with estimates from recent surveys conducted in other high-income settings, particularly among MSM and TGW in Europe and Italy. Previous studies have reported Doxy-PEP use ranging from approximately 10% to 30%, often concentrated among individuals with higher sexual risk profiles and prior engagement with HIV prevention services [15, 16, 23, 28]. Our findings align with this literature and confirm that Doxy-PEP uptake in Italy is no longer a marginal phenomenon, despite the absence of formal national guidance at the time of data collection.

The multivariable analysis provides important insights into the profile of individuals most likely to use Doxy-PEP. Current HIV PrEP use emerged as a strong independent predictor, reinforcing the notion that Doxy-PEP uptake occurs predominantly within established prevention pathways and among individuals engaged in sexual health care [15, 16]. The strong association with a recent STI diagnosis suggests that Doxy-PEP is perceived and used as a secondary prevention tool by individuals with high-risk sexual behaviors, consistent with eligibility criteria adopted in randomized trials and international guidelines [7, 8, 29].

Educational level also played a significant role. Participants with lower educational attainment had substantially lower odds of Doxy-PEP use compared with those with postgraduate education, suggesting potential inequalities in access to information, health literacy, or navigation of prevention services. This gradient mirrors patterns observed for other preventive interventions and highlights the risk that Doxy-PEP implementation could inadvertently widen existing disparities if not accompanied by targeted outreach and counseling, particularly given that lower educational attainment has been associated with a higher risk of STIs [30–32].

Notably, antibiotic self-medication was inversely associated with Doxy-PEP use. This finding suggests that Doxy-PEP users and individuals who self-medicate antibiotics may represent two partially distinct behavioral profiles: the former more integrated into formal healthcare pathways, the latter relying on informal strategies outside medical supervision. This distinction is relevant for both clinical management and public health planning. Nonetheless, a non-negligible proportion of participants reported obtaining doxycycline through informal or non-prescribed channels, raising important concerns regarding inappropriate use, lack of medical oversight, and potential implications for antimicrobial resistance and optimal STI management. Although the concept of “appropriate use” of Doxy-PEP is increasingly invoked, it often remains implicitly defined. Based on our findings, an operational, ex-post definition can be proposed, whereby appropriate use is characterized by medical prescription, adherence to the recommended regimen, integration within STI prevention and care services, and absence of concurrent antibiotic self-medication. This data-driven framework helps distinguish guideline-consistent Doxy-PEP use from broader patterns of inappropriate antibiotic exposure.

Willingness to use Doxy-PEP: implications for future implementation

Among participants who had never used Doxy-PEP, willingness to use it in the future if prescribed by a physician was high, with nearly three quarters expressing a positive or strongly positive attitude. This level of acceptability is comparable to that reported in international studies conducted among MSM using HIV PrEP in Asia, Europe, and America, where willingness often exceeds actual uptake [28, 33–35].

The discrepancy between high willingness and relatively limited current use likely reflects structural rather than individual barriers, including lack of clear clinical guidance, limited awareness among healthcare professionals, and uncertainty regarding prescribing responsibilities [36, 37]. This finding suggests that a substantial proportion of high-risk individuals could be rapidly reached through structured, physician-led Doxy-PEP programs, provided that clear eligibility criteria, monitoring protocols, and antimicrobial stewardship safeguards are established [36].

Antibiotic self-medication: magnitude, risks, and clinical implications

A particularly concerning finding of this study is the proportion of participants reporting antibiotic self-medication for STI prevention or treatment. Although the absolute number of self-medicating individuals is limited by sample size, the observed prevalence appears in line

compared with expectations derived from the existing literature, which is based on studies conducted more than a decade ago [13]. This suggests that antibiotic self-medication may be an underrecognized and potentially growing phenomenon in contemporary sexual health contexts.

