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Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who Have Sex with Men in Portugal

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Key Messages

Six clusters with diverse patterns of sexual behaviours, related to different STI and HIV vulnerability were found among an MSM population in Portugal

Factors other than sexual behaviour appear to reinforce the vulnerability to STIs suggesting a syndemic of STIs, HIV and other adverse conditions

Future interventions to decrease STI and HIV epidemic in MSM should include syndemic orientations and be informed by analyses including psychosocial and sexual health indicators

ABSTRACT

Objectives

Portugal has the highest HIV incidence rate in Western Europe. The proportion assigned to sexual contact between men recently increased to more than 24% of all HIV-infections. MSM are vulnerable to the acquisition of other STIs, increasing the per-contact risk of HIV-infection. Building on syndemic theory, the aim of this analysis was to identify patterns of current sexual behaviour in MSM, and explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-status.

Methods

A cross-sectional behavioural survey was conducted in Portugal among MSM, using a community-based participatory research approach. Hierarchical cluster analysis was used to identify patterns including behavioural and demographic factors.

Results

The analysis resulted in 6 clusters. Three clusters showed higher rates of current STI diagnosis (ranging from 11.7% to 17.1%), past STI diagnosis (ranging from 25.5% to 41.5%) and HIV positive sero-status (ranging from 13.0% to 16.7%). From the three clusters scoring lower on current and past STI and HIV diagnoses, one was characterized by a high number of sexual partners (62% had more than 12 partners in the last year), a high proportion (94.6%) of frequent visits to gay venues to meet sexual partners and high alcohol use (46.1%). The other two clusters scored lower on high risk sexual behaviour.

Conclusion

Factors other than sexual behaviour appear to reinforce the vulnerability to STIs and HIV of some MSM in this study, suggesting a syndemic of STIs, HIV and other adverse conditions. More research is needed to better understand the drivers of the STI/HIV epidemic in Portuguese MSM, using a concept that goes beyond risk behaviour, to develop effective combination prevention interventions.

Strengths and limitations of this study

- Hierarchical cluster analysis was used to identify behavioural patterns among MSM participating in a behavioural survey in Portugal
- The main findings from the cluster analysis are in line with the literature supporting linked epidemics of STIs and HIV in Portuguese MSM
- Using a syndemic approach it was possible to identify that factors not directly linked to sexual behaviour are linked to these epidemics
- The outcomes of this analysis relate to the study sample population and cannot be generalised to the wider MSM population
- We acknowledged that the reliance on self-reported STI and HIV outcomes is a weakness that may have caused social desirability bias

INTRODUCTION

Portugal had the highest rate of new HIV diagnoses in Western Europe in 2013.[1] Initially the Portuguese HIV-epidemic was predominantly prevalent in people who inject drugs (PWID), but since 2003 most of the reported infections are associated with sexual transmission.[2] In 2013, of all new HIV-infections occurring in Portugal, 30.3% were assigned to sexual contact between men.[3] The estimated percentage of Portuguese men who have sex with men (MSM) living with HIV was 10% in 2011, manifold the 0.6% estimate for Portuguese adults aged 15 to 49.[4] The median age of infection with HIV due to transmission among homosexual men has declined from 35 in 2007 to 32 in 2012, unlike the increasing trend due to transmission among heterosexual persons.[5]

MSM are also vulnerable to the acquisition of other sexually transmitted infections (STIs), some of which increase the per-contact risk of HIV-infection. The European MSM Internet Survey (EMIS) showed that 14.5% of MSM across Europe self-reported a history of gonorrhoea diagnoses, 13.4% of anal/genital warts, 8.6% of syphilis, 8.1% of chlamydial infection and 3.6% of anal/genital herpes.[6] MSM account for almost 50% of all syphilis cases

reported and 24% of gonorrhoea diagnoses in Europe.[7] For Portugal this information is incomplete[8, 9] and in the Portuguese Global AIDS Response Progress Reports there is no reporting of STI-data among MSM.[10] Underreporting is suggested to be high in Portugal, and related to the non-detection of syphilis and rectal gonorrhoea due to low rates of STI-testing and anal exams or swabbing.[11] Currently, in Portugal there are neither separate HIV/STI-policies for MSM nor specific national STI-testing policies or guidelines.

Recently, there have been numerous efforts to promote prevention/diagnosis/linkage of interventions for MSM, mainly organized by the community. CheckpointLX in Lisbon, the first community-based testing centre for MSM founded in April 2011, encourages combined HIV-STI testing for MSM.

The most recent national programme for the prevention and control of HIV/AIDS[12, 13] included MSM as a target group. Having as first objective to structure the epidemiological surveillance system for HIV, it encompasses information on other STIs and includes the screening of STIs as a secondary prevention method for HIV infection.[14, 15]

STIs and HIV have been researched in conjunction with mental health conditions, substance use, violence and sexual abuse in the framework of the syndemic theory.[16] These factors may reinforce one another and increase the health burden in at risk populations, such as MSM.[20,21] The concept of “afflictions” defining a syndemic[16-18] can be extended from just diseases to risk factors, and other health related conditions.

One way of exploring this syndemic is to identify subgroups of subjects that share a particular pattern with respect to relevant sexual behavioural variables that potentially interact in the syndemic, to this purpose the technique of cluster analysis was used in this study.

The term cluster in this context is not considered in the epidemiological sense of the term, ie a group that is connected in time and/or place but it was used to identify patterns of current sexual behaviour in Portuguese MSM, and to explore the associations with the self-reported current and past STIs and HIV sero-status.

A better understanding of these relationships can inform the design of combined interventions in MSM to both decrease STI and HIV burden, and improve sexual health.[19]

METHODS

A cross-sectional behavioural survey was conducted in Portugal among MSM as part of the Project PREVIH - HIV/AIDS infection in MSM and Sex Workers: Prevalence, Determinants, Prevention interventions and Access to health (2009-2013). The study used a community-based participatory research approach, engaging a Community Advisory Board (CAB) comprising MSM, representatives of non-governmental and governmental organisations, and academics. The CAB actively participated in the study design, implementation and interpretation of the results.[19, 20]

Sampling, Recruitment and Data Collection

The study population was reached through a venue-based recruitment strategy. Geographic and network mapping was conducted, based on formative research with the CAB, to identify data collection sites. Recruitment teams of outreach workers and MSM peers systematically approached potential participants at the sites, inviting them for a face-to-face interview. The inclusion criteria were: being at least 18 years and having had sex with a man in the last year. Participants were recruited from gay bars/clubs, cafes, streets in predominantly gay neighbourhoods, local community based organisations and community events. Additionally, the recruited respondents were asked to advertise the study among their social networks and peers.

Anonymity and confidentiality were guaranteed and informed consent was obtained from all participants. The study was approved by the Ethics Committee for Health of the North Regional Health Administration. The study procedures were revised and approved by the CAB and the project's scientific commission.

Data were collected from January to September 2011 using a structured questionnaire applied by trained peers recruited from community organisation partners. The questionnaire included closed-ended questions on socio-demographics, sexual behaviour, availability/accessibility of STI/HIV services, history of HIV testing, reported HIV status and current/history of other STIs.

The questionnaire was developed in collaboration with the community partners and included the indicators of the United Nations General Assembly Special Session on HIV/AIDS (UNGASS).[21] A more detailed description of the sampling, recruitment and data collection can be found elsewhere.[20]

Patient and public involvement

A community-based participatory research approach was used, in which a Community Advisory Board including representatives of non-governmental and governmental organizations, academics, and MSM was formed and actively participated in all phases of the project, as the study design, elaboration of the questionnaire, results interpretation, and discussion. Community partners were also involved in the data collection process.

Statistical Analysis

Data were analysed using hierarchical agglomerative cluster analysis, univariate and bivariate statistics, univariable, multivariate and mixed effect logistic regression analyses and statistical packages SPSS and STATA13 were used.

Figure 1 shows the cascade of the variables included in each step of the cluster analysis from the inclusion of all the variables and with the exclusion of some factors when the inclusion criteria were not met.

Multiple iterations of a hierarchical cluster analysis were used to identify the optimum number of clusters. The clustering was done based on Euclidean distances. Squared Euclidean distances were used to calculate the distance between any two individuals/subjects in the sample; the squared Euclidean distance is defined as the sum of the squared differences between the values for the (six) variables corresponding to these two individuals/subjects. Distances between identified clusters are obtained with the “between-groups linkage” method, i.e. the average of the distances between any two subjects in the corresponding clusters (syntax available as a supplementary file).

In consultation with key persons from the MSM community in Lisbon, the clusters were not labelled because of possible misperception and stigmatisation and will be referred to with a number.

The frequency of the variables self-reported current STI status ('Negative', 'Positive', 'Don't know'), past STI status ('Negative', 'Positive', 'Don't know') and HIV sero-status ('Negative', 'Positive', 'Don't know') in each of the clusters was examined.

The final list of variables included: (1) number of sexual male partners in the last 12 months (year) expressed as '1', '2-4', '5-12' and '>12'; (2) frequency of visiting gay clubs, bars, discos (venues) to meet male sexual partners ('Many times', 'Sometimes', 'Rarely' and 'Doesn't visit'), (3) condom use during the last anal sexual intercourse (AI) with male partner ('yes' and 'no'); (4) alcohol and (5) poppers consumption before or during the last sexual intercourse ('yes' and 'no'), and (6) age ('18-20', '21-30', '31-40', '41-50' and '>50').

