Diploma Thesis

Anonymous testing for sexually transmitted infections at the *AIDS-Hilfe Steiermark* in the pre-pandemic, pandemic, and post-pandemic period

submitted by

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in partial fulfilment of the requirements for the degree of

Doktorin der gesamten Heilkunde

(Dr^{in}. med. univ.)

at the

Medical University of Graz

executed at the

Diagnostic and Research Institute of Hygiene, Microbiology and Environmental Medicine

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Graz, date July 10, 2024

Declaration of Academic Integrity

I hereby confirm that the present diploma thesis is the result of my own independent scholarly work. I also confirm that in all cases, where material from the work of others (in books, articles, essays, dissertations, and on the internet) is acknowledged, quotations and paraphrases are clearly indicated. No material other than that cited in the reference list has been used. I have read and understood the Medical University's regulations and procedures concerning plagiarism.

Graz, date July 10, 2024 Anna Langeder eh.

Acknowledgement

I would like to express my gratitude to everyone who has supported me throughout the journey of completing this diploma thesis.

First, I would like to extend my thanks to my supervisor, Prof. Harald H. Kessler, for his invaluable guidance, encouragement, and insightful feedback. I would also like to thank my second supervisor, Dr. Evelyn Stelzl, whose constructive criticism and advice significantly improved the quality of my thesis. Their expertise and patience were critical to the making of this thesis. I am grateful to *AIDS-Hilfe Steiermark* and Mag. Manfred Rupp for providing essential data and unwavering support throughout the project.

My deepest gratitude goes to my family, whose love and encouragement have been the backbone of my entire academic journey. Your belief in me has been a source of strength and motivation, helping me persevere through challenging times. A special thank you to my beloved sister Sophie; with you, my time in Graz felt like home. I would also like to thank all my friends for their camaraderie and moral support. Your understanding and encouragement have been invaluable, and I cherish the moments of laughter and relief we have shared. Finally, I owe a huge thank you and hug to Iris, who supported me throughout the writing process.

Abstract in English

Background: In response to the COVID-19 pandemic, stringent containment measures leading to a significant reduction of social contacts were introduced in Austria. These measures may have affected sexual behavior and testing for sexually transmitted infections (STIs).

Objectives: To gain insight into the impact of the COVID-19 pandemic and containment measures on anonymous testing for STIs at the Styrian service facility *AIDS-Hilfe Steiermark*. To describe trends for testing and test results of STIs in the pre-pandemic, pandemic, and post-pandemic period.

Materials and methods: Anonymized data obtained from the *AIDS-Hilfe Steiermark* was investigated. Initial contacts were analyzed for demographic data, tests performed, and test results for human immunodeficiency virus (HIV), hepatitis C virus (HCV), *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG), and *Treponema pallidum* (TP). Data obtained in 2019 (pre-pandemic), 2021 (pandemic), and 2023 (post-pandemic) was compared. For statistical analysis, SPSS v. 29.0 was used.

Results: In 2019, 1494 clients had their initial contact with *AIDS-Hilfe Steiermark.* This number decreased to 1034 in 2021 (-30.8%) and increased to 1759 in 2023 (+70.1% compared to 2021 and +17.7% compared to 2019). The number of tests performed is shown in Table 1:

Pathogen(s)	No. of tests performed in		
	2019	2021	2023
HIV	1491	1022	1721
HCV	nt	443	782
CT/NG	nt	496	1173
TP	263	475	1033
Total	1754	2436	4709

nt, not tested

For HIV, 0.20% of all clients tested for HIV had a confirmed positive test result in 2019, while the percentages were found to be 0.20% in 2021 and 0.23% in 2023, respectively. For TP, corresponding percentages were 1.52% (2019), 1.26% (2021), and 2.03% (2023). For CT, 6.05% (2021) and 5.54% (2023) of tests were found to be positive. For NG, corresponding percentages were 1.81% (2021) and 1.02% (2023). For HCV, no positive results were found.

Conclusions: A considerable decrease of initial contacts with *AIDS-Hilfe Steiermark* was observed in 2021, possibly due to stringent containment measures. Together with a decline in testing, a decline in the absolute number of STIs diagnoses was found. When pre-pandemic, pandemic and post-pandemic periods were compared, the percentage of positive test results was found to be similar.

Abstract in German

Hintergrund: Als Reaktion auf die COVID-19-Pandemie wurden in Österreich strenge Eindämmungsmaßnahmen eingeführt, die zu einem erheblichen Rückgang sozialer Kontakte führten. Diese Maßnahmen könnten das Sexualverhalten und das Testen auf sexuell übertragbare Infektionen (STIs) beeinflusst haben.

Zielsetzung: Einblick in die Auswirkungen der COVID-19-Pandemie und der Eindämmungsmaßnahmen auf die anonyme STI-Testung der *AIDS-Hilfe Steiermark*. Beschreibung von Trends hinsichtlich STI-Testung und STIs präpandemisch, pandemisch und postpandemisch.

Material und Methodik: Anonymisierte Daten der *AIDS-Hilfe Steiermark* wurden analysiert. Erstkontakte wurden auf Demographie, durchgeführte Tests und Testergebnisse für Humanes Immundefizienz-Virus (HIV), Hepatitis-C-Virus (HCV), *Chlamydia trachomatis* (CT), *Neisseria gonorrhoeae* (NG) und *Treponema pallidum* (TP) untersucht. Daten aus den Jahren 2019 (präpandemisch), 2021 (pandemisch) und 2023 (postpandemisch) wurden miteinander verglichen. Für die statistische Analyse wurde SPSS v. 29.0 verwendet.

Ergebnisse: Im Jahr 2019 gab es 1494 Erstkontakte bei der *AIDS-Hilfe Steiermark*. Diese Zahl sank auf 1034 im Jahr 2021 (-30,8%) und stieg auf 1759 im Jahr 2023 (+70,1% im Vergleich zu 2021 und +17,7% im Vergleich zu 2019). Die Anzahl der durchgeführten Tests ist in Tabelle 1 zusammengefasst:

Erreger	Anzahl durchgeführter Tests		
	2019	2021	2023
HIV	1491	1022	1721
HCV	nt	443	782
CT/NG	nt	496	1173
TP	263	475	1033
Gesamt	1754	2436	4709

nt, nicht getestet

2019 waren 0,20% aller auf HIV getesteten Klient*innen bestätigt positiv, während die Prozentsätze 2021 bei 0,20 % und 2023 bei 0,23 % lagen. Die entsprechenden Zahlen für TP waren 1,52 % (2019), 1,26 % (2021) und 2,03 % (2023). Bei CT wurden 6,05 % (2021) und 5,54 % (2023) der Tests als positiv befunden. Für NG lagen die entsprechenden Prozentsätze bei 1,81 % (2021) und 1,02 % (2023). Für HCV wurden keine positiven Ergebnisse gefunden.

Schlussfolgerung: Im Jahr 2021 konnte ein deutlicher Rückgang der Erstkontakte bei der *AIDS-Hilfe Steiermark* festgestellt werden. Möglicherweise ist das auf die strengen Eindämmungsmaßnahmen zurückzuführen. Mit einem Rückgang der Tests wurde auch ein Rückgang der absoluten Zahl der STI-Diagnosen festgestellt. Im präpandemisch, pandemisch und postpandemischen Vergleich waren die Prozentsätze der positiven Tests ähnlich.

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List of Abbreviations

AIDS	Acquired immunodeficiency syndrome
CT	*Chlamydia trachomatis*
COVID-19	Coronavirus disease 2019
ELISA	Enzyme-linked immunosorbent assay
HCV	Hepatitis C virus
HIV	Human immunodeficiency virus
IB	Immunoblot
MSM	Men who have sex with men
NG	*Neisseria gonorrhoeae*
PCR	Polymerase chain reaction
PEP	Post-exposure prophylaxis
PrEP	Pre-exposure prophylaxis
RNA	Ribonucleic acid
SARS-CoV-2	Severe acute respiratory syndrome coronavirus type 2
STD	Sexually transmitted disease
STI	Sexually transmitted infection
TP	*Treponema pallidum*
TPPA	*Treponema pallidum* particle agglutination assay
VDRL	Venereal disease research laboratory test
WHO	World health organization

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1. Introduction

1.1. Background

In recent years, the global healthcare system has faced unprecedented challenges because of the Coronavirus disease 2019 (COVID-19) pandemic. The aim of this thesis is to show how stringent containment measures leading to a significant reduction of social contacts may have affected testing for and diagnosis of sexually transmitted diseases. Data of the years 2019, 2021, and 2023 is included to provide a comparison between the pre-pandemic, the pandemic, and the post-pandemic period.

1.1.1. The COVID-19 pandemic

At the end of December 2019, a new type of infectious disease emerged in the Chinese city of Wuhan. In January, its genetic sequence was identified for the first time, and the virus was named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). The virus spread across China and within a month there were approximately 85000 infections and 4000 associated deaths. From there, SARS-coV-2 disseminated worldwide (1). On March 11, 2020, the COVID-19 epidemic was declared a pandemic by the World Health Organization (2).

1.1.2. The COVID-19 pandemic in Austria

SARS-coV-2 began to spread in Austria, with the first case registered on February 25, 2020. As the number of positive tests and associated deaths increased, pandemic containment measures came into force on March 16, 2020 (3). In the following months, these measures were repeatedly modified and adapted to the pandemic situation.

In 2020, initial steps were taken to contain the spread of SARS-coV-2 in Austria. Public events were cancelled, and social distancing was recommended. On March 15, the Austrian National Council unanimously voted in favor of the COVID-19 Act, which created a legal basis for further restrictions (4). With March 16, an Austria-wide lockdown was imposed. As part of the lockdown, universities and schools were

closed, as were non-essential businesses. Nursing homes and old people's homes were closed to visitors. Travel restrictions and an advisory to avoid public places were issued. On April 3, the number of positive SARS-CoV-2 tests reached its then peak, with over 9000 confirmed infections (5). A transition back to normality took place from April 14 (Kowarz et al., 2020b). Over the summer, the number of infections decreased and the measures were largely relaxed or even lifted (6). In the healthcare sector, the pandemic led to significant changes. The use of telemedicine tools increased, resulting in less direct contact with health care professionals (7). In September 2020, the second wave of coronavirus infections began (8) and was followed by a renewed light lockdown in October, which included curfews, restrictions on gatherings and social distancing. As normal and intensive care beds in Austrian hospitals were gradually filling up, another hard lockdown was introduced in November 2020, similar to the one in spring. Measures were partially lifted over Christmas. However, a third hard lockdown was announced on December 26, 2020. Additionally, the first SARS-CoV-2 vaccinations were carried out in December (9).

In 2021, the vaccination campaign accelerated. Three vaccines were authorized at the end of January: BionTech/Pfizer, Moderna, and Astra Zeneca. The third hard lockdown ended on February 7, and measures were subsequently eased (9). Following the end of the lockdown, the number of infections rose again. However, the increase was significantly slower than during autumn 2020. The introduction of new containment measures now took place at a regional level, based on the infection situation in each of the nine federal states. During spring 2021, there were state-wide lockdowns and measures of varying severity (10). From May onwards, access to many public institutions was granted only to those who supplied proof of vaccination, a negative SARS-CoV-2 test, or evidence of a recent infection (≤ 6 months, 11). As vaccination rates increased, restrictions were largely lifted. However, at the end of June, a new variant of SARS-coV-2, the Delta variant, caused a surge in infections. In November, a new hard lockdown, similar to the previous ones, came into effect (12). The lockdowns lasted until mid-December (13).