From the patient perspective, both antibiotic self-medication and obtaining doxycycline without medical supervision may offer a short-term sense of reassurance or control but can ultimately undermine care outcomes. Unsupervised use may result in persistent or recurrent symptoms due to suboptimal treatment, uncertainty regarding infection status, missed opportunities for comprehensive STI screening, and lack of appropriate counseling on partner notification and risk-reduction strategies [38–40]. Over time, these experiences may erode trust in healthcare pathways and increase anxiety, rather than providing durable protection. Moreover, the implications for antimicrobial resistance are particularly relevant. Repeated, unregulated exposure to antibiotics may drive the emergence of antimicrobial resistance across a broad range of bacterial pathogens, with particular concern for *Neisseria gonorrhoeae*, for which resistance trends already pose major clinical challenges and underscore the need for a cautious and carefully monitored use of Doxy-PEP [41–44]. These risks are amplified when antibiotics are used for prophylactic or reassurance purposes in the absence of confirmed infection. It is worth also noting that antibiotic self-medication clustered among participants relying on informal strategies outside structured prevention and care models, reinforcing the need to address this behavior independently from guideline-based Doxy-PEP implementation.

Public health implications and the role of targeted education

Our findings highlight the urgent need for coordinated interventions addressing both Doxy-PEP use and antibiotic self-medication. Information and education campaigns should be designed to reach LGBTQIA+ communities through multiple channels, including STI clinics, community-based organizations, peer health initiatives, and digital platforms. Given the widespread use of social media among the target population, leveraging these channels may be particularly effective in disseminating accurate, evidence-based messages [45–47].

Educational efforts should focus not only on the potential benefits and limitations of Doxy-PEP, but also on the risks associated with unsupervised antibiotic use and the importance of accessing appropriate sexual health services. Importantly, these interventions should be non-stigmatizing and culturally competent, addressing the fears of judgment and discrimination that were frequently reported as barriers to care.

The organization of sexual health services within the Italian National Health Service also represents a key contextual factor for interpreting these findings. Although Italy provides universal coverage for STI diagnosis and treatment through specialized clinics and community-based services, access to HIV PrEP and other sexual health interventions is typically mediated through specialist pathways and varies across regions. In addition, HIV PrEP has been reimbursed within the National Health Service since 2023, and its implementation is still evolving [48]. In this context, structural and perceived barriers—such as organizational complexity, limited awareness of available services, and fear of stigma—may contribute to delayed access to care, particularly in some areas of the country. These factors may partly explain the persistence of informal antibiotic use observed in our study, as well as the reliance on non-prescribed channels for obtaining doxycycline.

Finally, the adoption of formal national guidelines on Doxy-PEP use in Italy represents a critical step. The implementation of clear, evidence-based, and context-specific recommendations is a public health priority to guide clinical practice, ensure appropriate use, and reduce informal antibiotic consumption.

Limitations

This study has several limitations. First, the relatively small sample size limits statistical power and precision of estimates; however, the number of respondents is comparable to that of similar surveys conducted in hard-to-reach populations, and reflects the inherent challenges of engaging LGBTQIA+ communities in research on sensitive topics [16, 23]. Second, participant recruitment relied on a single dissemination channel (Instagram), which may have introduced selection bias and resulted in a sample that is not representative of the broader LGBTQIA+ population in Italy. Nevertheless, Instagram is among the most widely used social media platforms in Italy (with 40 million monthly active users as of October 2024), particularly among younger and middle-aged adults [49], and it is reasonable to assume broad accessibility within the target population. Moreover, it reflects real-life information pathways within LGBTQIA+ communities and may therefore enhance the ecological validity of the findings by capturing behaviors and perceptions as they emerge within everyday information environments, rather than exclusively within clinical settings. Third, the cross-sectional design precludes any temporal or causal inference. It is not possible to determine whether Doxy-PEP use influences antibiotic self-medication behaviors or vice versa. Similarly, we were unable to assess whether recent diagnoses of STIs preventable by Doxy-PEP directly influenced subsequent preventive behaviors, as temporal sequencing could not be established. Fourth, no

sample size calculation specifically tailored for multivariable modeling was performed. Given the relatively small number of events in relation to the number of predictors, the possibility of model overfitting cannot be excluded. Furthermore, antibiotic self-medication was operationally defined as the use of antibiotics other than doxycycline, in accordance with the questionnaire structure. As a result, unsupervised doxycycline use—although partially captured through Doxy-PEP-related questions—was not included in this outcome, potentially leading to an underestimation of the overall extent of antibiotic self-medication.