The variables identified were included as covariates in multivariable logistic regression models using the variable self-reported current STI status ('Negative' vs. 'Positive'), past STI status ('Negative' vs. 'Positive') and HIV sero-status ('Negative' vs. 'Positive') as outcomes. In addition, in regression analysis, the multilevel structure induces correlation among observations within a cluster and to test the validity of the 6 variables identified, each of them was used independently as a random effect in mixed-effect logistic regression models.

The final list of variables identified was considered as potential factors of a pattern of sexual behaviour in MSM populations.

RESULTS

A total of 1046 MSM participated in this study. The refusal rate was 23.2% (1362 were approached). No differences were found between refusals and participants regarding age and education. Overall, 5.5% self-reported a current STI, 20.5% a previous STI and 9.1% HIV positive sero-status. The median and mean numbers of male sexual partners in the past year were 4 and 14.8, respectively. Condom use was reported by 76.2% of participants during their

last AI, either receptive or insertive; alcohol and poppers used before or during the last AI was reported by 25.3% and 7.8%, respectively.

The cluster analysis resulted in a 7-cluster solution but one cluster was discarded as it was too small to be epidemiologically relevant (n=12).

The characteristics of the clusters identified are presented in Table 1.

Table 1: Socio-demographic and behavioural characteristics of the clusters

	Clusters						
	1	2	3	4	5	6	Overall
Frequency	46	187	206	303	106	66	**1046**
% of total included in cluster analysis	5.0%	20.2%	22.2%	32.7%	11.4%	7.1%	
Age - range	40-73	18-47	18-49	18-48	18-50	41-78	**18-78**
Age - mean	47.3	27.8	29.6	27.6	32.8	51.2	**30**
Age - median	45	27	30	27	32.5	49	**31.9**
Male sexual partners in the last year (% of >12 parnters or % <5 partners)	58% >12	81% <5	62% >12	85% <5	59% >12	79% <5	
Male sexual partners in the last year (median)	20	3	17.5	2	18.5	2	**4**
Sometimes or often visits gay clubs/bars/discos for finding sexual partners (%)	71.7%	90.4%	94.6%	4.0%	2.8%	1.5%	**44.5**
Condom use at last AI (%)	82.6%	69.0%	93.7%	66.30%	84.0%	62.1%	**76.2**

Use of alcohol before or during last sexual intercourse (%)	30.4%	28.9%	46.1%	18.2%	15.1%	15.2%	**25.3**
Use of poppers before or during last sexual intercourse (%)	13.0%	4.8%	13.1%	3.6%	18.9%	3.0%	**7.8**

Cluster 1. This is the smallest cluster (n=46) with MSM who were almost all older than 40 years. They reported relatively more male sexual partners compared to the other clusters (58.7% reported 13 or more partners in the last year), 82% reported condom use during the last AI and 71.7% sometimes or often visited gay venues.

Cluster 2. In this cluster (n=187) MSM in their twenties were highly represented. They reported relatively fewer male sexual partners (81.3% had less than 5 in the last year), 69% reported condom use during the last AI and 90.4% sometimes or often visited gay venues.

Cluster 3. This cluster (n=206) included almost exclusively MSM between 20 and 40. They all reported relatively more male partners (61.7% had 13 or more partners in the last year). This cluster showed the highest proportion of condom use during the last AI (93.7%) and of visiting sometimes or often gay venues (94.6%).

Cluster 4. This cluster was the largest (n=303) and assembled the highest percentage of people between 18 and 20. They reported relatively few male sexual partners (85.1% had 4 or less partners in the last year), 66% reported condom use at the last AI and just 4% sometimes or often visited gay venues.

Cluster 5. Mostly MSM in their thirties populated this cluster (n=106). They reported relatively more male sexual partners, (58.5% had 13 or more in the last year), 84% reported condom use during the last AI and only a small proportion visited sometimes or often gay venues.

Cluster 6. This cluster (n=66) consisted of exclusively MSM older than 40 years. Over three-quarter reported 4 or less partners in the last year and only 1.5% reported to have attended gay venues. Of all clusters, they reported the lowest condom use during the last AI (62.1%).

From the 120 participants excluded from the cluster analysis, 1 failed to give his age, 63 did not answer how many partners they had in the last year, 26 failed to mark the frequency of their visits to gay venues and 62 did not answer whether they used a condom at last AI. Compared to the whole study population, the group of excluded participants was older, had less partners, frequented gay venues less frequently, more condom and less alcohol and poppers use.

Figure 2 shows the frequency of reported current STIs, past STIs and HIV sero-status within the six clusters. Cluster 1 had the highest rate of self-reported current STIs (17.1%), followed by cluster 6 (12.3%) and cluster 5 (11.7%). The other clusters had lower STI rates, ranging from 1.8% to 2.8%. The proportion of participants that did not know their current STI-status varied from 4.9% in cluster 1 to 17.0% in cluster 5.

Among the excluded participants that answered the question on reported current STI, the prevalence was 10.7% which is more than double the prevalence of the participants included in the analysis.

Cluster 1 reported the highest proportion of self-reported STI history (41.5%) followed by cluster 5 (26.1%), cluster 6 (25.5%) and cluster 3 (24.0%).

The highest prevalence of self-reported HIV was also found within the three clusters (from 13.0% to 16.7%) with the highest self-reported current and past STIs. Among the excluded participants, almost one in five reported being HIV-positive, a higher rate than any of the clusters.

From the regression analyses (Supplementary file), the mixed-effect models performed generally better than the multivariable logistic regression. The results presented here are from the mixed-effect models after adjusting for the other confounders (in the fixed part of the model). For the model on self-reported current STIs, age group and number of male sexual partners in the last year were statistically significant random effects. For the model on the self-reported previous STI, age group, number of male sexual partners in the last year and condom use during the last AI were statistically significant random effects. For the model on the self-

reported positive HIV sero-status, age group, number of male sexual partners in the last year and frequent visits to gay venues were significant random effects.

The mixed-effect models, confirmed the role of age, number of sexual partners, condom use and frequent visits to gay venues as factors that could be used to detect possible clusters in this MSM population, related to current or past STI diagnosis or HIV sero-status.

DISCUSSION

The cluster analysis identified six clusters with diverse patterns of sexual behaviours, related to different STI and HIV vulnerability. In the discussion we further explore the higher STI/HIV prevalence clusters, using descriptive data (available on request) from variables not included in the cluster analysis.

High Risk Pattern - High STI/HIV-vulnerability

In cluster 1, including the highest STI rates and high number of partners, almost all had occasional sex partners and around half of MSM took part in group sex in the last year. Although more than 80% reported using condoms at last AI, almost half also reported unprotected AI in the last year with a partner whose HIV sero-status was unknown. This is in line with previous studies demonstrating that relationships in which condomless sex happens, are multiple, overlapping and sequential, resulting in a high-risk level for STIs and HIV.[18]

Seemingly Low Risk Pattern - High STI/HIV-vulnerability

Cluster 6 was the oldest cluster, and although except for UAI, it scored low on the other sexual risk variables but it had the second highest STI-prevalence and the highest HIV prevalence. Of all the clusters, this group reported the most frequently sex with a transgender partner, with a woman and with a sex worker. Lastly, compared to the whole sample, the MSM in this cluster were the least likely to have been reached by an HIV campaign.

This suggests that cluster 6 contained a group of older MSM that might not identify as gay and might face a lot of barriers to access reliable information about the risks of their sexual

behaviours. A previous study from Portugal showed that in this sample of MSM, low self-risk perception was the major motive of never having been tested for HIV.[22]

Similar Patterns - Different STI/HIV-vulnerability

Both clusters 5 and 3 represented a sexually active pattern in MSM of the same age range. A quarter of MSM in both clusters reported past STI diagnoses but MSM in cluster 5 had a higher proportion of current STI diagnoses, suggesting higher recurrence of STIs, and much higher self-reported HIV prevalence. However, about the same proportion in each cluster reported unprotected AI in the last year with a partner whose HIV sero-status was unknown. Contrary to cluster 3, MSM in cluster 5 almost never visited gay venues and did not drink alcohol at last AI. It has been demonstrated that the frequency of unprotected intercourse does not solely explain risk exposure, but having unprotected intercourse within certain high-risk sexual networks does expose MSM to a heightened risk.[23] This suggests that sexual networks outside the Portuguese public gay scene are more risky in terms of HIV/STI acquisition.

The majority of MSM in these clusters was currently not affected by HIV or other STIs and although they would be categorised as high risk to be infected with STIs and HIV, there are protective factors, among others shamelessness, social support and self-monitoring, that might play an important role in HIV/STI prevention interventions but have not been researched enough.

Strengths and Limitations

Data on HIV and STI prevalence were self-reported and interviews were not self-administered but done by community based researchers who were trained to apply the questionnaire. This might have provoked memory and social desirability bias. There might be a bias as to why certain questions were not answered, as is suggested by the high self- reported HIV prevalence in the 'missing' cluster. Due to the intimate and sensitive nature of the study questionnaire and the stigma associated with risky sexual behaviour and HIV/STI positive

sero-status, under-reporting in this study was to be expected.

Careful attention was paid to the process of selection of relevant variables as potential members of the syndemic of risky sexual behaviours. Although it is difficult to prove that the group of afflictions identified as one of the common patterns in this MSM population is a syndemic, its potential is significant.