In 2022, the disease became milder with the emergence of the Omicron variant. Restrictions were relaxed further, and the plan to make vaccination mandatory was

not implemented (13). In summer, individuals with a positive SARS-CoV-2 test no longer had to isolate but instead needed to obey certain rules in public spaces, such as wearing a FFP mask (14).

In 2023, all measures were lifted. The public health emergency of international concern declared by the WHO on January 30, 2020 due to COVID-19 was declared over on May 5, 2023. Since July 1, 2023, COVID-19 is no longer a notifiable disease and individuals who test positive are no longer subject to any restrictions (3).

1.2. Sexually transmitted infections

Sexually transmitted infections (STIs) are caused by bacteria, viruses, or parasites, and are primarily spread through sexual contact. The term “sexually transmitted disease” (STD) is used if said infection leads to a manifest disease. As the collective term STD covers many different conditions, the following sections describe only the pathogens relevant for this study.

1.2.1. Human immunodeficiency virus

If left untreated, human immunodeficiency virus (HIV) can progress to acquired immunodeficiency syndrome (AIDS), the most advanced stage of infection. At the end of 2022, an estimated 39 million individuals worldwide were infected. HIV is most widespread in the WHO African region (15). In the WHO European region, an estimated 3 million individuals are infected (16), with an increase in HIV diagnoses between 2021 and 2022 in many countries (17). In Austria, between 300 and 500 new HIV infections have been diagnosed each year in recent years. HIV positive patients are not obliged to officially report their infection in Austria (16).

There are two species of HIV viruses. HIV-1 and HIV-2 both are lentiviruses, family of retroviruses. HIV-1 is found worldwide while HIV-2 is mainly present in west African countries. HIV-1 consists of p24 proteins forming an icosahedral capsid. It is surrounded by a plasma membrane of host-cell origin containing gp120, the external surface glycoprotein and gp41, the transmembrane glycoprotein. Inside the capsid are two copies of a single-stranded RNA (ribonucleic acid) genome tightly

bound to nucleocapsid proteins p6 and p7, reverse transcriptase, integrase, and protease (18).

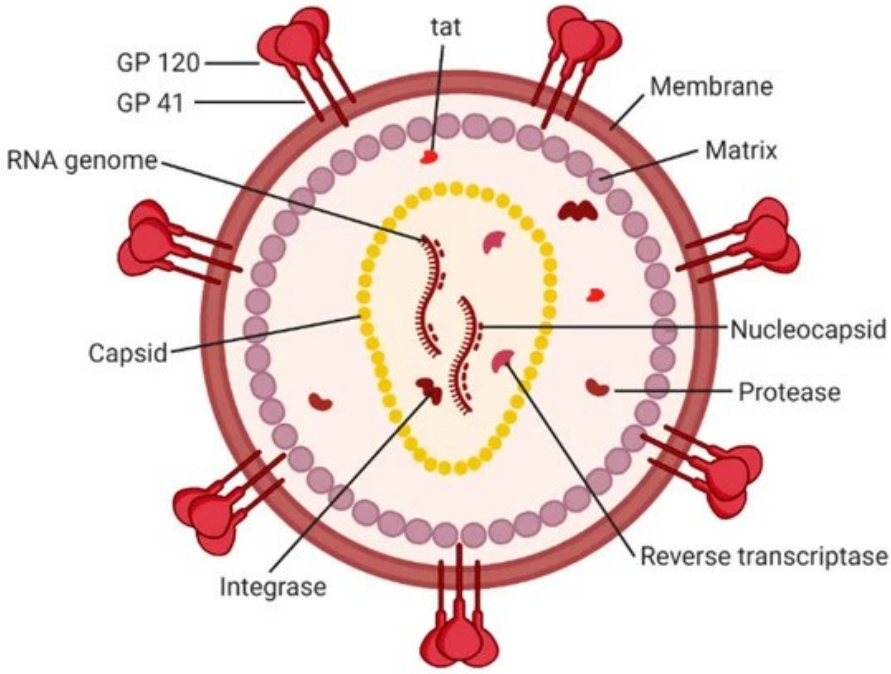

Figure 1: The HIV-1 virion. Source: https://www.mdpi.com/2075-1729/11/2/100, accessed 2024 Apr 23.

The HIV viral load is highest shortly after infection and at a significantly advanced stage of the disease. The virus is mainly found in sperm, vaginal secretion, blood, plasma, serum, and breast milk. HIV is transmitted via unprotected sexual contact, fresh blood, or vertical from mother to child. The risk of infection depends on the type of sexual contact (Table 1; 19).

Table 1: Risk of HIV transmission during unprotected sex with an HIV positive partner without antiretroviral therapy. Source: https://www.aidsgesellschaft.at/wp-content/uploads/2022/05/Leitlinien-zur-PEP_Stand-2022.pdf, accessed 2024 Apr 23.

Type of sexual contact	Risk per 10.000 expositions	95% confidence interval
Anal sex passive	138	102-186
Anal sex active	11	4-28
Vaginal sex passive	8	6-11
Vaginal sex active	4	1-14
Oral sex	Only individual cases are described	

An HIV infection can be divided into three clinical stages: the acute infection, the asymptomatic phase, and the symptomatic phase, also referred to as AIDS. After an incubation time of around two to six weeks, clinical symptoms occur. Headache, fever, swelling of lymph nodes, muscle pain, and a sore throat, make confusion with mononucleosis likely. Exanthema, oral ulcer, and Candida albicans infection may also occur. At this stage, infected individuals are particularly contagious. After about 14 days, the symptoms disappear. The asymptomatic stage can last from months to several years. Virus replication continues at a low level, which is why individuals are still infectious, although less so than in the first and end stage of the disease. If not treated appropriately, ten years after infection around 50% of infected individuals develop severe immunodeficiencies (18, 20, 21).

HIV diagnostic is based on the detection of antibodies against HIV, the detection of HIV antigens, and the detection of HIV nucleic acid in blood samples. Around three weeks after infection, antibodies can be detected. This serodiagnostic window is shortened by antigen detection according to the Enzyme-linked immunosorbent assay (ELISA) principle (around 14 days post-infection) and viral nucleic acid detection with polymerase chain reaction (PCR; around seven days post-infection). A combined antigen-antibody ELISA is usually used as a screening test. The

positive results are then confirmed by an Immunoblot (IB), which is highly specific for HIV antibodies (20, 21).

HIV is still an incurable infection. However, there are drugs that interfere with key structural elements and processes of HIV and inhibit its replication. This minimizes the damage to the immune system caused by HIV as well as the infectiousness of individuals. The therapy comprises the following substance groups: nucleoside and nucleotide reverse transcriptase inhibitors (NRTIs), non-nucleoside reverse transcriptase inhibitors (NNRTIs), protease inhibitors (PIs), integrase strand inhibitors (INSTIs), and co-receptor (CCR5) blocker (20, 21). A combination of two to three different substance groups is recommended in the guidelines of the European AIDS Clinical Society (EASC): two NRTIs plus one INSTI, one NRTI plus one INSTI, or two NRTIs plus one NNRTI (22).

It is also possible to take prophylactic medication. Post-exposure prophylaxis (PEP) is recommended after unprotected sexual contact with an HIV positive individual, after sharing devices for intravenous drug use with an HIV positive individual, or after percutaneous injuries with potentially infectious medical devices. Pre-exposure prophylaxis (PrEP) is recommended to individuals who have unprotected sex with casual or HIV positive partners. MSM (men who have sex with men) and transgender individuals in particular are advised to consider taking PrEP (22).

1.2.2. Hepatitis C virus

The hepatitis C virus (HCV) is prevalent worldwide, with an estimated 50 million individuals chronically infected, and 1 million new infections per year. HCV has the highest prevalence in the eastern Mediterranean region (23). Due to the frequently asymptomatic course of the disease, it is highly likely that many infections remain undetected. In Austria, the number of positive HCV antibody tests was 910 in 2022. With the approval of direct-acting antiviral agents in 2023, a decrease in infections was recorded in Austria (24).

HCV is a member of the genus Hepacivirus in the family of Flaviviridae. There are eight genotypes, each featuring several subtypes. As a result of its high mutation rate, HCV exhibits pronounced genetic variability, which leads to the development

of so-called quasispecies. HCV is an enveloped virus with a single-stranded RNA genome. The nucleocapsid is surrounded by a lipid membrane containing the glycoproteins E1 and E2. It can be transmitted parenterally via contaminated blood and body fluids, through unprotected sexual intercourse, and vertically from mother to child (25).

Incubation time is around six to ten weeks. Around 80% of acute infections are asymptomatic. Potential symptoms are an elevation of the aminotransferase and icterus. In 50 to 90% of cases, the HCV infection lasts longer than six months. The disease is then called chronic hepatitis C. The first few years of infection are usually asymptomatic. When symptoms do occur, they are unspecific, such as fatigue, nausea, loss of appetite, and fever. More specific possible symptoms are icterus, pruritus, and an enlarged liver and spleen. One quarter of chronically infected individuals develop liver cirrhosis, usually around 10 to 20 years post infection. This can lead to liver failure and increases the risk of hepatocellular carcinoma significantly (25, 26, 27).

For HCV diagnostics, detection of HCV antibodies or HCV RNA is utilized. The serodiagnostic window is six to eight weeks, while HCV RNA can be detected one to two weeks post-infection. For screening, an immunoassay is used. A positive result is confirmed with PCR (25, 26).

HCV infection is curable. Treatment is recommended for all patients with a replicative HCV infection where HCV RNA is detectable. Pharmaceuticals used are NS3 protease inhibitors, NS5A replication complex inhibitors, NS5B nucleoside inhibitors, and NS5B non-nucleoside inhibitors. A 12-week combination therapy is a definitive cure for HCV in most cases (26, 28).

1.2.3. *Chlamydia trachomatis*

Chlamydia trachomatis (CT) is the causative agent of a highly prevalent STD. CT is found worldwide, with an estimated 128.5 million new infections among those aged 15 to 49 years in 2020. The prevalence is known to be higher in young individuals (29).

CT is a gram-negative bacterium which exists in two stages: the elementary bodies are the extracellular inactive form, the reticulate bodies are the intracellular, metabolically active form. In European countries serotypes D to K are the most prevalent and represent the most common STI. Serotypes L1 to L3 are the causative agents of lymphogranuloma venereum and are more frequent in Africa, Asia, and South America. However, they have been occurring more frequently in Europe in recent years. These CT serotypes are transmitted primarily through sexual contact, and less frequently via smear infection. A vertical transmission during childbirth is possible (30, 31, 32).