Conclusion

This study provides relevant evidence on Doxy-PEP use, willingness to use, and antibiotic self-medication for STI management among the Italian LGBTQIA+ community. Our findings support the potential acceptability of Doxy-PEP within structured healthcare pathways, while simultaneously raising concerns about unregulated antibiotic use. Addressing these issues will require integrated clinical, educational, and public health strategies to maximize preventive benefits while minimizing unintended consequences for antimicrobial resistance and sexual health outcomes.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-026-27274-8>.

Supplementary Material 1.

Supplementary Material 2.

Acknowledgements

This study was conducted as part of the ANTIB-IST project (Sexually transmitted infections and antibiotic self-medication: estimating the magnitude of the phenomenon and analyzing behavioral patterns within the LGBTQIA+ community in the era of Doxy-PEP), Principal Investigator: Pietro Ferrara. The authors would like to sincerely thank all individuals who participated in the survey for their time, openness, and willingness to share personal experiences related to sexual health and antibiotic use. Their contribution was essential to the successful completion of this study and to generating evidence on a sensitive and underexplored public health topic.

Authors' contributions

I.C.A., I.P., M.C., I.U., R.P., M.A. contributed to the development of the study and questionnaire, and participated in the interpretation of the results. I.P. also coordinated the dissemination of the survey. L.L. and D.R. analyzed the data. P.F. conceived and coordinated the study, developed the study protocol and analysis plan, supervised the data analysis, and drafted the manuscript. All authors critically revised the manuscript and approved the final version for publication.

Funding

This research received no external funding.

Data availability

The dataset generated and analyzed during the current study is not publicly available due to privacy and ethical restrictions. Information is available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and was approved by the Ethics Committee of the University of Milan–Bicocca (protocol no. 955/2025). Participation in the study was entirely voluntary. Informed consent to participate was obtained electronically. At the beginning of the questionnaire, participants were presented with an information page describing the study objectives, voluntary nature of participation, and anonymity. Consent was provided by actively proceeding with the survey. Participants could withdraw at any time by exiting the questionnaire prior to submission. No personal identifiers were collected, and all data were collected and analyzed anonymously.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Department of Environmental and Prevention Sciences, University of Ferrara, Ferrara, Italy

²Center for Public Health Research, University of Milan-Bicocca, Via Cadore 48 (U38 building), Monza 20900, Italy

³Arcigay Associazione LGBTQIA+ Italiana APS, Bologna, Italy

⁴Department of Social and Political Sciences, University of Milan, Milan, Italy

⁵Pegaso Telematic University, Naples, Italy

⁶University of Milan–Bicocca, Monza, Italy

⁷Clinic of Infectious Diseases and Tropical Medicine, San Paolo Hospital, ASST Santi Paolo e Carlo, Department of Health Sciences, University of Milan, Milan, Italy