The strength of a cluster analysis is that it can intercept groups of homogeneous units in the population, in terms of a group of relevant variables. However, the results and interpretation of any cluster analysis depend on several researcher's choices and assumptions, such as that actual groups exist, the choice of the variables on which the elements in the groups should be similar, the distance measure, the clustering procedure and the number of clusters.[24, 25]

The presented clusters describe the study sample population, obtained via venue based recruitment, and therefore cannot be extrapolated to the whole MSM population.

Conclusions

The main findings are in line with other studies that demonstrated the association between HIV-infection with higher incidence and prevalence rates for STIs, contributing to the ongoing transmission among MSM and supporting linked epidemics of STIs and HIV in Portuguese MSM.[26-28] Interventions for MSM should combine HIV- and comprehensive STI- testing, including rectal and pharyngeal swabbing.[29]

The results suggest some factors not directly linked to sexual behaviour reinforce the epidemics. Besides a critical need for improved STI symptom recognition, screening and treatment, future interventions should have a syndemic orientation, unfolding the entire set of factors that create excess burden of disease, being informed by analyses including psychosocial variables and sexual health indicators.[30] Capturing concepts of autonomy, well-being, sexual satisfaction, intimacy and social values in relation to sexuality, health scientists and other health professionals might start identifying a different set of risk and protective factors.

Contributions

SD, AG, RF and LM were involved in the design and conducting of the survey. AS, IT and KB chose the main directions for data analysis and participated in the interpretation of results. AS, MF and KB performed the statistical analyses. KB, IT, MF, SD, AS, MT, AG collaborated in the writing of the manuscript. RF and LM complemented the manuscript with contextual data. KB, SD, MF, AS, AG, RF, LM, MT and IT revised the manuscript before submission. All authors approved the final manuscript submitted

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Competing interests

None of the authors have conflicts of interest to declare.

Ethics Approval

This article does not contain any studies with animals performed by any of the authors. All procedures performed involving human participants in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by the Ethics Committee for Health of the North Regional Health Administration.

Informed consent was obtained from all individual participants included in the study.

The ethics committee approval number is No.18.09CES.

Data sharing statement

No additional data available

Patient consent for publication

Informed consent was obtained from all individual participants included in this study

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Disclaimer

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Figure 1: Flow-chart of variable selection for the study

Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

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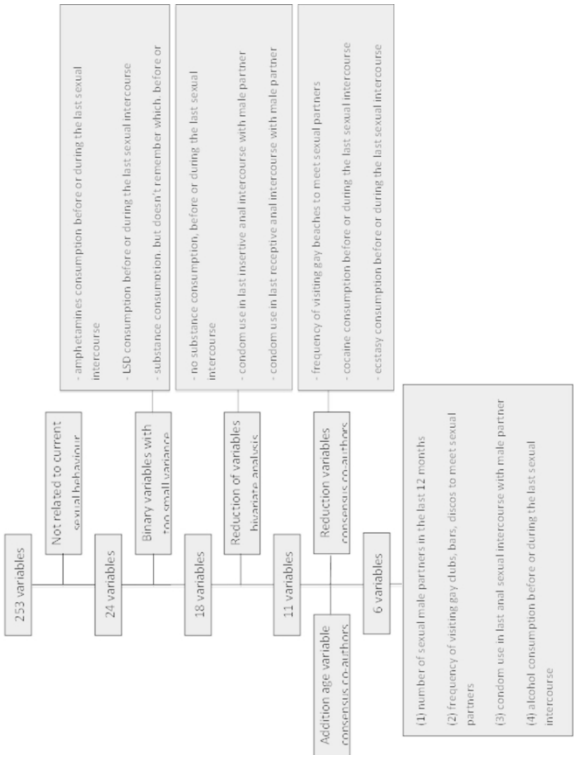

Figure 1: Flow-chart of variable selection for the study

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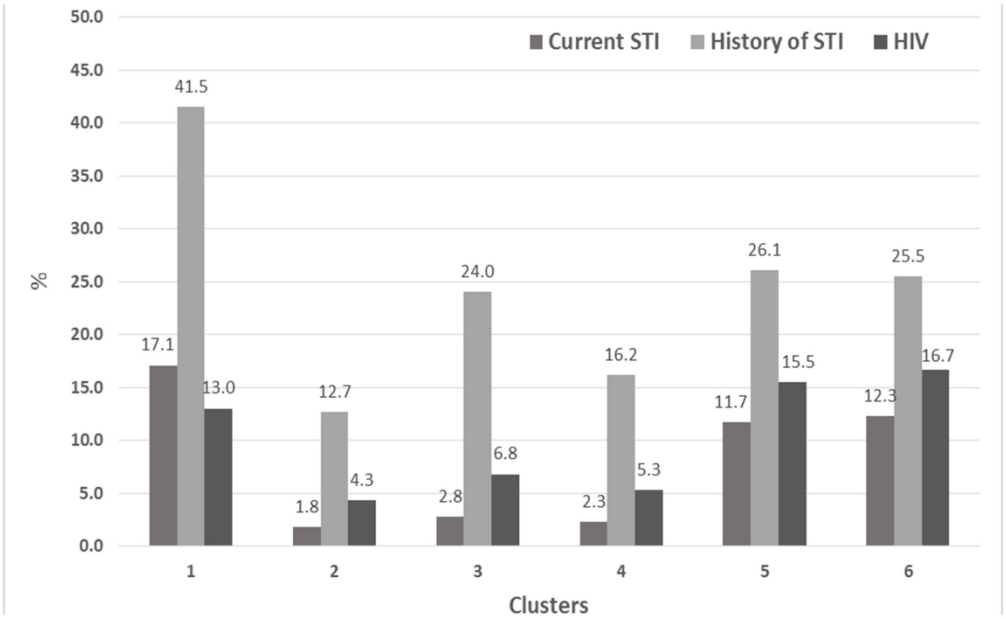

Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

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SUPPLEMENTARY FILE 1

SPSS SYNTAX FILE USED FOR THE CLUSTER ANALYSIS
CLUSTER

```
Age_REC_5cat_2
SexMen_number_REC_4cat
MCLUB
REC_CondomLast_Male
SubsSex_Alc
SubsSex_Pop
/METHOD BAVERAGE
/MEASURE=SEUCLID
/PRINT SCHEDULE CLUSTER(4,9)
/PRINT DISTANCE
/PLOT VICICLE
/SAVE CLUSTER(4,9).
```

Tab. 1 Adjusted Odds Ratios from a multivariable logistic regression for self-reported current STI (diagnosed positive)

Current STI	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	0.39	0.192	0.10	1.60
31-40	0.89	0.866	0.24	3.37
41-50	**3.73**	0.052	0.99	14.05
>50	1.18	0.862	0.18	7.78
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.59	0.399	0.18	2.00
5-12	2.26	0.126	0.80	6.41
>12	1.79	0.297	0.60	5.38
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.13	0.150	0.66	14.79
Rarely	**4.38**	0.062	0.93	20.72
Doesn't visit	**6.06**	0.030	1.20	30.76
Condom use in last sex intercourse				
No	ref.			
Yes	1.72	0.260	0.67	4.44
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.45**	0.081	0.89	6.71
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.98	0.955	0.44	2.15

Tab. 2 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported current STI (diagnosed positive) with age group as a random effect

Current STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.59	0.391	0.18	1.97
5-12	2.25	0.125	0.80	6.36
>12	1.85	0.269	0.62	5.52
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.05	0.158	0.65	14.29
Rarely	**4.25**	0.066	0.91	19.92
Doesn't visit	**6.05**	0.029	1.20	30.39
Condom use in last sex intercourse				
No	ref.			
Yes	1.70	0.270	0.66	4.37
Popper use before or during last sex intercourse				
No	ref.			
Yes	2.32	0.100	0.85	6.30
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.97	0.936	0.44	2.12
RANDOM EFFECT				
AGE GROUP (var)	**0.50**		0.10	2.43

Tab. 3 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported current STI (diagnosed positive) with number of sexual male partners in the last 12 months as a random effect

Current STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Age group				
18-20	ref.			
21-30	0.39	0.185	0.10	1.57
31-40	0.93	0.909	0.25	3.45
41-50	**3.83**	0.045	1.03	14.18
>50	1.18	0.864	0.18	7.63
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.00	0.165	0.64	14.16
Rarely	**3.84**	0.090	0.81	18.27
Doesn't visit	**4.78**	0.060	0.94	24.35
Condom use in last sex intercourse				
No	ref.			
Yes	1.90	0.177	0.75	4.83
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.62**	0.057	0.97	7.06
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.97	0.946	0.44	2.13
RANDOM EFFECT				
Number of sexual male partners in the last 12 months (var)	**0.10**		0.00	2.90

Tab. 1 Adjusted Odds Ratios from a multivariable logistic regression for self-reported HIV positive serostatus

HIV positive serostatus	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	1.73	0.470	0.39	7.71
31-40	**3.79**	0.076	0.87	16.56
41-50	**6.58**	0.015	1.44	30.01
>50	**9.45**	0.007	1.86	47.89
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	1.85	0.154	0.79	4.30
5-12	1.40	0.483	0.55	3.58
>12	**3.58**	0.004	1.50	8.54
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.41**	0.039	0.18	0.95
Rarely	1.15	0.720	0.54	2.42
Doesn't visit	1.02	0.963	0.43	2.42
Condom use in last sex intercourse				
No	ref.			
Yes	1.35	0.383	0.69	2.63
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.07**	0.059	0.97	4.41
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.186	0.35	1.23