Serotypes D to K are the causative agents of urogenital CT infection. The incubation time is about two to six weeks. Infections frequently manifest without overt symptoms, thus remaining undiagnosed and untreated. In women, purulent urethritis, inflammation of the Bartholin's glands, and cervicitis can occur. Progression of the disease to salpingitis often results in infertility. Chronic infections are particularly prevalent in women. In men purulent urethritis is the main symptom (31). Serotypes L1 to L3 are the causative agents of lymphogranuloma venereum. In addition to the symptoms of urogenital infections, the external genital area exhibits severe but painless ulcer or papules. In the second stage, the inguinal lymph nodes exhibit swelling, purulent inflammation, and fibrotic changes. Consequences of the progressive disease include anogenital strictures, fibrosis, fistulas, and necrosis (33).

CT diagnostics are based on the detection of DNA using PCR. It is recommended that sample swabs be taken from the cervix or urethra. In addition, urine samples and rectal and throat swabs can be considered (31).

Chlamydia is a curable STD. However, the recurrence/reinfection rate is relatively high at 10% (31). For an uncomplicated urogenital infection, the recommended first-line therapy is doxycycline p.o. for seven days or azithromycin p.o. once, for lymphogranuloma venereum doxycycline p.o. for 21 days. Sexual partners are always treated at the same time (34).

1.2.4. *Neisseria gonorrhoeae*

Gonorrhea, the corresponding disease to *Neisseria gonorrhoeae* (NG), is widespread worldwide. Due to the lack of mandatory reporting in many countries, it is not possible to give an accurate incidence figure. The number of unreported cases is thought to be very high (35). According to the WHO, it is the third most common STI, with approximately 87 million new cases per year (36).

There are no official figures for Austria, as there is only a limited obligation to report having gonorrhea, which is only enforced if there is a risk of the disease spreading or if the patient is avoiding treatment. In 2021, the national reference center AGES analyzed 356 gonococcal isolates of 342 patients (37). In 2019, a total of 1601 gonorrhea cases were reported in Austria (38).

NG gram-negative diplococci colonize mucous membranes and can occur in the respiratory and gastrointestinal tracts of the human body. Thanks to their extremely variable surface textures, they can adapt perfectly to their host. NG is highly sensitive to external influences such as pH value, temperature, and dehydration. These facts must be taken into consideration regarding the cultural detection of the bacteria (39).

NG is transmitted through close contact with mucous membranes, especially during sexual contact. However, vertical infection during childbirth is also possible (39).

The symptoms of gonorrhea are different for women and men. In women, the inflammation begins in the submucosa of the endocervix. Vaginal discharge is typically observed approximately eight days after infection. Gonococcal urethritis is a common occurrence. About 50% of female patients experience a subclinical course of the disease. In men, a purulent infection of the urethral mucosa two to six days after infection is typical. This can progress to prostatitis and epididymitis, usually associated with signs of generalized infection (39).

NG diagnostic is performed using PCR for nucleic acid detection, microscopy, or cultural detection (39).

Resistance to NG is increasing. The recommended first-line therapy is a combination of ceftriaxone i.v. or i.m. and azithromycin oral (39).

1.2.5. *Treponema pallidum*

Treponema pallidum (TP) is the causative agent of syphilis. TP is found worldwide, with an estimated 7.1 million new infections among those aged 15 to 49 years in 2020 (40). In EU/EEA countries, 25270 confirmed syphilis cases were reported, which corresponds to a notification rate of 7 cases per 100 000 (41).

TP is a spirochaete bacterium coated by a peptidoglycan layer. Due to lack of classic virulence factors and only a small amount of surface molecules, it has low antigenicity. It is also referred to as ‘stealth pathogen’. TP is transmitted through sexual contact or other mucosal contact. Mucosal lesions increase the likelihood of transmission; micro dermal lesions may also allow transmission through the skin. Vertical transmission during pregnancy is possible (42).

After an incubation period of around 21 days, a painless, highly contagious ulcer develops at the site of primary infection. Lymphadenitis of local lymph nodes can be observed. This primary stage is followed by a latency period of four to six weeks. The secondary stage is characterized by bacteremia. Organ involvement can manifest itself as hepatitis, glomerulonephritis, or arthritis. In addition, common clinical symptoms such as fatigue, fever, and headache can occur. At this stage, syphilitic exanthema can be found all over the body and individuals are infectious. The tertiary stage occurs after several years of latency and affects almost a third of untreated individuals. Among others, most common organ manifestations concern the skin, the cardiovascular system, and the central nervous system (42, 43).

TP diagnostic is mainly based on serological methods. However, direct pathogen detection with PCR can be done during the primary stage. The most common testing methods are the nontreponemal veneral disease research laboratory test (VDRL) and the rapid plasma regain test (RPR), which detect IgM- and IgG antibodies typical for the tissue destruction caused by syphilis. Treponemal tests are highly specific and detect antibodies against TP proteins. These tests are more effective in detecting an early stage of syphilis. Typical are the Treponema pallidum particle agglutination test (TPPA), and the Treponema pallidum hemagglutination test (TPHA) (44, 45).

TP is sensitive to penicillin. In case of a penicillin allergy, alternative antibiotics such as cephalosporins, macrolides, and tetracyclines can be used. Macrolide resistance is more prevalent than penicillin resistance (45).

1.3. Testing for sexually transmitted diseases in Austria

In addition to medical professionals and institutions, Austria also boasts a range of other facilities that provide STI testing. The regional branches of *AIDS-Hilfe Österreich* (AIDS support Austria) provide confidential sexual health counseling and diagnostic testing services for several STIs in each federal state. *Venus Med*, a center for sexual medicine in Vienna, offers risk checks for the most common STIs. Additionally, pharmacies offer STI self-testing kits.

1.4. *AIDS-Hilfe Steiermark*

AIDS-Hilfe Steiermark is a regional branch of *AIDS-Hilfe Österreich* and provides support within the federal state of Styria. *AIDS-Hilfe Steiermark*, like other *AIDS-Hilfe* organizations, offers advice, tests, support, and preventative services regarding sexual health. *AIDS-Hilfe Steiermark* has been providing anonymous HIV tests since its inception in 1968. Over the past few years, the range of services offered by the organization has expanded. Since 2011, syphilis (TP) tests have been provided and, in 2020 tests for hepatitis A, B, and C, chlamydia (CT), and gonorrhea (NG) were added (46).

2. Objectives

No publications on Austrian STI testing behavior and test results obtained before, during and after the COVID-19 pandemic have been published so far. The aim of this thesis was to gain insight into the impact of the COVID-19 pandemic and containment measures on anonymous testing for STIs at the Styrian service facility *AIDS-Hilfe Steiermark*. Trends for testing and test results were described by comparing pre-pandemic (2019), pandemic (2021), and post-pandemic (2023) data. The clients of *AIDS-Hilfe Steiermark* were analyzed for demographic data. Furthermore, sexual behavior and risk behavior/factors were examined. Correlations between demographics, sexual behavior, and risk behavior/factors and infections were investigated.

3. Materials and methods

3.1. Data collection

For this retrospective study, data obtained from *AIDS-Hilfe Steiermark* was utilized. Inclusion criteria comprised all clients accessing *AIDS-Hilfe Steiermark* for the first time (initial contacts) during the years 2019, 2021, and 2023.

To maintain confidentiality and anonymity, each client was assigned a unique code word and sequence at *AIDS-Hilfe Steiermark*. A questionnaire was administered to each client. Part of the questionnaire concerned demographic information such as birth year, sex (female or male, at initial contact), and sexual orientation (heterosexual, homosexual, bisexual). Homosexual and bisexual men were combined as MSM for some analyses. Data on sexual behavior (vaginal sex, anal sex active, anal sex passive, oral sex active, oral sex passive, petting) was also captured. All types of sexual behavior included in the analysis below were unprotected. Additionally, the questionnaire included questions about personal risk behavior/factors (drug use, HIV positive, region with high infection risk, holiday acquaintance, one-night stand, affair, promiscuous behavior, condom failure, contact with prostitutes) and risk behavior/factors of the sexual partner (drug use, HIV positive, region with high infection risk, holiday acquaintance, affair, promiscuous behavior, condom failure, contact with prostitutes). The questionnaire is shown in the appendix.

AIDS-Hilfe Steiermark recorded performed tests for each client in 2019, 2021, and 2023. Test results from 2019 and 2021 were provided by AGES (Austrian Agency for Health and Food Safety) Vienna.

3.2. Testing for sexually transmitted infections

Testing for HIV and TP has been offered at *AIDS-Hilfe Steiermark* 2019 through 2023. Both the combined CT/NG test and the HCV test have been offered at *AIDS-Hilfe Steiermark* from 2020 onwards.

3.2.1. Human immunodeficiency virus

HIV diagnostics offered by *AIDS-Hilfe Steiermark* is based on the following methods: PCR for detection of HIV-1 RNA, ELISA for combined detection of anti-HIV antigen/antibodies (either rapid or classic assay), and IB for detection of antibodies against specific HIV surface proteins/glycoproteins.

The HIV-1 PCR test was only carried out if specifically requested by clients. Detection of HIV-1 RNA is characterized by the shortest diagnostic window (approximately seven days).

The HIV rapid antibody/antigen test used was *Determine™ HIV Early Detect* manufactured by *Abbott*. According to the manufacturer's package insert, this is an *in vitro* qualitative immunoassay for the detection of antibodies (Ab) to HIV-1 and HIV-2 and the detection of non-immunocomplexed (free) HIV-1 p24 antigen (Ag) in human capillary and venous whole blood, plasma, or serum.

To confirm positive screening results, PCR and/or IB tests were performed. In the following analysis, 'HIV test performed' means one or more of the offered HIV tests (PCR, ELISA rapid or classic, IB) were performed. A single client may request more than one HIV test. In this study, all confirmed positive results, i.e., ELISA and IB positive, were included in the statistical analysis.

3.2.2. Hepatitis C virus

For HCV diagnostics, anti-HCV antibody detection is used. *ANTI HCV II* with *Roche COBAS e411* was used in 2019 and *Anti HCV II* with *Abbott Alinity i* was used in 2021 and 2023.

3.2.3. *Chlamydia trachomatis/Neisseria gonorrhoeae*

For CT and NG diagnostics, a PCR test is used. Clients provide separate samples from anal, vaginal, urinary, and oral swabs by self-smear. For diagnostics, the samples are not pooled.

The *Cobas 4800* CT/NG test for use on the *Cobas 4800 system* manufactured by *Roche* (pipetting robot: *Cobas x 480*; LightCycler: *Cobas z 480*) was used in 2019. *Alinity m* manufactured by *Abbott* (*STI AMP Kit*) was used in 2021 and 2023.

3.2.4. *Treponema pallidum*

For TP diagnostics, an antibody test is used. In case of a positive antibody test, a TPPA is performed. If the TPPA is reactive, a VDRL is performed.

To confirm TP diagnosis, Roche COBAS e411 with Elecsys Syphilis was used in 2019, and ABBOTT Alinity *i* with *Syphilis TP* was used in 2021 and 2023.

3.3. Statistical analysis

For the statistical analysis, Statistical Package for the Social Sciences (SPSS) v. 29.0 was used. The analysis primarily focused on descriptive statistics to summarize and describe the central tendency of data.