⁸Laboratory of Public Health, IRCCS Istituto Auxologico Italiano, Milan, Italy

Received: 12 January 2026 / Accepted: 31 March 2026

Published online: 06 April 2026

References

- Chandra S, Broom A, Ridge D, et al. Treatment 'cultures', sexually transmitted infections and the rise of antimicrobial resistance. *Social Health Illn*. 2025;47(1):e13832. <https://doi.org/10.1111/1467-9566.13832>.
- White AT, Vaughn VM, Petty LA, et al. Development of patient safety measures to identify inappropriate diagnosis of common infections. *Clin Infect Dis*. 2024;78(6):1403–11. <https://doi.org/10.1093/cid/ciae044>.
- Attram N, Dela H, Behene E, et al. Antimicrobial use of patients with sexually transmitted infection symptoms prior to presentation at five health facilities in Southern Ghana. *Antimicrob Resist Infect Control*. 2023;12(1):146. <https://doi.org/10.1186/s13756-023-01351-8>.
- Muteeb G, Kazi RNA, Aatif M, Azhar A, Oirdi ME, Farhan M. Antimicrobial resistance: Linking molecular mechanisms to public health impact. *SLAS Discov*. 2025;33:100232. <https://doi.org/10.1016/j.slasd.2025.100232>.
- Peters RPH, Grinsztejn B, Celum C, et al. Innovations in the biomedical prevention, diagnosis, and service delivery of HIV and other sexually transmitted infections. *Lancet*. 2025;406(10155):2133–51. [https://doi.org/10.1016/S0140-6736\(25\)00983-3](https://doi.org/10.1016/S0140-6736(25)00983-3).
- Raccagni AR, Diotallevi S, Lolatto R, et al. Antimicrobial use for the treatment of bacterial sexually transmitted infections among doxycycline post-exposure prophylaxis (DoxyPEP) users in Milan, Italy. *J Antimicrob Chemother*. 2025;80(9):2484–6. <https://doi.org/10.1093/jac/dkaf244>.
- Luetkemeyer AF, Donnell D, Dombrowski JC, et al. Postexposure doxycycline to prevent bacterial sexually transmitted infections. *N Engl J Med*. 2023;388(14):1296–306. <https://doi.org/10.1056/NEJMoa2211934>.
- Szondy I, Meznerics FA, Lőrincz K, et al. Doxycycline prophylaxis for the prevention of sexually transmitted infections: a systematic review and meta-analysis of randomized controlled trials. *Int J Infect Dis*. 2024;147:107186. <https://doi.org/10.1016/j.ijid.2024.107186>.
- Chu VT, Glascock A, Donnell D, et al. Impact of doxycycline post-exposure prophylaxis for sexually transmitted infections on the gut microbiome and antimicrobial resistance. *Nat Med*. 2025;31(1):207–17. <https://doi.org/10.1038/s41591-024-03274-2>.
- Kenyon C. Doxycycline post-exposure prophylaxis could theoretically select for resistance to various antimicrobials in 19 pathobionts: an in silico analysis. *Int J Infect Dis*. 2024;142:106974. <https://doi.org/10.1016/j.ijid.2024.02.017>.
- Teker B, Hoornenborg E, Van Der Schim MF, et al. Emergent informal use of doxycycline post- and pre-exposure prophylaxis among men who have sex with men and transgender and gender diverse people, the Netherlands, 2024. *Eurosurveillance*. 2025;30(26). <https://doi.org/10.2807/1560-7917.ES.2025.30.26.2400707>.
- Hornuss D, Mathé P, Usadel S, Zimmermann S, Müller M, Rieg S. Already current practice? A snapshot survey on doxycycline use for prevention of sexually transmitted infections in parts of the German MSM community. *Infection*. 2023;51(6):1831–4. <https://doi.org/10.1007/s15010-023-02086-9>.
- Gomez GB, Garnett GP, Ward H. Self-medication prevalence for sexually transmitted diseases: meta-analysis and meta-regression of population level determinants. *Sex Transm Dis*. 2009;36(2):112–9. <https://doi.org/10.1097/OLQ.0b013e31818b2116>.