Tab. 2 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with age group as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	1.85	0.153	0.80	4.30
5-12	1.42	0.468	0.55	3.62
>12	**3.69**	0.003	1.54	8.81
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.42**	0.045	0.18	0.98
Rarely	1.18	0.661	0.56	2.50
Doesn't visit	1.09	0.842	0.46	2.58
Condom use in last sex intercourse				
No	ref.			
Yes	1.33	0.399	0.68	2.60
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.02**	0.067	0.95	4.29
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.189	0.35	1.23
	RANDOM EFFECT			
AGE GROUP (var)	**0.40**		0.07	2.42

Tab. 3 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with number of sexual male partners in the last 12 months as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.80	0.439	0.41	8.01
31-40	**4.03**	0.064	0.92	17.60
41-50	**6.93**	0.012	1.52	31.56
>50	**9.80**	0.006	1.94	49.60
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.41**	0.038	0.18	0.95
Rarely	1.10	0.796	0.52	2.33
Doesn't visit	0.91	0.824	0.38	2.14
Condom use in last sex intercourse				
No	ref.			
Yes	1.45	0.276	0.74	2.81
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.24**	0.036	1.05	4.78
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.197	0.36	1.24
	RANDOM EFFECT			
Number of sexual male partners in the last 12 months (var)	**0.14**		0.02	1.21

Tab. 4 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with frequency of visiting gay clubs, bars, discos to meet sexual partners as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.71	0.482	0.38	7.59
31-40	**3.72**	0.080	0.85	16.22
41-50	**6.55**	0.015	1.44	29.86
>50	**9.43**	0.007	1.87	47.53
Number of Partner				
1	ref.			
2-4	1.82	0.165	0.78	4.22
5-12	1.34	0.539	0.53	3.39
>12	**3.32**	0.006	1.41	7.83
Condom use last sex intercourse				
No	ref.	0.757	0.61	2.00
Yes	1.32	0.411	0.68	2.57
Popper use last sex intercourse				
No	ref.			
Yes	**2.05**	0.061	0.97	4.35
Alcohol use last sex intercourse				
No	ref.			
Yes	0.63	0.149	0.34	1.18
	RANDOM EFFECT			
Frequency of visiting gay clubs, bars, discos to meet sexual partners (var)	**0.09**		0.01	1.02

Tab. 1 Adjusted Odds Ratios from a multivariable logistic regression for self-reported previous STI (diagnosed positive)

Previous STI	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	1.55	0.313	0.66	3.61
31-40	**2.59**	0.029	1.10	6.07
41-50	**2.96**	0.023	1.16	7.54
>50	**4.74**	0.006	1.56	14.48
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.72	0.289	0.40	1.32
5-12	**1.66**	0.091	0.92	3.00
>12	**2.60**	0.002	1.42	4.73
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.09	0.776	0.60	1.98
Rarely	1.52	0.173	0.83	2.79
Doesn't visit	0.98	0.955	0.48	2.01
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.48**	0.001	0.31	0.75
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.34	0.346	0.73	2.45
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.29	0.237	0.85	1.95

Tab. 2 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with age group as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.73	0.302	0.40	1.33
5-12	**1.67**	0.086	0.93	3.01
>12	**2.68**	0.001	1.47	4.89
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.10	0.750	0.61	2.00
Rarely	1.55	0.156	0.85	2.83
Doesn't visit	1.02	0.953	0.50	2.09
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.47**	0.001	0.30	0.74
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.34	0.343	0.73	2.44
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.29	0.224	0.85	1.96
RANDOM EFFECT				
AGE GROUP (var)	**0.11**		0.01	1.18

Tab. 3 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with number of sexual male partners in the last 12 months as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Age group				
18-20	ref.			
21-30	1.56	0.303	0.67	3.64
31-40	**2.65**	0.024	1.13	6.22
41-50	**3.04**	0.020	1.20	7.75
>50	**4.76**	0.006	1.57	14.45
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.08	0.806	0.59	1.96
Rarely	1.47	0.216	0.80	2.68
Doesn't visit	0.91	0.794	0.44	1.86
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.50**	0.002	0.32	0.78
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.40	0.270	0.77	2.57
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.30	0.219	0.86	1.97
RANDOM EFFECT				
Number of sexual male partners in the last 12 months (var)	**0.19**		0.03	1.04

Tab. 4 Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with condom use in last sexual intercourse as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Age group				
18-20	ref.			
21-30	1.54	0.317	0.66	3.60
31-40	**2.59**	0.029	1.11	6.06
41-50	**2.96**	0.023	1.16	7.54
>50	**4.78**	0.006	1.57	14.52
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.69	0.233	0.38	1.27
5-12	1.56	0.139	0.86	2.83
>12	**2.43**	0.004	1.32	4.44
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	1.10	0.757	0.61	2.00
Sometimes	1.54	0.165	0.84	2.81
Rarely	0.99	0.970	0.48	2.02
Doesn't visit				
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.35	0.331	0.74	2.46
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.28	0.250	0.84	1.94
RANDOM EFFECT				
Condom use in last sexual intercourse (var)	**0.10**		0.01	1.21

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	Figure 1 (pag 7)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	8-10

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who Have Sex with Men in Portugal

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Secondary Subject Heading:	Epidemiology, Infectious diseases, HIV/AIDS, Public health
Keywords:	sexual health, STI, HIV & AIDS < INFECTIOUS DISEASES, SYNDEMIC, MSM

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Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who Have Sex with Men in Portugal

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Keywords*:* Men who have sex with men, sexually transmitted infections, HIV, sexual behaviour, cluster analysis, syndemic.

ABSTRACT

Objectives

Portugal has the highest HIV incidence rate in Western Europe. The proportion assigned to sexual contact between men recently increased to more than 30% of all HIV-infections. Men who have Sex with Men (MSM) are vulnerable to the acquisition of other Sexually Transmitted Infections (STIs), increasing the per-contact risk of HIV-infection. Building on syndemic theory, the aim of this analysis was to identify patterns of current sexual behaviour in MSM, and explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-status.

Design

A cross-sectional behavioural survey was conducted in Portugal among MSM, using a community-based participatory research approach. Hierarchical cluster analysis was used to identify patterns including behavioural and demographic factors.

Results

The analysis resulted in 6 clusters. Three clusters showed higher rates of current STI diagnosis (ranging from 11.7% to 17.1%), past STI diagnosis (ranging from 25.5% to 41.5%) and HIV positive sero-status (ranging from 13.0% to 16.7%). From the three clusters scoring lower on current and past STI and HIV diagnoses, one was characterized by a high number of sexual partners (62% had more than 12 partners in the last year), a high proportion (94.6%)

of frequent visits to gay venues to meet sexual partners and high alcohol use (46.1%). The other two clusters scored lower on high risk sexual behaviour.

Conclusion

Factors other than sexual behaviour appear to reinforce the vulnerability to STIs and HIV of some MSM in this study, suggesting a syndemic of STIs, HIV and other adverse conditions. More research is needed to better understand the drivers of the STI/HIV epidemic in Portuguese MSM, using a concept that goes beyond risk behaviour, to develop effective combination prevention interventions.

Strengths and limitations of this study

- Hierarchical cluster analysis was used to identify behavioural patterns among MSM participating in a behavioural survey in Portugal
- The main findings from the cluster analysis are in line with the literature supporting linked epidemics of STIs and HIV in Portuguese MSM
- Using a syndemic approach it was possible to identify that factors not directly linked to sexual behaviour are linked to these epidemics
- The outcomes of this analysis relate to the study sample population and cannot be generalised to the wider MSM population
- We acknowledged that the reliance on self-reported STI and HIV outcomes is a weakness that may have caused social desirability bias

INTRODUCTION

Portugal had the highest rate of new HIV diagnoses in Western Europe in 2013.[1] Initially the Portuguese HIV-epidemic was predominantly prevalent in people who inject drugs (PWID), but since 2003 most of the reported infections are associated with sexual transmission.[2] In 2013, of all new HIV-infections occurring in Portugal, 30.3% were assigned to sexual contact

between men.[3] The estimated percentage of Portuguese men who have sex with men (MSM) living with HIV was 10% in 2011, manifold the 0.6% estimate for Portuguese adults aged 15 to 49.[4] The median age at HIV diagnosis due to transmission among homosexual men has declined from 35 in 2007 to 32 in 2012, unlike the increasing trend due to transmission among heterosexual persons.[5]

MSM are also vulnerable to the acquisition of other sexually transmitted infections (STIs), some of which increase the per-contact risk of HIV-infection. The European MSM Internet Survey (EMIS) showed that 14.5% of MSM across Europe self-reported a history of gonorrhoea diagnoses, 13.4% of anal/genital warts, 8.6% of syphilis, 8.1% of chlamydial infection and 3.6% of anal/genital herpes.[6] MSM account for almost 50% of all syphilis cases reported and 24% of gonorrhoea diagnoses in Europe.[7] For Portugal this information is incomplete[8, 9] and in the Portuguese Global AIDS Response Progress Reports there is no reporting of STI-data among MSM.[10] Underreporting is suggested to be high in Portugal, and related to the non-detection of syphilis and rectal gonorrhoea due to low rates of STI-testing and anal exams or swabbing.[11] Currently, in Portugal there are neither separate HIV/STI-policies for MSM nor specific national STI-testing policies or guidelines.