The chi-square test was used to determine the significance of associations between nominal dichotomous variables. A result is considered significant if $p < 0.05$.

To measure the strength of correlation, the Phi test for dichotomous variables was conducted. Phi assumes values between -1 and 1; 0 means no correlation, and 1 or -1 means perfect correlation (47).

For graphical representation Microsoft Excel v2402 was used.

4. Results

4.1. Demographic data of *AIDS-Hilfe Steiermark* clients

In total, there were 4287 initial clients at *AIDS-Hilfe Steiermark* in the years 2019, 2021, and 2023. In 2019, the number of initial contacts was 1494, in 2021 it was 1034, and in 2023 it was 1759 (Table 2).

Table 2: Initial contacts with *AIDS-Hilfe Steiermark* in 2019, 2021, and 2023.

No. of initial contacts in			
2019	2021	2023	Total
1494	1034	1759	4287

4.1.1. Sex and age

Only the sexes male and female were available for selection in the questionnaire. Of 4287 initial contacts, 1903 (44.4%) identified themselves as female and 2384 (55.6%) as male. The distribution is shown in Figure 2.

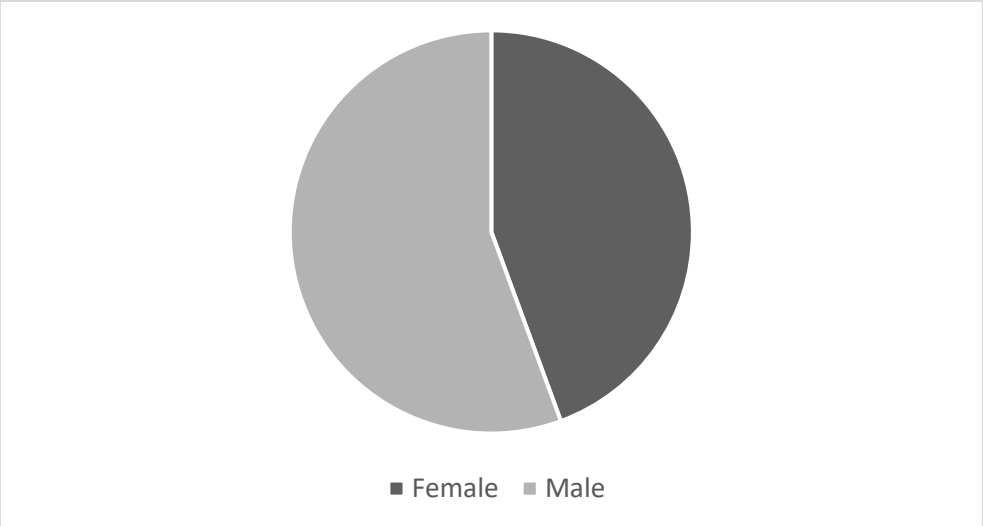

Figure 2: Sex of 4287 clients based on the questionnaire at the initial contact with *AIDS-Hilfe Steiermark* throughout the years.

The age of clients was calculated using the year of birth with the cut-off date January 1st of every year. The mean age of all clients investigated in this study was 29.9 years old, age range 14 to 81. Fifty percent of clients were found to be aged between 24 and 34. The age of 28 was not available.

For female clients, the mean age was 28.5, age range 15 to 70. For male clients, the mean age was 31.0, age range 14 to 81 (Figure 3).

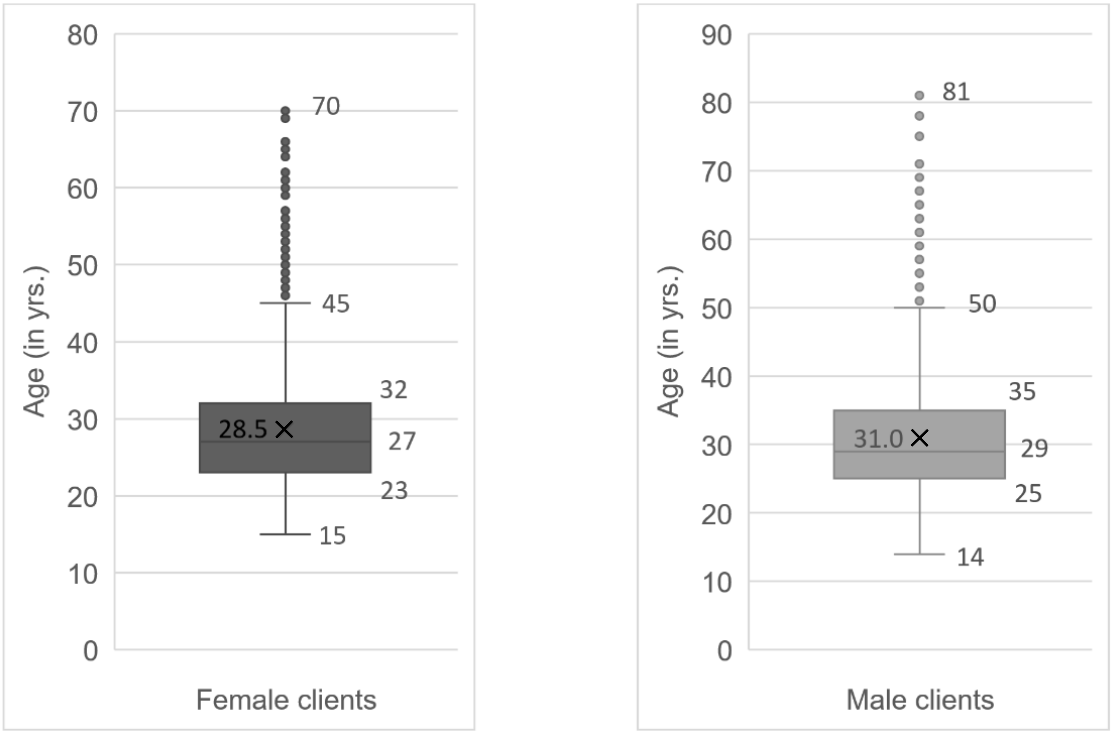

Figure 3: Age (in yrs., cut-off date Jan. 1st) of clients at the initial contact with *AIDS-Hilfe Steiermark* throughout the years. On the left, age distribution for female clients (n = 1903); on the right, age distribution for male clients (n = 2384). Lower and upper fences are 25th and 75th percentiles, with the median in between. The x represents the mean.

4.1.2. Sexual orientation

Of 4287 clients, 3396 (79.2%) stated that they were heterosexual while 388 (9.1%) were homosexual, and 412 (9.6%) were bisexual (Figure 4). Ninety-one clients (2.1%) did not indicate any sexual orientation in the questionnaire.

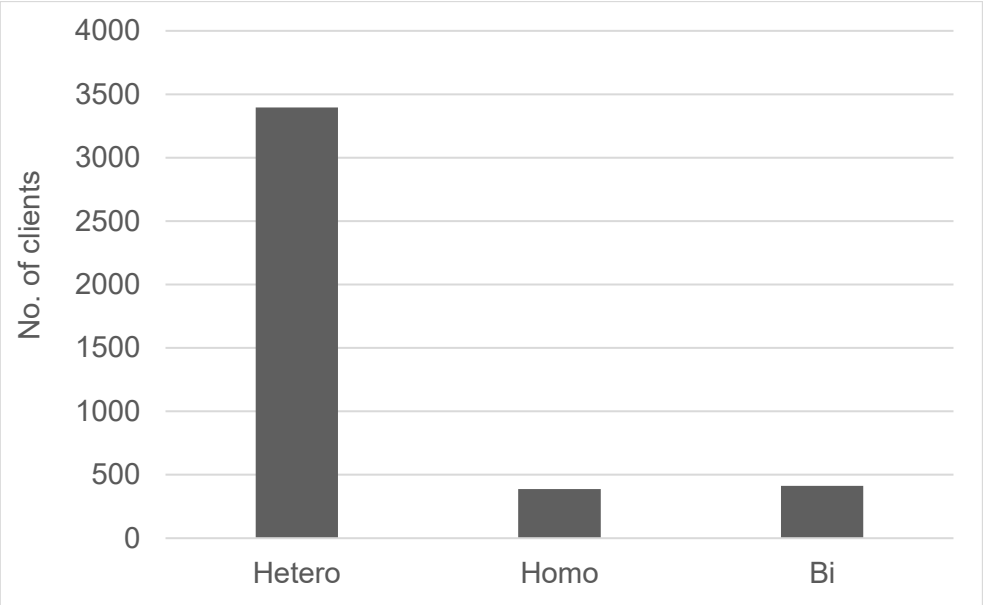

Figure 4: Sexual orientation as stated in the questionnaire by 4196 of clients at the initial contact with *AIDS-Hilfe Steiermark* throughout the years.

The percentage of female clients who indicated being heterosexual, homosexual, and bisexual was 85.7%, 1.2%, and 10.9%, respectively. For males, the corresponding percentages were 74.1%, 15.3%, and 8.6% (Figure 5). The chi-square test showed a significant association between sex and homosexuality ($\chi^2(1, N = 4287) = 255.659$, $p < 0.001$).

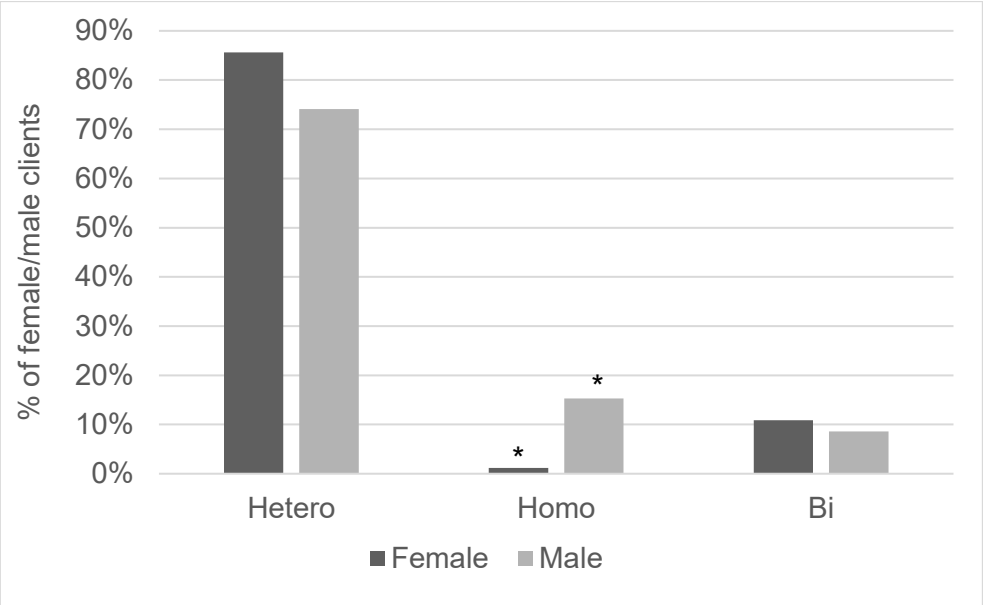

Figure 5: Sexual orientation in percentages as stated by 1860 female and 2336 male clients at the initial contact with *AIDS-Hilfe Steiermark* throughout the years. *, $p < 0.001$

4.2. Sexual behavior and risk behavior/factors in the years 2019, 2021, and 2023

4.2.1. Sexual behavior

Overall, out of 4287 clients, 3721 (86.8%) reported unprotected sexual behavior. Of these clients, 1941 indicated a specific type of unprotected sexual behavior. In 2019, 1155 (77.3%) clients reported unprotected sexual behavior, in 2021, it was 967 (93.5%) clients, and in 2023, 1599 (90.9%) clients. The chi-square test showed a significant difference in unprotected sexual behavior between the years 2019 and 2021 ($\chi^2(1, N = 2528) = 119.124$, $p < 0.001$) and between the years 2021 and 2023 ($\chi^2(1, N = 2793) = 5.970$, $p < 0.015$).