- Sachdev C, Anjankar A, Agrawal J. Self-medication with antibiotics: an element increasing resistance. *Cureus Published online Oct. 2022*;29. <https://doi.org/10.7759/cureus.30844>.
- Raccagni AR, Diotallevi S, Lolatto R, et al. DoxyPEP: real-life effectiveness in a cohort of men who have sex with men in Milan, Italy. *Lancet Infect Dis*. 2025;25(1):e1–3. [https://doi.org/10.1016/S1473-3099\(24\)00726-6](https://doi.org/10.1016/S1473-3099(24)00726-6).
- Donà MG, Zaccarelli M, Giuliani M, et al. Early uptake of doxycycline prophylaxis among MSM in Rome: Insights from a reference STI clinic. *Int J STD AIDS Published online Oct. 2025*;9:09564624251375877. <https://doi.org/10.1177/09564624251375877>.
- Eysenbach G. Improving the quality of web surveys: the checklist for reporting results of internet E-surveys (CHERRIES). *J Med Internet Res*. 2004;6(3):e34. <https://doi.org/10.2196/jmir.6.3.e34>.
- Coburn K, Troy K, Busch CA et al. Cisnormative Language and Erasure of Trans* and Genderqueer Student Representation in Biology Education Research. Eddy S, ed. *CBE—Life Sci Educ*. 2025;24(1):ar3. <https://doi.org/10.1187/cbe.24-01-0033>.
- Bui HTM, Adamson PC, Klausner JD, Le GM, Gorbach PM. Doxycycline prophylaxis for bacterial sexually transmitted infection prevention in Vietnam: awareness, attitudes and willingness to use among men who have sex with men using HIV-PrEP. *Sex Transm Infect*. 2025;101(6):367–73. <https://doi.org/10.1136/sextrans-2024-056449>.
- Traeger MW, Krakower DS, Mayer KH, Jenness SM, Marcus JL. Use of doxycycline and other antibiotics as bacterial sexually transmitted infection prophylaxis in a US sample of primarily gay and bisexual men. *Sex Transm Dis*. 2024;51(12):763–71. <https://doi.org/10.1097/OLQ.0000000000002061>.
- Cheung DH, Samoh N, Jonas KJ, Lim SH, Kongjareon Y, Guadamuz TE. Patterns of chemsex substance use and its association with hiv transmission risk among men who have sex with men in Thailand: a latent class analysis. *Arch Sex Behav*. 2024;53(9):3527–36. <https://doi.org/10.1007/s10508-024-02868-8>.
- Kounta CH, Chazelle E, Ousseine YM, Lot F, Veltier A. Factors associated with bacterial sexually transmitted infection screening uptake and diagnosis among men who have sex with men in France. *BMC Infect Dis*. 2024;24(1):1431. <https://doi.org/10.1186/s12879-024-10310-6>.
- Villanueva Baselga S, Ruben M, Luis V. A practice already in use: a snapshot survey on the use of doxycycline as a preventive strategy (Doxy-PEP and Doxy-PrEP) in the GBMSM population in Spain. *Infection*. 2025;53(1):437–41. <https://doi.org/10.1007/s15010-024-02320-y>.
- Lemeshow S, editor. *Adequacy of Sample Size in Health Studies*. Repr. Wiley; 1993.
- Hosmer DW, Lemeshow S, Sturdivant RX. *Applied Logistic Regression*. 1st ed. Wiley; 2013. <https://doi.org/10.1002/9781118548387>.
- Ponticelli D, Losa L, Antonazzo IC, et al. Respiratory syncytial virus (RSV) and intention to recommend RSV Vaccination: a cross-sectional survey of cardiologists and cardiac nurses in Southern Italy. *Infect Dis Rep*. 2024;16(1):128–41. <https://doi.org/10.3390/idr16010010>.
- StataCorp. *Stata Statistical Software: Release 19*. Published online 2025. <https://www.stata.com>.
- Vanbaelen T, Rotsaert A, De Baetselier I, et al. Doxycycline post-exposure prophylaxis among men who have sex with men and transgender women in Belgium: awareness, use and antimicrobial resistance concerns in a cross-sectional online survey. *Sex Transm Infect*. 2025;101(1):34–40. <https://doi.org/10.1136/sextrans-2024-056261>.