Recently, there have been numerous efforts to promote prevention/diagnosis/linkage of interventions for MSM, mainly organized by the community. CheckpointLX in Lisbon, the first community-based testing centre for MSM founded in April 2011, encourages combined HIV-STI testing for MSM.

The most recent national programme for the prevention and control of HIV/AIDS[12, 13] included MSM as a target group. Having as first objective to structure the epidemiological surveillance system for HIV, it encompasses information on other STIs and includes the screening of STIs as a secondary prevention method for HIV infection.[14, 15]

STIs and HIV have been researched in conjunction with mental health conditions, substance use, violence and sexual abuse in the framework of the syndemic theory.[16] These factors may reinforce one another and increase the health burden in at risk populations, such as MSM.[20,21] The concept of “afflictions” defining a syndemic[16-18] can be extended from just

diseases to risk factors, and other health related conditions.

A syndemic of risky sexual behaviours is a group of co-existing factors that describe the sexual behavioural patterns in a specific population.

One way of exploring this syndemic is to identify subgroups of subjects that share a particular pattern with respect to relevant sexual behavioural variables that potentially interact in the syndemic, to this purpose the technique of cluster analysis was used in this study.

The term cluster in this context is not considered in the epidemiological sense of the term, ie a group that is connected in time and/or place but it was used to identify patterns of current sexual behaviour in Portuguese MSM, and to explore the associations with the self-reported current and past STIs and HIV sero-status.

A better understanding of these relationships can inform the design of combined interventions in MSM to both decrease STI and HIV burden, and improve sexual health.[19]

The aim of this analysis was to identify patterns of current sexual behaviour in MSM, and explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-status.

METHODS

A cross-sectional behavioural survey was conducted in Portugal among MSM as part of the Project PREVIH - HIV/AIDS infection in MSM and Sex Workers: Prevalence, Determinants, Prevention interventions and Access to health (2009-2013). The study used a community-based participatory research approach, engaging a Community Advisory Board (CAB) comprising MSM, representatives of non-governmental and governmental organisations, and academics. The CAB actively participated in the study design, implementation and interpretation of the results.[19, 20]

Sampling, Recruitment and Data Collection

The study population was reached through a venue-based recruitment strategy. Geographic and network mapping was conducted, based on formative research with the CAB, to identify

data collection sites. Recruitment teams of outreach workers and MSM peers systematically approached potential participants at the sites, inviting them for a face-to-face interview. The inclusion criteria were: being at least 18 years and having had sex with a man in the last year. Participants were recruited from gay bars/clubs, cafes, streets in predominantly gay neighbourhoods, local community based organisations and community events. Additionally, the recruited respondents were asked to advertise the study among their social networks and peers.

Anonymity and confidentiality were guaranteed, and informed consent was obtained from all participants. The study was approved by the Ethics Committee for Health of the North Regional Health Administration. The study procedures were revised and approved by the CAB and the project's scientific commission.

Data were collected from January to September 2011 using a structured questionnaire applied by trained peers recruited from community organisation partners. The questionnaire included closed-ended questions on socio-demographics, sexual behaviour, availability/accessibility of STI/HIV services, history of HIV testing, reported HIV status and current/history of other STIs. The questionnaire was developed in collaboration with the community partners and included the indicators of the United Nations General Assembly Special Session on HIV/AIDS (UNGASS).[21] A more detailed description of the sampling, recruitment and data collection can be found elsewhere.[20]

Patient and public involvement

A community-based participatory research approach was used, in which a Community Advisory Board including representatives of non-governmental and governmental organizations, academics, and MSM was formed and actively participated in all phases of the project, as the study design, elaboration of the questionnaire, results interpretation, and discussion. Community partners were also involved in the data collection process.

Statistical Analysis

Data were analysed using hierarchical agglomerative cluster analysis, univariate and bivariate statistics, univariable, multivariate and mixed effect logistic regression analyses and statistical packages SPSS and STATA13 were used.

Figure 1 shows the cascade of the variables included in each step of the cluster analysis from the inclusion of all the variables and with the exclusion of some factors when the inclusion criteria were not met.

Multiple iterations of a hierarchical cluster analysis were used to identify the optimum number of clusters. The clustering was done based on Euclidean distances. Squared Euclidean distances were used to calculate the distance between any two individuals/subjects in the sample; the squared Euclidean distance is defined as the sum of the squared differences between the values for the (six) variables corresponding to these two individuals/subjects. Distances between identified clusters are obtained with the "between-groups linkage" method, i.e. the average of the distances between any two subjects in the corresponding clusters (syntax available as a supplementary file).

In consultation with key persons from the MSM community in Lisbon, the clusters were not labelled because of possible misperception and stigmatisation and will be referred to with a number.

The frequency of the variables self-reported current STI status ('Negative', 'Positive', 'Don't know'), past STI status ('Negative', 'Positive', 'Don't know') and HIV sero-status ('Negative', 'Positive', 'Don't know') in each of the clusters was examined.

The final list of variables included: (1) number of sexual male partners in the last 12 months (year) expressed as '1', '2-4', '5-12' and '>12'; (2) frequency of visiting gay clubs, bars, discos (venues) to meet male sexual partners ('Many times', 'Sometimes', 'Rarely' and 'Doesn't visit'), (3) condom use during the last anal sexual intercourse (AI) with male partner ('yes' and 'no'); (4) alcohol and (5) poppers consumption before or during the last sexual intercourse ('yes' and 'no'), and (6) age ('18-20', '21-30', '31-40', '41-50' and '>50').

A sensitivity analysis was performed to test the validity of the variables identified through the clustering. The variables identified were included as covariates in multivariable logistic

regression models using the variable self-reported current STI status ('Negative' vs. 'Positive'), past STI status ('Negative' vs. 'Positive') and HIV sero-status ('Negative' vs. 'Positive') as outcomes. The results of the regression models can be found as supplementary files. In addition, in regression analysis, the multilevel structure induces correlation among observations within a cluster and to test the validity of the 6 variables identified, each of them was used independently as a random effect in mixed-effect logistic regression models.

The final list of variables identified was considered as potential factors of a pattern of sexual behaviour in MSM populations.

RESULTS

A total of 1046 MSM participated in this study. The refusal rate was 23.2% (1362 were approached). No differences were found between refusals and participants regarding age and education. Overall, 5.5% self-reported a current STI, 20.5% a previous STI and 9.1% HIV positive sero-status. The median and mean numbers of male sexual partners in the past year were 4 and 14.8, respectively. Condom use was reported by 76.2% of participants during their last AI, either receptive or insertive; alcohol and poppers used before or during the last AI was reported by 25.3% and 7.8%, respectively.

The cluster analysis resulted in a 7-cluster solution, but one cluster was discarded as it was too small to be epidemiologically relevant (n=12).

The characteristics of the clusters identified are presented in Table 1.

Table 1: Socio-demographic and behavioural characteristics of the clusters

	Clusters						
	1	2	3	4	5	6	Overall
Frequency	46	187	206	303	106	66	**1046**
% of total included in cluster analysis	5.0%	20.2%	22.2%	32.7%	11.4%	7.1%	

Age - range	40-73	18-47	18-49	18-48	18-50	41-78	**18-78**
Age - mean	47.3	27.8	29.6	27.6	32.8	51.2	**30**
Age - median	45	27	30	27	32.5	49	**31.9**
Male sexual partners in the last year	58%	81%	62%	85%	59%	79%	
(% of >12 parnters or % <5 partners)	>12	<5	>12	<5	>12	<5	
Male sexual partners in the last year (median)	20	3	17.5	2	18.5	2	**4**
Sometimes or often visits gay clubs/bars/discos for finding sexual partners (%)	71.7%	90.4%	94.6%	4.0%	2.8%	1.5%	**44.5**
Condom use at last AI (%)	82.6%	69.0%	93.7%	66.30%	84.0%	62.1%	**76.2**
Use of alcohol before or during last sexual intercourse (%)	30.4%	28.9%	46.1%	18.2%	15.1%	15.2%	**25.3**
Use of poppers before or during last sexual intercourse (%)	13.0%	4.8%	13.1%	3.6%	18.9%	3.0%	**7.8**
Groups sex in the past 12 month (%)	53.5%	19.7%	48.0%	8.6%	43.6%	14.1%	**26.2**
Unprotected Anal Intercourse in the last	48.4%	22.2%	25.0%	18.5%	27.5%	18.9%	**23.3**

12 months with a partner whose HIV sero-status was unknown							
Sexual intercourse with a transgender partner in the last 12 months	7.1%	4.2%	6.6%	2.1%	1.0%	10.5%	**4.2**
Sexual intercourse with a woman in the last 12 months	12.5%	19.4%	8.0%	10.5%	13.4%	28.1%	**13.2**
Sexual intercourse with a sex worker in the last 12 months	11.6%	3.9%	3.5%	3.0%	4.0%	17.2%	**4.8**

Cluster 1. This is the smallest cluster (n=46) with MSM who were almost all older than 40 years old. They reported relatively more male sexual partners compared to the other clusters (58.7% reported 13 or more partners in the last year), 71.7% sometimes or often visited gay venues.

Eighty-two percent reported condom use during the last AI, however almost half (48.4%) reported unprotected AI in the last year with a partner whose HIV sero-status was unknown. and 53.5% took part in group sex in the last year.

Cluster 2. In this cluster (n=187) MSM in their twenties were highly represented. Compared to the other clusters, they reported relatively fewer male sexual partners (81.3% had less than 5 in the last year), 69% reported condom use during the last AI and 90.4% sometimes or often visited gay venues.