In 2019, 54.5% of the clients indicated having vaginal sex. The percentages were 30.6% in 2021 and 21.3% in 2023. The percentages of clients who reported having oral sex (active and/or passive) were 26.8% in 2019, 32.6% in 2021, and 6.4% in 2023. The proportion of clients who indicated having anal sex (active and/or

passive) was 3.9% in 2019, 1.7% in 2021, and 0.6% in 2023. The percentages of clients who reported engaging in petting were 9.2% in 2019, 16.8% in 2021, and 13.9% in 2023. Absolute numbers are shown in Table 3.

Table 3: Types of unprotected sexual contact as indicated by 3721 clients in 2019, 2021, and 2023; N/A, not available. *Active and/or passive

Type of unprotected sexual contact	No. of clients in		
	2019 (n = 1494)	2021 (n = 1034)	2023 (n = 1759)
Vaginal sex	814	316	375
Oral sex active	389	327	102
Oral sex passive	354	118	95
Oral sex*	400	334	113
Anal sex active	33	15	4
Anal sex passive	47	13	7
Anal sex*	58	18	11
Petting	138	174	245
N/A	152	592	1036

4.2.2. Personal risks and partner risks

Overall, out of 4287 clients, 901 (21.0%) reported at least one type of personal risk behavior/factors and/or partner risk behavior/factors. Moreover, 591 (13.8%) stated at least one type of personal risk behavior/factors, 110 (2.6%) stated at least one type of partner risk behavior/factors, and 3386 clients (79.0%) did not report any type of risk behavior/factors. Two hundred clients (4.7%) reported both partner and personal risk behavior/factors.

In 2019, 270 clients (18.1%) reported a type of personal risk behavior/factors, 44 clients (2.9%) reported a type of partner risk behavior/factors, and 118 reported both. In 2021, the corresponding numbers were 166 (16.1%), 28 (2.7%), and 41 (4.0%). In 2023, it was 155 (8.8%), 38 (2.2%), and 41 (2.3%).

Table 4: Reported personal and partner risk behavior/factors in 2019, 2021, and 2023; N/A, not available.

Risk behavior/factors	No. of clients in		
	2019 (n = 1494)	2021 (n = 1034)	2023 (n = 1759)
Personal risk	270	166	155
Partner risk	44	28	38
Personal and partner risk	118	41	41
N/A	1062	799	1525

4.2.3. Types of personal and partner risk behavior/factors

The personal risks most frequently cited were “One-night stand” (6.8%) and “Promiscuous behavior” (6.6%). The partner risk most frequently cited was “Promiscuous behavior” (5.0%).

All types of personal and partner risk behavior/factors are shown in the appendix (Tables 12 and 13).

4.3. Test behavior and detected sexually transmitted infections in the years 2019, 2021, and 2023

4.3.1. Initial contacts with *AIDS-Hilfe Steiermark*

Over the years 2019, 2021, and 2023, a total of 4287 individuals were registered as first-time clients. In 2019, 1494 clients had their initial contact with *AIDS-Hilfe Steiermark.* This number decreased to 1034 in 2021 (30.8% less compared to 2019)

and increased to 1759 in 2023 (+70.1% compared to 2021, +17.7% compared to 2019). Figure 6 shows the trend of initial contacts over the three years.

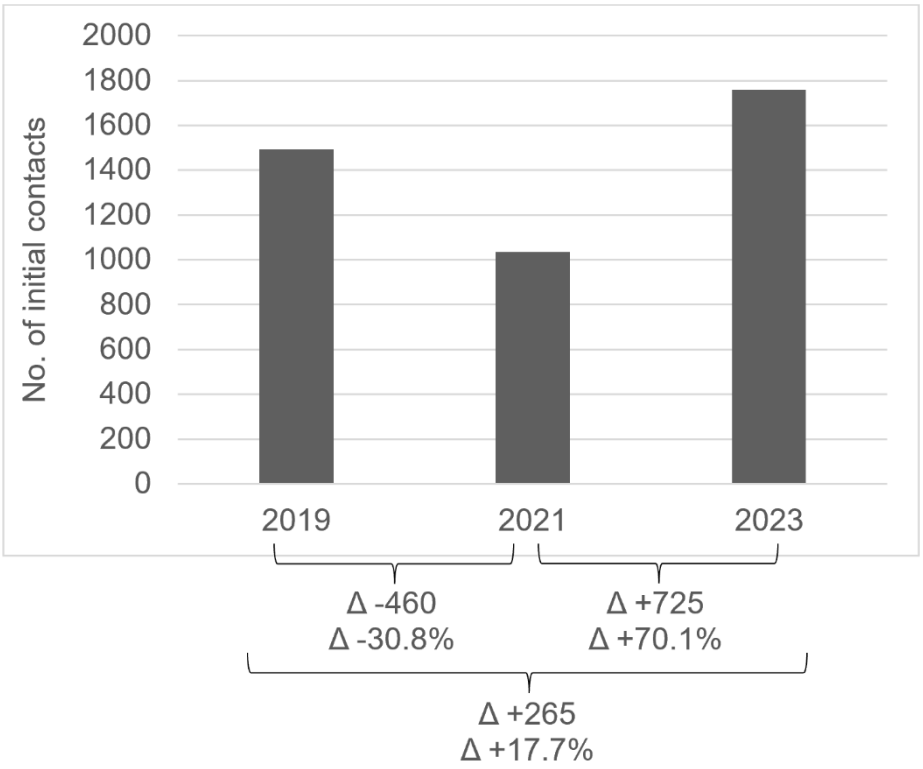

Figure 6: Number of initial contacts with *AIDS-Hilfe Steiermark* in 2019, 2021, and 2023 with corresponding absolute and relative changes.

Figure 7 shows the monthly development of initial contacts in the years 2019, 2021, and 2023. In 2019, the mean was 124.5 initial clients per month, with a minimum in September (94) and a maximum in January (161). In 2021, the mean was 86.2 clients per month. The fewest initial contacts were recorded in December (47), the most in October (106). In 2023, there was a mean of 146.6 clients per month, with a minimum in December (98) and a maximum in March (184).

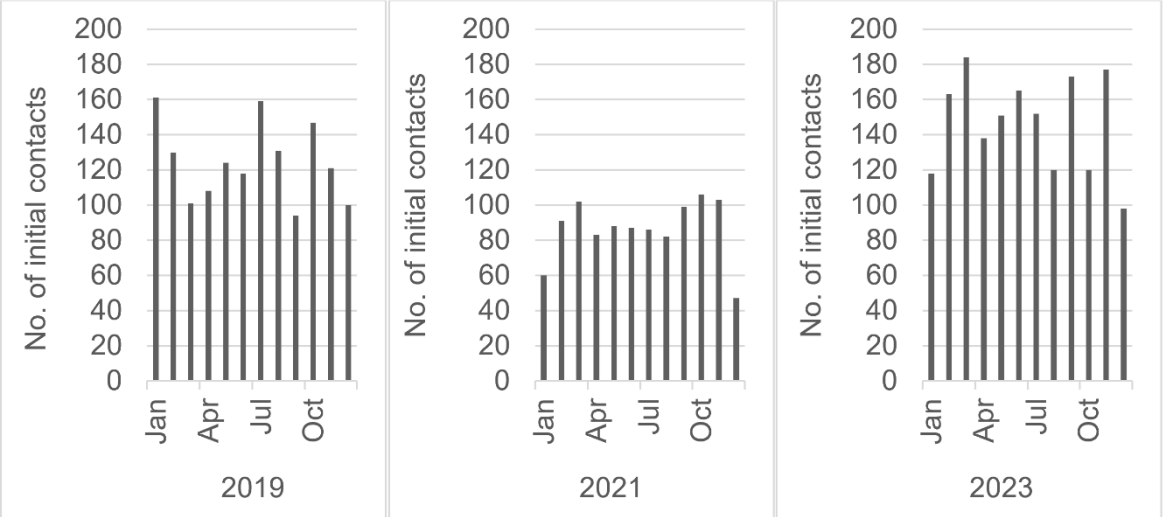

Figure 7: Number of initial contacts with *AIDS-Hilfe Steiermark* per month in 2019, 2021, and 2023.

4.3.2. Tests performed

In 2019, a total of 1754 tests were performed. In 2021, the number of tests performed increased to 2436 (+38.9% compared to 2019). In 2023, the number of tests performed was 4709 (+93.3% compared to 2021, +168.5% compared to 2019). Results are shown in Table 5.

Table 5: Number of diagnostic tests performed for each pathogen(s) in 2019, 2021, and 2023; N/A, not available.

Pathogen(s)	No. of tests performed in		
	2019	2021	2023
HIV	1491	1022	1721
HCV	N/A	443	782
CT/NG	N/A	496	1173
TP	263	475	1033
Total	1754	2436	4709

In 2019, 1491 HIV tests were performed (Table 5, Figure 8). The number decreased to 1022 in 2021 (-31.5% compared to 2019) and increased to 1721 in 2023 (+68.4% compared to 2021). Table 6 provides an overview of the numbers and types of HIV tests used.

Table 6: Types of HIV tests used in 2019, 2021, and 2023. A single client could undergo multiple types of HIV tests.

Type of HIV test	No. of HIV tests in		
	2019 (n = 1491)	2021 (n = 1022)	2023 (n = 1721)
PCR	15	14	16
ELISA classic	1491	1021	1721
ELISA rapid	433	114	81

In 2021, 443 HCV tests were performed, with an increase to 728 in 2023 (+76.5% compared to 2021; Table 5, Figure 8).

In 2021, 496 CT/NG tests were performed, with an increase to 1173 in 2023 (+136.5% compared to 2021; Table 5, Figure 8).

The number of TP tests performed was 263 in 2019. It increased to 475 in 2021 (+80.6% compared to 2019) and to 1033 in 2023 (+117.5% compared to 2021; Table 5, Figure 8).