29. Bachmann LH, Barbee LA, Chan P, et al. CDC Clinical Guidelines on the Use of Doxycycline Postexposure Prophylaxis for Bacterial Sexually Transmitted Infection Prevention, United States, 2024. *MMWR Recomm Rep*. 2024;73(2):1–8. <https://doi.org/10.15585/mmwr.rr7302a1>.
30. Harb AK, Town K, Callan E, Furegato M, Connor N, Dunbar JK. Who is coming back for more chlamydia testing within non-specialist health services and where do they go? England, 2013–2016. *Public Health*. 2020;180:136–40. <https://doi.org/10.1016/j.puhe.2019.11.010>.
31. Slurink IA, Götz HM, Van Aar F, Van Benthem BH. Educational level and risk of sexually transmitted infections among clients of Dutch sexual health centres. *Int J STD AIDS*. 2021;32(11):1004–13. <https://doi.org/10.1177/09564624211013670>.
32. Goulet V, De Barbeyrac B, Raheison S, et al. Prevalence of Chlamydia trachomatis: results from the first national population-based survey in France. *Sex Transm Infect*. 2010;86(4):263–70. <https://doi.org/10.1136/sti.2009.038752>.
33. Gallardo-Cartagena JA, German-Quiñones DLG, Rosas-Benancio FG, et al. High willingness to use and recommend doxycycline postexposure prophylaxis for bacterial STI prevention in Peru. *Sex Transm Dis* Published online Oct. 2025;30. <https://doi.org/10.1097/OLQ.0000000000002268>.
34. Liang P, Zhao P, Huang S, Wang C. Willingness to accept Doxycycline post-exposure prophylaxis for bacterial stis prevention among men who have sex with men in Southern China: a cross-sectional analysis. *BMC Infect Dis*. 2025;25(1):911. <https://doi.org/10.1186/s12879-025-11290-x>.
35. Chen YT, Lin KY, Sun HY et al. Awareness and willingness toward doxycycline post-exposure prophylaxis use for bacterial sexually transmitted infections among men who have sex with men. Wang C, ed. *Sex Health*. 2025;22(3). <https://doi.org/10.1071/SH24136>.
36. Bird J, Alawya B, Spernovasilis N, Alon-Ellenbogen D. From cure to prevention: doxycycline's potential in prophylaxis for sexually transmitted infections. *Antibiotics*. 2024;13(12):1183. <https://doi.org/10.3390/antibiotics13121183>.
37. Rossotti R, Raccagni AR, D'Amico F et al. Attitudes and prescribing practices on doxycycline postexposure prophylaxis (DoxypEP) among Italian infectious diseases physicians: findings from a National SIMIT Survey. *Sex Transm Infect*. Published online September 1, 2025;sextrans-2025-056595. <https://doi.org/10.1136/sextrans-2025-056595>.
38. Rather IA, Kim BC, Bajpai VK, Park YH. Self-medication and antibiotic resistance: Crisis, current challenges, and prevention. *Saudi J Biol Sci*. 2017;24(4):808–12. <https://doi.org/10.1016/j.sjbs.2017.01.004>.
39. Lescure D, Paget J, Schellevis F, Van Dijk L. Determinants of self-medication with antibiotics in European and anglo-saxon countries: a systematic review of the literature. *Front Public Health*. 2018;6:370. <https://doi.org/10.3389/fpubh.2018.00370>.
40. Grigoryan L, Monnet D, Haajjer-Ruskamp F, Bonten M, Lundborg S, Verheij T. Self-medication with antibiotics in Europe: a case for action. *Curr Drug Saf*. 2010;5(4):329–32. <https://doi.org/10.2174/157488610792246046>.
41. Van Praet JT, Reynders M, Floré K. Local resistance of gonorrhoea for doxycycline should be considered before initiation of doxy-PEP. *Sex Transm Dis* Published online Oct. 2025;21. <https://doi.org/10.1097/OLQ.00000000000002260>.
42. Aljinović-Vučić V. Self-medication as a global health concern: overview of practices and associated factors—a narrative review. *Healthcare*. 2025;13(15):1872. <https://doi.org/10.3390/healthcare13151872>.
43. Carpenter L, Miller S, Flynn E, et al. Exposure to doxycycline increases risk of carrying a broad range of enteric antimicrobial resistance determinants in an elderly cohort. *J Infect*. 2024;89(4):106243. <https://doi.org/10.1016/j.jinf.2024.106243>.
44. Helekal D, Mortimer TD, Grad YH. Expansion of *tetM*-Carrying *Neisseria gonorrhoeae* in the United States, 2018–2024. *N Engl J Med*. 2025;393(2):198–200. <https://doi.org/10.1056/NEJMc2504010>.
45. O'Farrell M, Corcoran P, Davoren MP. Examining LGBT+ inclusive sexual health education from the perspective of both youth and facilitators: a systematic review. *BMJ Open*. 2021;11(9):e047856. <https://doi.org/10.1136/bmjopen-2020-047856>.
46. Gabarron E, Wynn R. Use of social media for sexual health promotion: a scoping review. *Glob Health Action*. 2016;9(1):32193. <https://doi.org/10.3402/gha.v9.32193>.
47. Delmonaco D, Li S, Paneda C, et al. Community-engaged participatory methods to address lesbian, gay, bisexual, transgender, queer, and questioning young people's health information needs with a resource website: participatory design and development study. *JMIR Form Res*. 2023;7:e41682. <https://doi.org/10.2196/41682>.
48. Nozza S, Masoero T, Tavelli A et al. Implementation of HIV pre-exposure prophylaxis (PrEP) in Italy (2023–2024): results from the PrIDE cohort survey. *Int J Infect Dis* Published online March 2026:108555. <https://doi.org/10.1016/j.ijid.2026.108555>.
49. Covelli V, Marelli A, Visco MA, Crescenzo P, Bavagnoli A. Instagram addiction in Italian young adults: the role of social influence processes, meaningful relationships and fear of missing out. *Behav Sci*. 2025;15(12):1711. <https://doi.org/10.3390/bs15121711>.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.