The use of alcohol and poppers during or before the last sexual intercourse was reported by the 28.9% and 4.8% of respondents, respectively.

Cluster 3. This cluster (n=206) included almost exclusively MSM between 20 and 40. They all reported relatively more male partners (61.7% had 13 or more partners in the last year). This cluster showed the highest proportion of condom use during the last AI (93.7%) and of visiting sometimes or often gay venues (94.6%).

The use of alcohol and poppers before or during the last sexual intercourse was reported by 46.1% and 13.1%, respectively.

Cluster 4. This cluster was the largest (n=303) and assembled the highest percentage of people between 18 and 20. They reported relatively few male sexual partners (85.1% had 4 or less partners in the last year), 66% reported condom use at the last AI and just 4% sometimes or often visited gay venues.

Sixty-six percent reported the use of condom during the last AI while 18.2% reported the use of alcohol and 3.6% reported the use of poppers during or before the last sexual intercourse.

Cluster 5. Mostly MSM in their thirties populated this cluster (n=106). Compared to the other clusters, they reported relatively more male sexual partners, (58.5% had 13 or more in the last year), 84% reported condom use during the last AI and only a small proportion visited sometimes or often gay venues.

Eighty-four percent reported the use of condom during the last AI while 15.1% used alcohol before or during the last sexual intercourse and 18.9% used poppers.

Cluster 6. This cluster (n=66) consisted of exclusively MSM older than 40 years. Over three-quarter reported 4 or less partners in the last year and only 1.5% reported to have attended gay venues. Of all clusters, they reported the lowest condom use during the last AI (62.1%) and only marginally use alcohol (15.2%) or poppers (3.0%) before or during the last sexual intercourse.

Of all the clusters, this group reported the most frequently sex with a transgender partner, with a woman and with a sex worker (10.5%, 28.1% and 17.2%, respectively).

From the 120 participants excluded from the cluster analysis, 1 failed to give his age, 63 did not answer how many partners they had in the last year, 26 failed to mark the frequency of their visits to gay venues and 62 did not answer whether they used a condom at last AI. Compared to the whole study population, the group of excluded participants was older, had less partners, frequented gay venues less frequently, more condom and less alcohol and poppers use.

Figure 2 shows the frequency of reported current STIs, past STIs and HIV sero-status within the six clusters. Cluster 1 had the highest rate of self-reported current STIs (17.1%), followed by cluster 6 (12.3%) and cluster 5 (11.7%). The other clusters had lower STI rates, ranging from 1.8% to 2.8%. The proportion of participants that did not know their current STI-status varied from 4.9% in cluster 1 to 17.0% in cluster 5.

Among the excluded participants that answered the question on reported current STI, the prevalence was 10.7% which is more than double the prevalence of the participants included in the analysis.

Cluster 1 reported the highest proportion of self-reported STI history (41.5%) followed by cluster 5 (26.1%), cluster 6 (25.5%) and cluster 3 (24.0%).

The highest prevalence of self-reported HIV was also found within the three clusters (from 13.0% to 16.7%) with the highest self-reported current and past STIs. Among the excluded participants, almost one in five reported being HIV-positive, a higher rate than any of the clusters.

From the sensitivity analysis (Supplementary file), the mixed-effect models performed generally better than the multivariable logistic regression. The results presented here are from the mixed-effect models after adjusting for the other confounders (in the fixed part of the model). For the model on self-reported current STIs, age group and number of male sexual partners in the last year were statistically significant random effects. For the model on the self-reported previous STI, age group, number of male sexual partners in the last year and condom use during the last AI were statistically significant random effects. For the model on the self-

reported positive HIV sero-status, age group, number of male sexual partners in the last year and frequent visits to gay venues were significant random effects.

The mixed-effect models, confirmed the role of age, number of sexual partners, condom use and frequent visits to gay venues as factors that could be used to detect possible clusters in this MSM population, related to current or past STI diagnosis or HIV sero-status.

DISCUSSION

The cluster analysis identified six clusters with diverse patterns of sexual behaviours, related to different STI and HIV vulnerability. In the discussion we further explore the higher STI/HIV prevalence clusters, using descriptive data (available on request) from variables not included in the cluster analysis.

High Risk Pattern - High STI/HIV-vulnerability

Cluster 1 well represents this pattern: it presents the highest STI rates and high number of partners and a high proportion of at risk sexual behaviours such as group sex and unprotected sex with a partner whose HIV sero-status was unknown .. This is in line with previous studies demonstrating that relationships in which condomless sex happens, are multiple, overlapping and sequential, resulting in a high-risk level for STIs and HIV.{Singer, 2006 #119;Ferrer, 2015 #212}

Seemingly Low Risk Pattern - High STI/HIV-vulnerability

Cluster 6 was the oldest cluster, and although except for UAI, it scored low on the other sexual risk variables but it had the second highest STI-prevalence and the highest HIV prevalence. They reported having sexual intercourses with transgender partners, women and sex workers. This suggests that cluster 6 contained a group of older MSM that might not identify as gay and might face a lot of barriers to access reliable information about the risks of their sexual behaviours. A previous study from Portugal showed that in this sample of MSM, low self-risk perception was the major motive of never having been tested for HIV.[22]

Similar Patterns - Different STI/HIV-vulnerability

Both clusters 5 and 3 represented a sexually active pattern in MSM of the same age range. A quarter of MSM in both clusters reported past STI diagnoses but MSM in cluster 5 had a higher proportion of current STI diagnoses, suggesting higher recurrence of STIs, and much higher self-reported HIV prevalence. However, about the same proportion in each cluster reported unprotected AI in the last year with a partner whose HIV sero-status was unknown. Contrary to cluster 3, MSM in cluster 5 almost never visited gay venues and did not drink alcohol at last AI. It has been demonstrated that the frequency of unprotected intercourse does not solely explain risk exposure, but having unprotected intercourse within certain high-risk sexual networks does expose MSM to a heightened risk.[23]

The majority of MSM in these clusters was currently not affected by HIV or other STIs and although they would be categorised as high risk to be infected with STIs and HIV, there are protective factors, among others shamelessness, social support and self-monitoring, that might play an important role in HIV/STI prevention interventions but have not been researched enough.

Strengths and Limitations

Data on HIV and STI prevalence were self-reported and interviews were not self-administered but done by community based researchers who were trained to apply the questionnaire. This might have provoked memory and social desirability bias. There might be a bias as to why certain questions were not answered, as is suggested by the high self- reported HIV prevalence in the 'missing' cluster. Due to the intimate and sensitive nature of the study questionnaire and the stigma associated with risky sexual behaviour and HIV/STI positive sero-status, under-reporting in this study was to be expected.

The strength of a cluster analysis is that it can intercept groups of homogeneous units in the

population, in terms of a group of relevant variables. However, the results and interpretation of any cluster analysis depend on several researcher's choices and assumptions, such as that actual groups exist, the choice of the variables on which the elements in the groups should be similar, the distance measure, the clustering procedure and the number of clusters.[24, 25] The presented clusters describe the study sample population, obtained via venue based recruitment, and therefore cannot be extrapolated to the whole MSM population.

Conclusions

The main findings are in line with other studies that demonstrated the association between HIV-infection with higher incidence and prevalence rates for STIs, contributing to the ongoing transmission among MSM and supporting linked epidemics of STIs and HIV in Portuguese MSM.[26-28] Interventions for MSM should combine HIV- and comprehensive STI- testing, including rectal and pharyngeal swabbing.[29]

However, the information on the natural history of these asymptomatic infections is scarce, and it remains unclear the public health benefit and the risks are associated with the implementation of this screening strategy.

The results also suggest some factors not directly linked to sexual behaviour reinforce the epidemics.

Although it is difficult to prove that the group of afflictions identified as one of the common patterns in this MSM population is a syndemic, its potential is significant.

Besides a critical need for improved STI symptom recognition, screening and treatment, future interventions should have a syndemic orientation, unfolding the entire set of factors that create excess burden of disease, being informed by analyses including psychosocial variables and sexual health indicators.[30] Capturing concepts of autonomy, well-being, sexual satisfaction, intimacy and social values in relation to sexuality, health scientists and other health professionals might start identifying a different set of risk and protective factors.

Contributions

SD, AG, RF and LM were involved in the design and conducting of the survey. AS, IT and KB chose the main directions for data analysis and participated in the interpretation of results. AS, MF and KB performed the statistical analyses. KB, IT, MF, SD, AS, MT, AG collaborated in the writing of the manuscript. RF and LM complemented the manuscript with contextual data. KB, SD, MF, AS, AG, RF, LM, MT and IT revised the manuscript before submission. All authors approved the final manuscript submitted

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Competing interests

None of the authors have conflicts of interest to declare.

Ethics Approval

This article does not contain any studies with animals performed by any of the authors. All procedures performed involving human participants in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by the Ethics Committee for Health of the North Regional Health Administration. Informed consent was obtained from all individual participants included in the study.
The ethics committee approval number is No.18.09CES.

Data sharing statement

No additional data available

Patient consent for publication

Informed consent was obtained from all individual participants included in this study

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Disclaimer

The authors are staff members of the World Health Organization. The authors alone are responsible for the views expressed in this publication and they do not necessarily represent the views, decisions or policies of the World Health Organization.