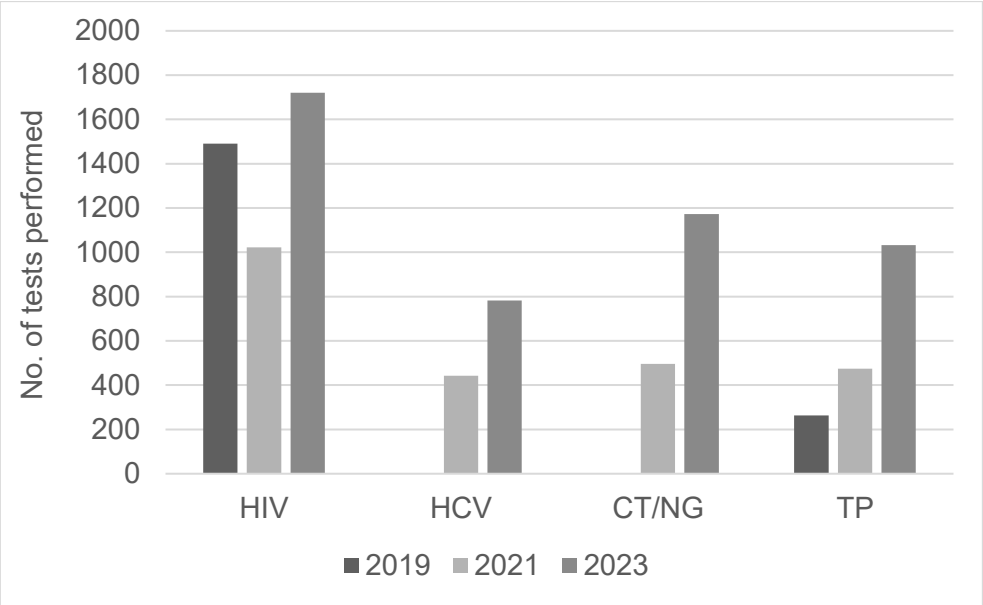

Figure 8: Number of tests performed for each pathogen(s) in 2019, 2021, and 2023.

4.3.3. Testing for multiple infections

Overall, 2274 clients (53.0%) were tested for only one infection, 860 (20.0%) were tested for two or three infections, and 1153 (26.9%) were tested for four infections. This results in a mean value of 2.1 tests per client (Table 7).

Table 7: Number of clients who tested for one or more pathogens in 2019, 2021, and 2023. *In 2019, only two types of tests were offered.

No. of tests performed	No. of clients in		
	2019 (n = 1494)	2021 (n = 1034)	2023 (n = 1759)
1	1234	480	560
2	260	112	195
3	0*	36	257
4	0*	406	747
Mean	1.2	2.4	2.7

While the percentage of clients tested for four infections increased from 39.3% in 2021 to 42.5% in 2023, the percentage of clients tested for only one infection decreased from 46.4% in 2021 to 31.8% in 2023. The trend is shown in Figure 9.

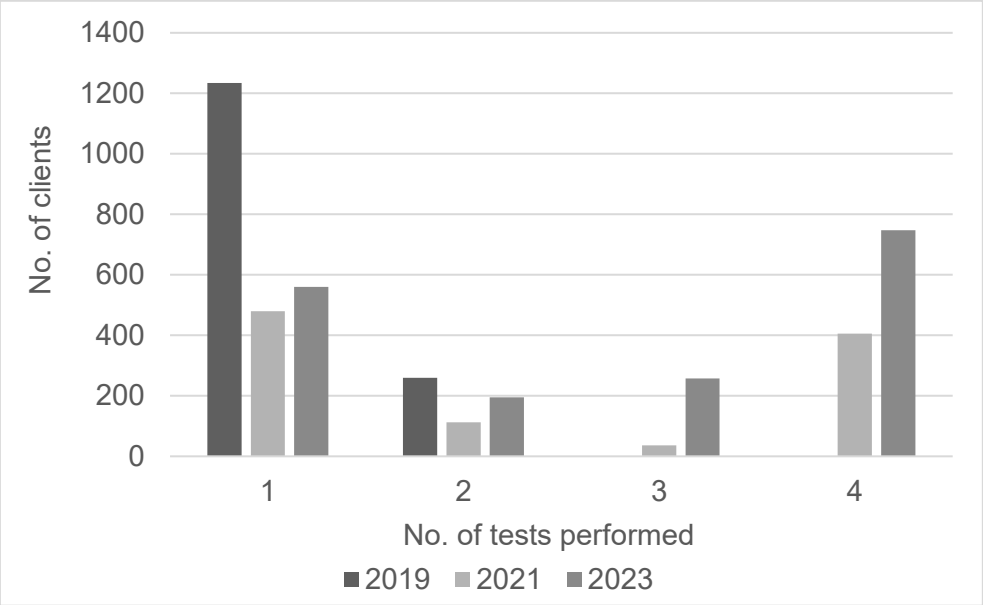

Figure 9: Number of clients who tested for one or more pathogens in 2019, 2021, and 2023.

4.3.4. Correlations between performed tests

For the correlation analysis, only data from clients showing up in 2021 and 2023 (N = 2793) was used, as some tests were not yet available in 2019.

A total of 2743 clients (98.2%) underwent HIV testing. The correlation coefficients for HIV testing and HCV, CT/NG, and TP testing were $\varphi = 0.092$, $p < 0.001$; $\varphi = -0.105$, $p < 0.001$; and $\varphi = 0.097$, $p < 0.001$, respectively.

The correlation coefficient for HCV and CT/NG testing was $\varphi = 0.641$, $p < 0.001$. Of 1225 clients who tested for HCV, 95.3% were also tested for CT/NG. The correlation coefficient for HCV and TP testing was $\varphi = 0.746$, $p < 0.001$. Of 1225 clients who tested for HCV, 96.1% were also tested for TP.

The correlation coefficient for CT/NG and TP testing was $\varphi = 0.760$, $p < 0.001$. Of 1669 clients who tested for CT/NG, 85.1% were also tested for TP.

4.3.5. Infections detected

Overall, in 2019, seven infections were detected (0.40% of all tests performed), in 2021, 47 infections (1.93% of all tests performed), and, in 2023, 102 infections (2.17% of all tests performed; Table 8; Figure 10).

Table 8: Number of (confirmed) infections for each pathogen in 2019, 2021, and 2023; nt, not tested. *12 clients had received treatment in the past.

Pathogen	No. of (confirmed) infections in		
	2019	2021	2023
HIV	3	2	4
HCV	nt	0	0
CT	nt	30	65
NG	nt	9	12
TP	4	6	21*
Total	7	47	102

In 2019, 3 clients (0.20%) out of all tested for HIV were found to be infected. The corresponding numbers were 2 (0.20%) in 2021 and 4 (0.23%) in 2023.

No positive HCV results were found.

In 2021, 30 clients (6.05%) out of all tested for CT were found to be infected. In 2023, the number was 65 (5.54%).

In 2021, 9 clients (1.81%) out of all tested for NG were found to be infected. In 2023, the number was 12 (1.02%).

In 2019, 4 clients (1.52%) out of all tested for TP were found to be infected. The corresponding numbers were 6 (1.26%) in 2021 and 21 (2.03%) in 2023.

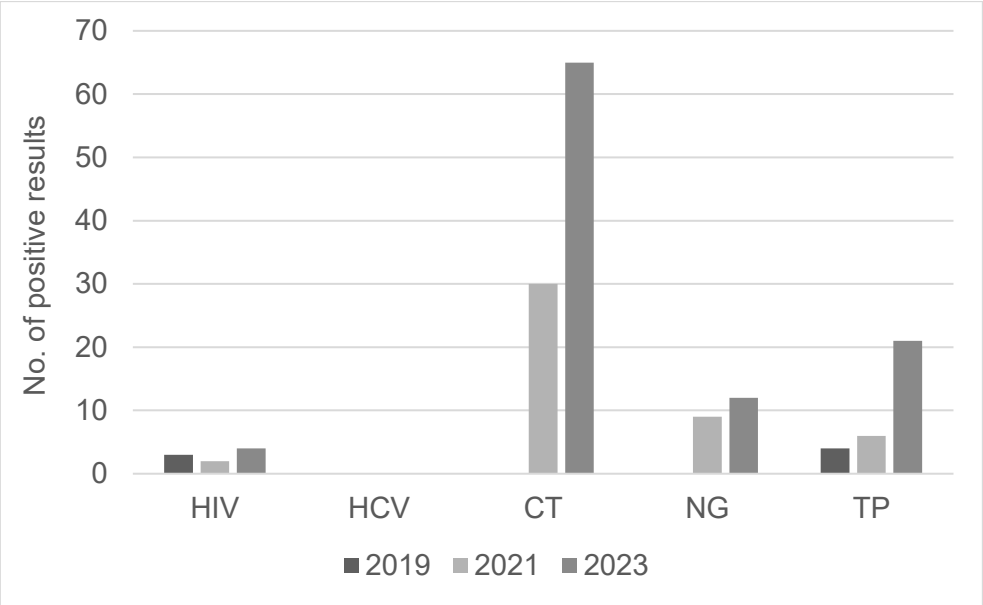

Figure 10: Number of (confirmed) infections for each pathogen in 2019, 2021, and 2023.

4.3.6. Multiple infections

Of 145 clients who tested positive for one or more infections, 7 (4.8%) had a double infection, and 2 clients (1.4%) had a triple infection. Numbers for each year are shown in Table 9.

No multiple infections were detected in 2019.

In 2021, two clients tested positive for two infections. Both clients (female, aged 19, sexual orientation N/A; female, aged 25, heterosexual) tested positive for CT and NG.

In 2023, five clients tested positive for two infections. Three of them (female, aged 21, heterosexual; male, aged 28, bisexual; male, aged 28, homosexual) tested positive for CT and NG. One client (male, aged 53, homosexual) tested positive for CT and TP and one client (male, aged 27, bisexual) tested positive for NG and TP. Two clients tested positive for three infections. One client (male, aged 31, homosexual) tested positive for HIV, CT, and TP. The other client (male, aged 22, homosexual) tested positive for HIV, NG, and TP.

Table 9: Number of clients with one or multiple infections in 2019, 2021, and 2023. *In 2019, only two types of tests were offered.

No. of infections	No. of clients in 2019 (n = 1494)	2021 (n = 1034)	2023 (n = 1759)
1	7	43	86
2	0	2	5
3	0*	0	2

4.4. Demographic and risk behavior/factors of infected clients

4.4.1. Infections regarding sex

Overall, 88 (3.7%) of 2384 male clients and 57 (3.0%) of 1903 female clients had at least one infection (Table 10). All HIV positive clients (9) were found to be men. For CT, the percentage was 2.7% for women and 1.8% for men (Figure 11). For NG, 0.3% of women had a positive test result and 0.7% of men. For TP, 0.1% of women were found to be positive in comparison to 1.2% of men.

The chi-square test showed a significant difference in the proportion of STI infections between female and male clients for HIV ($\chi^2(1, N = 4287) = 7.199$, $p = 0.007$), for CT, ($\chi^2(1, N = 4287) = 5.114$, $p = 0.024$), and for TP $\chi^2(1, N = 4287) = 18.207$, $p < 0.001$). It was not significant for NG ($\chi^2(1, N = 4287) = 3.621$, $p = 0.057$).

Table 10: Infections detected in 1903 female and 2384 male clients throughout the years. Total means clients with at least one infection; multiple infections are possible.