Figure 1: Flow-chart of variable selection for the study

Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

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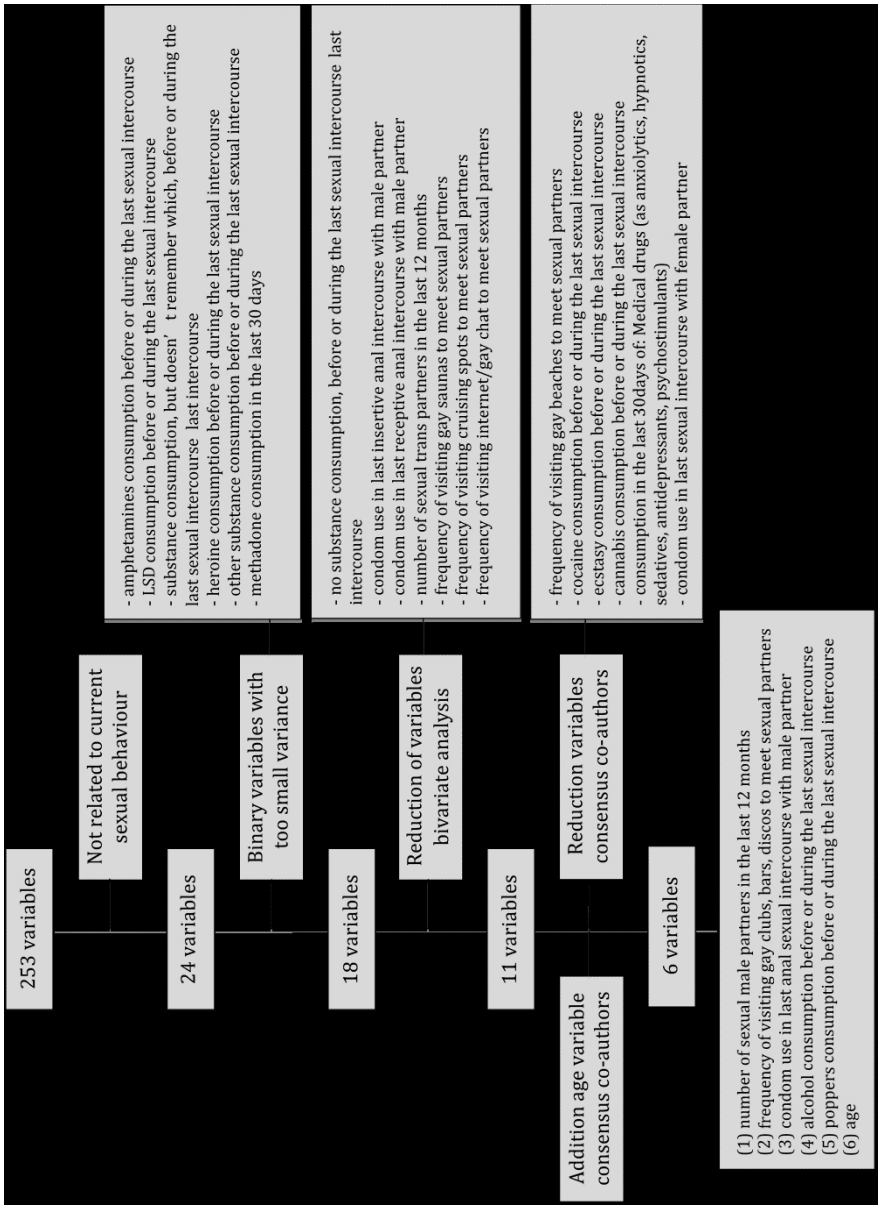

Figure 1: Cascade inclusion variables in cluster analysis

352x483mm (72 x 72 DPI)

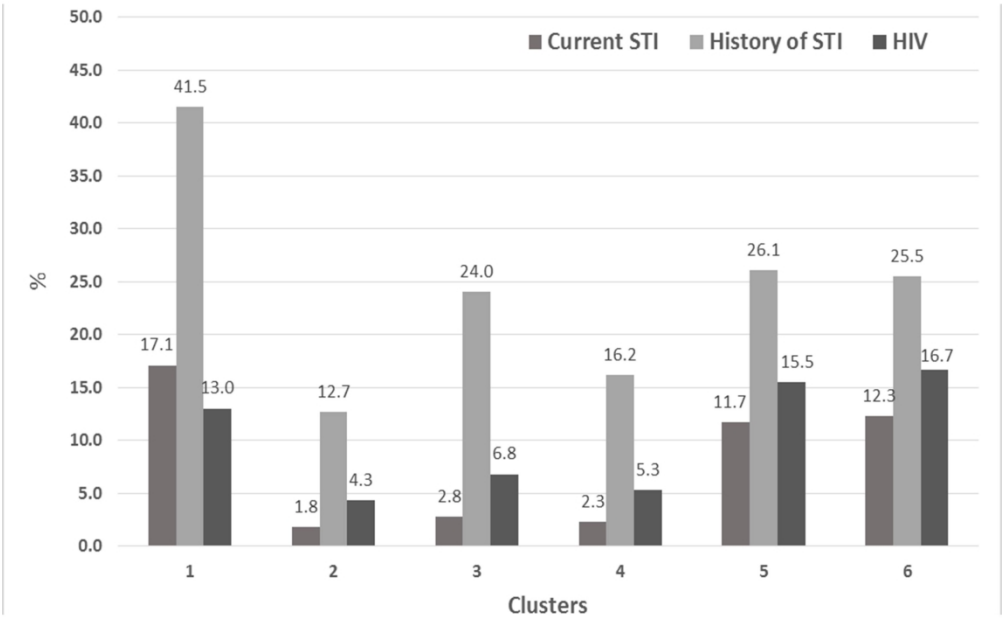

Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

254x190mm (307 x 307 DPI)

SUPPLEMENTARY FILE 1

SPSS SYNTAX FILE USED FOR THE CLUSTER ANALYSIS
CLUSTER

```
Age_REC_5cat_2
SexMen_number_REC_4cat
MCLUB
REC_CondomLast_Male
SubsSex_Alc
SubsSex_Pop
/METHOD BAVERAGE
/MEASURE=SEUCLID
/PRINT SCHEDULE CLUSTER(4,9)
/PRINT DISTANCE
/PLOT VICICLE
/SAVE CLUSTER(4,9).
```

Tab. 1a Adjusted Odds Ratios from a multivariable logistic regression for self-reported previous STI (diagnosed positive)

Previous STI	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	1.55	0.313	0.66	3.61
31-40	**2.59**	0.029	1.10	6.07
41-50	**2.96**	0.023	1.16	7.54
>50	**4.74**	0.006	1.56	14.48
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.72	0.289	0.40	1.32
5-12	**1.66**	0.091	0.92	3.00
>12	**2.60**	0.002	1.42	4.73
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.09	0.776	0.60	1.98
Rarely	1.52	0.173	0.83	2.79
Doesn't visit	0.98	0.955	0.48	2.01
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.48**	0.001	0.31	0.75
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.34	0.346	0.73	2.45
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.29	0.237	0.85	1.95

Tab. 2a Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with age group as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.73	0.302	0.40	1.33
5-12	**1.67**	0.086	0.93	3.01
>12	**2.68**	0.001	1.47	4.89
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.10	0.750	0.61	2.00
Rarely	1.55	0.156	0.85	2.83
Doesn't visit	1.02	0.953	0.50	2.09
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.47**	0.001	0.30	0.74
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.34	0.343	0.73	2.44
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.29	0.224	0.85	1.96
RANDOM EFFECT				
AGE GROUP (var)	**0.11**		0.01	1.18

Tab. 3a Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with number of sexual male partners in the last 12 months as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.56	0.303	0.67	3.64
31-40	**2.65**	0.024	1.13	6.22
41-50	**3.04**	0.020	1.20	7.75
>50	**4.76**	0.006	1.57	14.45
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.08	0.806	0.59	1.96
Rarely	1.47	0.216	0.80	2.68
Doesn't visit	0.91	0.794	0.44	1.86
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.50**	0.002	0.32	0.78
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.40	0.270	0.77	2.57
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.30	0.219	0.86	1.97
	RANDOM EFFECT			
Number of sexual male partners in the last 12 months (var)	**0.19**		0.03	1.04

Tab. 4a Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with condom use in last sexual intercourse as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Age group				
18-20	ref.			
21-30	1.54	0.317	0.66	3.60
31-40	**2.59**	0.029	1.11	6.06
41-50	**2.96**	0.023	1.16	7.54
>50	**4.78**	0.006	1.57	14.52
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.69	0.233	0.38	1.27
5-12	1.56	0.139	0.86	2.83
>12	**2.43**	0.004	1.32	4.44
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	1.10	0.757	0.61	2.00
Sometimes	1.54	0.165	0.84	2.81
Rarely	0.99	0.970	0.48	2.02
Doesn't visit				
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.35	0.331	0.74	2.46
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.28	0.250	0.84	1.94
RANDOM EFFECT				
Condom use in last sexual intercourse (var)	**0.10**		0.01	1.21

Tab. 1b Adjusted Odds Ratios from a multivariable logistic regression for self-reported current STI (diagnosed positive)