Positive result for	No. of clients being	
	Female (n = 1903)	Male (n = 2384)
HIV	0	9
CT	53	42
NG	5	16
TP	2	29
Total	57	88

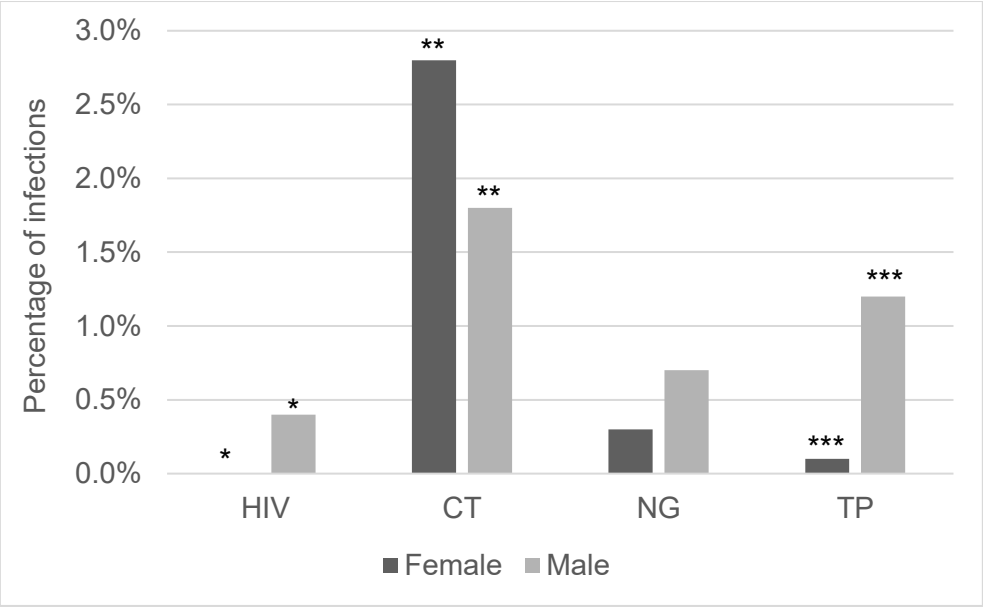

Figure 11: Proportion of infections detected in 1903 female and 2384 male clients throughout years. *, $p = 0.007$; **, $p = 0.024$; ***, $p < 0.001$.

4.4.2. Infections in male clients regarding sexual orientation

Thirty-five (2.0%) of heterosexual male clients, 31 (8.5%) of homosexual male clients, and 20 (9.8%) of bisexual male clients, were found to have least one infection. Numbers are shown in Table 11.

The percentages of HIV positive clients were 0.1% in heterosexual men, 1.4% in homosexual men, and 1.0% in bisexual men. For CT corresponding percentages were 1.6%, 2.7%, and 1.5%. For NG, they were 0.2%, 1.4%, and 3.9% and for TP 0.1%, 4.7%, and 4.4%.

Table 11: Infections of 2384 male clients regarding their sexual orientation. Total means clients with at least one infection; multiple infections are possible; N/A, not available.

Positive result for	No. of male clients being			
	Hetero (n = 1766)	Homo (n = 365)	Bi (n = 205)	N/A (n = 48)
HIV	1	5	2	1
CT	29	10	3	0
NG	3	5	8	0
TP	2	17	9	1
Total	35	31	20	2

Overall, 51 (8.9%) of MSM clients were found to have at least one infection. The proportion of infections was 1.2% for HIV, 2.3% for CT, 2.3% for NG, and 4.6% for TP (Figure 12).

The chi-square test showed a significant difference in the proportion of STI infections between MSM and heterosexual male clients for HIV ($\chi^2(1, N = 2336) = 17.326$, $p < 0.001$), for NG ($\chi^2(1, N = 2336) = 28.225$, $p < 0.001$), and for TP ($\chi^2(1, N = 2336) = 71.995$, $p < 0.001$). It was not significant for CT ($\chi^2(1, N = 2336) = 0.995$, $p = 0.318$).

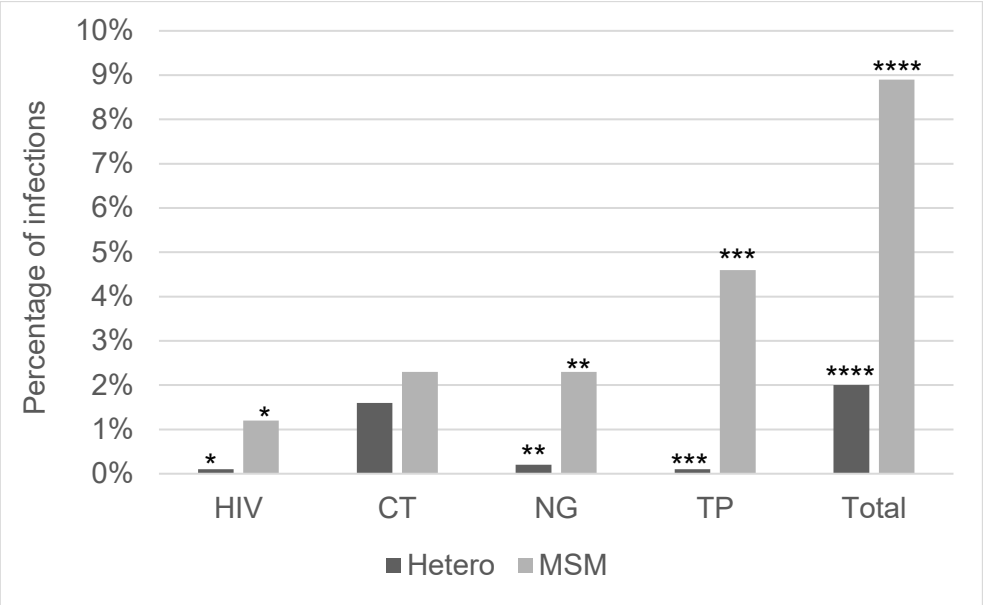

Figure 12: Percentages of infections for each pathogen among 1766 heterosexual men and 570 MSM (i.e., homosexual and bisexual men) throughout the years. Total means clients with at least one infection; multiple infections are possible. *, $p < 0.001$; **, $p < 0.001$; ***, $p < 0.001$; ****, $p < 0.001$.

4.4.3. Infections regarding unprotected sexual behavior

Of 3721 clients who reported unprotected sexual behavior, 134 (3.6%) had at least one infection. Of the 566 remaining clients who did not report unprotected sexual behavior, 11 (1.9%) had at least one infection. The chi-square test showed a significant association between unprotected sexual behavior and STI infections ($\chi^2(1, N = 4287) = 4.131$, $p = 0.042$).

4.4.4. HIV infections regarding types of sexual behavior

All nine HIV positive clients reported having unprotected sex. Four of the clients did not indicate a specific type of sexual behavior. Two (5.7%) of the 35 clients who reported having unprotected anal sex (but not oral sex) showed a positive HIV test result. One (0.1%) of the 795 clients who reported having unprotected oral sex (but not anal sex) showed a positive HIV test result. Two (3.9%) of the 52 clients who reported having both unprotected anal and oral sex, were found to be HIV positive. The proportion of HIV positive clients is shown in Figure 13.

A chi-square test showed a significant difference in the proportion of HIV infections between clients who indicated exclusively having anal sex and clients who indicated exclusively having oral sex ($\chi^2(1, N = 830) = 29.072$, $p < 0.001$).

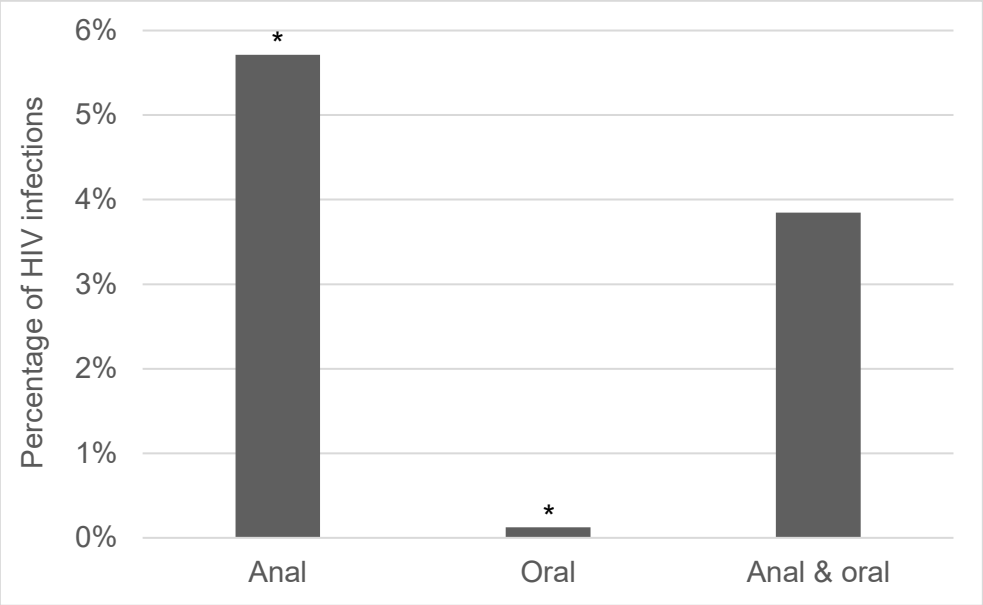

Figure 13: Percentages of HIV infections among clients who indicated exclusively having anal sex (n = 35), exclusively having oral sex (n = 795), and having both anal and oral sex (n = 52) throughout the years. *, $p < 0.001$.

4.4.5. Infections regarding personal and partner risk behavior/factors

Of 901 clients who reported at least one type of personal and/or partner risk behavior/factors, 36 (4.0%) had at least one infection. Of the remaining 3386 clients who did not indicate any risk behavior/factors, 109 (3.2%) had at least one infection.

Of 591 clients who indicated at least one type of personal risk behavior/factors, 18 (3.1%) had at least one infection. Of 110 clients who indicated at least one type of partner risk behavior/factors, 5 (4.6%) had at least one infection. Of 200 clients who indicated both at least one type of personal risk behavior/factors and at least one type of partner risk behavior/factors, 13 (6.5%) had at least one infection (Figure 14). The chi-square test showed a significant association between personal and partner risk behavior/factors and STI infections ($\chi^2(1, N = 3586) = 6.185$, $p = 0.013$).

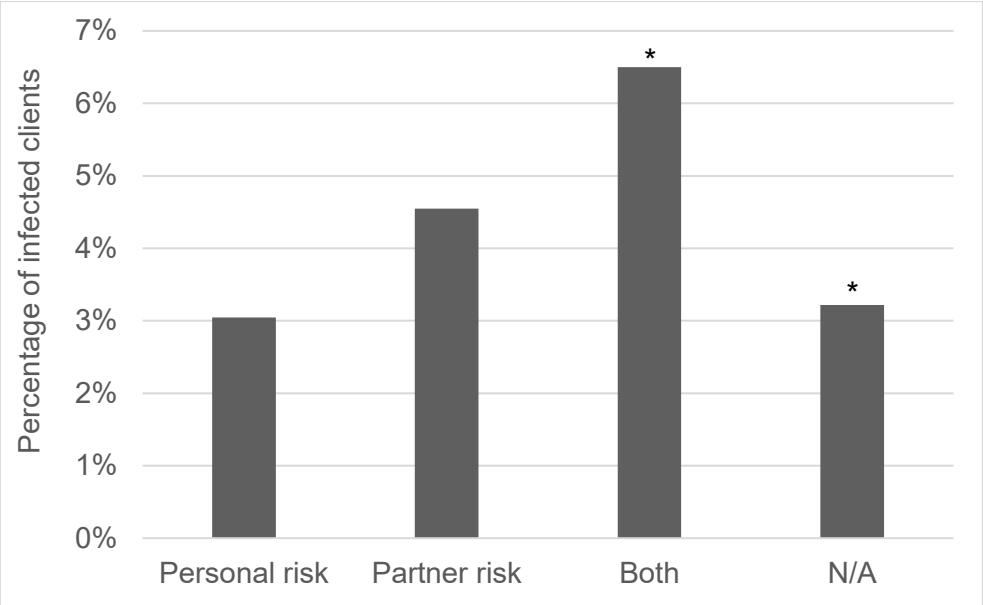

Figure 14: Percentages of STI infections among clients who exclusively indicated personal risk(s) (n = 591), exclusively partner risk(s) (n = 110), and both personal and partner risk(s) (n = 200) throughout the years. *, $p < 0.013$.

5. Discussion

In this thesis, the data of 4287 clients contacting *AIDS-Hilfe Steiermark* for the first time in the pre-pandemic (2019), pandemic (2021), and post-pandemic (2023) period was investigated.

There were slightly more male than female clients. Female clients were found to be approximately three years younger than male clients at the initial contact. Most clients indicated being heterosexual. The percentage of homosexuals was significantly higher among male clients compared to female clients ($p < 0.001$). Recent studies indicate that MSM are more aware of STIs and STI testing than heterosexual males (48, 49). Furthermore, it has been shown that the prevalence of STIs is higher among MSM than among heterosexual men (50, 51). The low proportion of homosexual and bisexual clients in this study may be attributed to pre-existing testing and the high percentage of homosexuals and bisexuals under treatment/already diagnosed.

Most clients reported unprotected sexual behavior in the questionnaire. The proportion significantly increased from 2019 to 2021 ($p < 0.001$) and significantly decreased from 2021 to 2023 ($p = 0.015$). In contrast, specific risk behavior/factors declined 2019 through 2023.

In 2021, there was a decline in initial contacts with *AIDS-Hilfe Steiermark*, which correlates with the high SARS-CoV-2 activity along with stringent containment measures leading to a significant reduction of social contacts in Austria (10, 12). When looking at the monthly frequency of initial contacts, no seasonal trend in testing behavior was observed.

While the number of initial contacts decreased in 2021, the number of tests performed increased. This result can be attributed to additional tests being offered by *AIDS-Hilfe Steiermark*. HCV and CT/NG tests were added to the test program in 2020. In 2023, both the number of initial contacts and the number of tests performed increased. A major reason for this may be the lift of the COVID-19 pandemic restrictions.

A trend towards multiple testing could be identified 2019 through 2023. The proportion of clients undergoing two or more tests was considerably higher in 2023 than in 2019 and in 2021. Based on the results of this study, clients who tested for HCV were more likely to test for CT/NG and TP than clients who did not test for HCV. Clients who tested for CT/NG were more likely to test for TP than clients who did not test for CT/NG.

As expected, the absolute number of annual diagnoses increased with the number of tests performed over the three years. It is important to note that the proportion of infections to performed tests also increased.

For HIV, the proportion of infections to tests performed, was slightly higher in 2023 compared to 2019 and to 2021. For CT and NG, the proportions of infections to tests performed, were slightly higher in 2021 than in 2023. For TP, the proportion of infections to tests performed was highest in 2023 and lowest in 2021.

Clients with multiple infections were only detected in 2021 and 2023. This can be explained with the expanded range of tests. The number of clients with more than one infection increased 2021 through 2023. However, only two clients with three infections were observed. Both were homosexual men and were found to be HIV positive. As reported recently, HIV positive individuals are more likely to have co-infections with other STIs than those who are HIV negative (52).

The proportion of infections was generally higher in men than in women. All HIV-positive individuals were male. The proportions of NG infections (n.s.) and TP infections ($p < 0.001$) were higher in men than in women. Only CT infections showed a reversed distribution, with a significantly higher proportion in women than in men ($p = 0.024$).

The incidence of STIs was found to be significantly higher in MSM compared to heterosexual men ($p < 0.001$). This is consistent with studies showing a higher prevalence of HIV in MSM compared to heterosexual men (50, 51).

The proportion of STI infections was significantly higher in clients who indicated unprotected sexual behavior ($p = 0.042$). However, some clients with STIs did not

indicate unprotected sex. Knowing that an STI can only be transmitted through unprotected sexual behavior, some clients may not have provided correct information about their actual sexual behavior.

The proportion of HIV positive results was higher among clients who reported having unprotected anal sex compared to those who reported having unprotected oral sex. One of the HIV positive clients (male, homosexual) indicated exclusively having oral sex. It has been found that oral sex has a substantially lower risk for HIV transmission compared to anal sex (53, 54). It may be that the aforementioned client who indicated exclusively having oral sex, did not accurately describe his real sexual behavior.

The proportion of infections was slightly higher in clients who reported any risk behavior/factors (n.s.). The proportion of positive results was higher in clients who indicated partner risk behavior/factors compared to clients who indicated personal risk behavior/factors. In clients who reported both personal and partner risk behavior/factors the proportion of infections was more than twice as high as in clients who did not report any risk behavior/factors ($p < 0.001$). The indicated risk factors are known to increase the likelihood of receiving STIs (55, 56).

5.1. Strengths and limitations of the study

Due to the high number of clients and tests, this study presents reliable data on STI testing behavior. By analyzing data from three years (2019 pre-pandemic, 2021 pandemic, and 2023 post-pandemic), this study aims to provide insights into trends and changes over time, offering a more comprehensive understanding of the impact of the pandemic on STI testing and infections.

By using data from an anonymous testing facility, potential biases associated with stigma or fear of judgment are reduced. This results in more accurate reporting of STI testing and infection rates. Additionally, it protects the privacy and confidentiality of participants, addressing ethical concerns associated with STI testing and research.

Due to the small number of infections, the proportion of positive cases could only be assessed and interpreted to a limited extent. For HIV, the expected frequencies for the chi-square analysis were < 5 (4.4.1. Infections regarding sex, 4.4.2. Infections in male clients regarding sexual orientation, 4.4.4. HIV infections regarding types of sexual behavior).

The questionnaire used by *AIDS-Hilfe Steiermark* was insufficiently detailed in some parts. Clients having to specify only their biological sex is not sufficient. Since September 2020, the Austrian government has provided six gender registration options: female, male, inter, diverse, open, and 'not specified' (57). Additionally, it would be important to include a category for transgender individuals. Furthermore, information on sexual orientation does not always correspond to sexual behavior. Heterosexual clients may have had same-sex sexual contact, and for bisexual clients, it is unclear whether they have engaged in same-sex or opposite-sex sexual intercourse. Therefore, it would be beneficial to specify the type of sexual contact that occurred. It would also be helpful to inquire about any previous STIs, STI treatments, or use of PrEP.

5.2. Conclusion

Low-threshold access to STI testing significantly contributes to early detection of STIs. As shown in this study, a considerable number of STIs were detected which may not have been detected without an anonymous testing facility. Thanks to an early detection of STIs, therapeutic regimens can be started earlier, and transmission can be prevented efficiently.

The data obtained in this study may help to develop an improved approach towards anonymous STI testing and its benefits.

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7. Supplemental material

Questionnaire

Code word:

Sequence:

Date of initial contact:

Year of birth:

Sex

- ☐ Female
- ☐ Male

Sexual orientation

- ☐ Heterosexual
- ☐ Homosexual
- ☐ Bisexual

Sexual risk behavior

- ☐ Unprotected sexual behavior

If yes

- ☐ Vaginal sex
- ☐ Oral sex active
- ☐ Oral sex passive
- ☐ Anal sex active
- ☐ Anal sex passive
- ☐ Petting

Personal risk behavior/factors

- ☐ Drug use
- ☐ HIV positive
- ☐ Region with high infection risk
- ☐ Holiday acquaintance
- ☐ One-night stand
- ☐ Affair
- ☐ Promiscuous behavior
- ☐ Condom failure
- ☐ Contact with prostitutes

Partner risk behavior/factors

- ☐ Drug use
- ☐ HIV positive
- ☐ Region with high infection risk
- ☐ Holiday acquaintance
- ☐ Affair
- ☐ Promiscuous behavior
- ☐ Condom failure
- ☐ Contact with prostitutes

Requested test

- ☐ HIV PCR
- ☐ HIV ELISA classic
- ☐ HIV ELISA rapid
- ☐ HIV IB

- ☐ HCV antibody test

- ☐ CT/NG PCR oral swipe
- ☐ CT/NG PCR anal swipe
- ☐ CT/NG PCR vaginal swipe
- ☐ CT/NG PCR urin

- ☐ TP antibody test

Table 12: Specific personal risks of clients in 2019, 2021, and 2023.

Personal Risk	No. of clients in			
	2019 (n = 1494)	2021 (n = 1034)	2023 (n = 1759)	Total (n = 4287)
Drug use	3 0.2%	1 0.1%	3 0.2%	7 0.2%
HIV positive	3 0.2%	2 0.2%	1 0.1%	6 0.1%
Region with high infection risk	4 0.3%	1 0.1%	9 0.5%	14 0.3%
Holiday acquaintance	13 0.9%	14 1.4%	8 0.5%	35 0.8%
One night stand	159 10.6%	98 9.5%	36 2.0%	293 6.8%
Affair	33 2.2%	14 1.4%	11 0.6%	58 1.4%
Promiscuous behavior	121 8.1%	82 7.9%	81 4.6%	284 6.6%
Condom failure	87 5.8%	19 1.8%	48 2.7%	154 3.6%
Contact with prostitutes	30 2.0%	7 0.7%	19 1.1%	56 1.3%
N/A	1106 74.0%	827 80.0%	1563 88.9%	3496 81.5%

Table 13: Specific risks of sexual partners in 2019, 2021, and 2023.

Partner risk	No. of clients in 2019 (n = 1494)	2021 (n = 1034)	2023 (n = 1759)	Total (n = 4287)
Drug use	7 0.5%	2 0.2%	2 0.1%	11 0.3%
HIV positive	11 0.7%	5 0.5%	0 0.0%	16 0.4%
Region with infection risk	15 1.0%	2 0.2%	0 0.0%	17 0.4%
Holiday acquaintance	1 0.1%	0 0.0%	2 0.1%	3 0.1%
Affair	21 1.4%	13 1.3%	14 0.8%	48 1.1%
Promiscuous behavior	118 7.9%	46 4.4%	51 2.9%	215 5.0%
Condom failure	0 0.0%	3 0.3%	10 0.6%	13 0.3%
Contact with prostitutes	2 0.1%	0 0.0%	3 0.2%	5 0.1%
N/A	1332 89.2%	965 93.3%	1680 95.5%	3977 92.8%