Current STI	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	0.39	0.192	0.10	1.60
31-40	0.89	0.866	0.24	3.37
41-50	**3.73**	0.052	0.99	14.05
>50	1.18	0.862	0.18	7.78
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.59	0.399	0.18	2.00
5-12	2.26	0.126	0.80	6.41
>12	1.79	0.297	0.60	5.38
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.13	0.150	0.66	14.79
Rarely	**4.38**	0.062	0.93	20.72
Doesn't visit	**6.06**	0.030	1.20	30.76
Condom use in last sex intercourse				
No	ref.			
Yes	1.72	0.260	0.67	4.44
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.45**	0.081	0.89	6.71
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.98	0.955	0.44	2.15

Tab. 2b Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported current STI (diagnosed positive) with age group as a random effect

Current STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.59	0.391	0.18	1.97
5-12	2.25	0.125	0.80	6.36
>12	1.85	0.269	0.62	5.52
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.05	0.158	0.65	14.29
Rarely	**4.25**	0.066	0.91	19.92
Doesn't visit	**6.05**	0.029	1.20	30.39
Condom use in last sex intercourse				
No	ref.			
Yes	1.70	0.270	0.66	4.37
Popper use before or during last sex intercourse				
No	ref.			
Yes	2.32	0.100	0.85	6.30
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.97	0.936	0.44	2.12
RANDOM EFFECT				
AGE GROUP (var)	**0.50**		0.10	2.43

Tab. 3b Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported current STI (diagnosed positive) with number of sexual male partners in the last 12 months as a random effect

Current STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Age group				
18-20	ref.			
21-30	0.39	0.185	0.10	1.57
31-40	0.93	0.909	0.25	3.45
41-50	**3.83**	0.045	1.03	14.18
>50	1.18	0.864	0.18	7.63
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.00	0.165	0.64	14.16
Rarely	**3.84**	0.090	0.81	18.27
Doesn't visit	**4.78**	0.060	0.94	24.35
Condom use in last sex intercourse				
No	ref.			
Yes	1.90	0.177	0.75	4.83
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.62**	0.057	0.97	7.06
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.97	0.946	0.44	2.13
RANDOM EFFECT				
Number of sexual male partners in the last 12 months (var)	**0.10**		0.00	2.90

Tab. 1c Adjusted Odds Ratios from a multivariable logistic regression for self-reported HIV positive serostatus

HIV positive serostatus	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	1.73	0.470	0.39	7.71
31-40	**3.79**	0.076	0.87	16.56
41-50	**6.58**	0.015	1.44	30.01
>50	**9.45**	0.007	1.86	47.89
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	1.85	0.154	0.79	4.30
5-12	1.40	0.483	0.55	3.58
>12	**3.58**	0.004	1.50	8.54
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.41**	0.039	0.18	0.95
Rarely	1.15	0.720	0.54	2.42
Doesn't visit	1.02	0.963	0.43	2.42
Condom use in last sex intercourse				
No	ref.			
Yes	1.35	0.383	0.69	2.63
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.07**	0.059	0.97	4.41
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.186	0.35	1.23

Tab. 2c Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with age group as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	1.85	0.153	0.80	4.30
5-12	1.42	0.468	0.55	3.62
>12	**3.69**	0.003	1.54	8.81
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.42**	0.045	0.18	0.98
Rarely	1.18	0.661	0.56	2.50
Doesn't visit	1.09	0.842	0.46	2.58
Condom use in last sex intercourse				
No	ref.			
Yes	1.33	0.399	0.68	2.60
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.02**	0.067	0.95	4.29
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.189	0.35	1.23
RANDOM EFFECT				
AGE GROUP (var)	**0.40**		0.07	2.42

Tab. 3c Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with number of sexual male partners in the last 12 months as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.80	0.439	0.41	8.01
31-40	**4.03**	0.064	0.92	17.60
41-50	**6.93**	0.012	1.52	31.56
>50	**9.80**	0.006	1.94	49.60
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.41**	0.038	0.18	0.95
Rarely	1.10	0.796	0.52	2.33
Doesn't visit	0.91	0.824	0.38	2.14
Condom use in last sex intercourse				
No	ref.			
Yes	1.45	0.276	0.74	2.81
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.24**	0.036	1.05	4.78
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.197	0.36	1.24
	RANDOM EFFECT			
Number of sexual male partners in the last 12 months (var)	**0.14**		0.02	1.21

Tab. 4c Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with frequency of visiting gay clubs, bars, discos to meet sexual partners as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.71	0.482	0.38	7.59
31-40	**3.72**	0.080	0.85	16.22
41-50	**6.55**	0.015	1.44	29.86
>50	**9.43**	0.007	1.87	47.53
Number of Partner				
1	ref.			
2-4	1.82	0.165	0.78	4.22
5-12	1.34	0.539	0.53	3.39
>12	**3.32**	0.006	1.41	7.83
Condom use last sex intercourse				
No	ref.	0.757	0.61	2.00
Yes	1.32	0.411	0.68	2.57
Popper use last sex intercourse				
No	ref.			
Yes	**2.05**	0.061	0.97	4.35
Alcohol use last sex intercourse				
No	ref.			
Yes	0.63	0.149	0.34	1.18
	RANDOM EFFECT			
Frequency of visiting gay clubs, bars, discos to meet sexual partners (var)	**0.09**		0.01	1.02

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	Figure 1 (pag 7)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	8-10

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who Have Sex with Men in Portugal

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ABSTRACT

Objectives

Portugal has the highest HIV incidence rate in Western Europe. The proportion assigned to sexual contact between men recently increased to more than 30% of all HIV-infections. Men who have Sex with Men (MSM) are vulnerable to the acquisition of other Sexually Transmitted Infections (STIs), increasing the per-contact risk of HIV-infection. Building on syndemic theory, the aim of this analysis was to identify patterns of current sexual behaviour in MSM, and explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-status.

Design

A cross-sectional behavioural survey was conducted in Portugal among MSM, using a community-based participatory research approach. Hierarchical cluster analysis was used to identify patterns including behavioural and demographic factors.

Results

The analysis resulted in 6 clusters. Three clusters showed higher rates of current STI diagnosis (ranging from 11.7% to 17.1%), past STI diagnosis (ranging from 25.5% to 41.5%) and HIV positive sero-status (ranging from 13.0% to 16.7%). From the three clusters scoring lower on current and past STI and HIV diagnoses, one was characterized by a high number of sexual partners (62% had more than 12 partners in the last year), a high proportion (94.6%)

of frequent visits to gay venues to meet sexual partners and high alcohol use (46.1%). The other two clusters scored lower on high risk sexual behaviour.

Conclusion

Factors other than sexual behaviour appear to reinforce the vulnerability to STIs and HIV of some MSM in this study, suggesting a syndemic of STIs, HIV and other adverse conditions. More research is needed to better understand the drivers of the STI/HIV epidemic in Portuguese MSM, using a concept that goes beyond risk behaviour, to develop effective combination prevention interventions.

Strengths and limitations of this study

- Hierarchical cluster analysis was used to identify behavioural patterns among MSM participating in a behavioural survey in Portugal
- The main findings from the cluster analysis are in line with the literature supporting linked epidemics of STIs and HIV in Portuguese MSM
- Using a syndemic approach it was possible to identify that factors not directly linked to sexual behaviour are linked to these epidemics
- The outcomes of this analysis relate to the study sample population and cannot be generalised to the wider MSM population
- We acknowledged that the reliance on self-reported STI and HIV outcomes is a weakness that may have caused social desirability bias

INTRODUCTION

Portugal had the highest rate of new HIV diagnoses in Western Europe in 2013.[1] Initially the Portuguese HIV-epidemic was predominantly prevalent in people who inject drugs (PWID), but since 2003 most of the reported infections are associated with sexual transmission.[2] In 2013, of all new HIV-infections occurring in Portugal, 30.3% were assigned to sexual contact

between men.[3] The estimated percentage of Portuguese men who have sex with men (MSM) living with HIV was 10% in 2011, manifold the 0.6% estimate for Portuguese adults aged 15 to 49.[4] The median age at HIV diagnosis due to transmission among homosexual men has declined from 35 in 2007 to 32 in 2012, unlike the increasing trend due to transmission among heterosexual persons.[5]

MSM are also vulnerable to the acquisition of other sexually transmitted infections (STIs), some of which increase the per-contact risk of HIV-infection. The European MSM Internet Survey (EMIS) showed that 14.5% of MSM across Europe self-reported a history of gonorrhoea diagnoses, 13.4% of anal/genital warts, 8.6% of syphilis, 8.1% of chlamydial infection and 3.6% of anal/genital herpes.[6] MSM account for almost 50% of all syphilis cases reported and 24% of gonorrhoea diagnoses in Europe.[7] For Portugal this information is incomplete[8, 9] and in the Portuguese Global AIDS Response Progress Reports there is no reporting of STI-data among MSM.[10] Underreporting is suggested to be high in Portugal, and related to the non-detection of syphilis and rectal gonorrhoea due to low rates of STI-testing and anal exams or swabbing.[11] Currently, in Portugal there are neither separate HIV/STI-policies for MSM nor specific national STI-testing policies or guidelines.

Recently, there have been numerous efforts to promote prevention/diagnosis/linkage of interventions for MSM, mainly organized by the community. CheckpointLX in Lisbon, the first community-based testing centre for MSM founded in April 2011, encourages combined HIV-STI testing for MSM.

The most recent national programme for the prevention and control of HIV/AIDS[12, 13] included MSM as a target group. Having as first objective to structure the epidemiological surveillance system for HIV, it encompasses information on other STIs and includes the screening of STIs as a secondary prevention method for HIV infection.[14, 15]

STIs and HIV have been researched in conjunction with mental health conditions, substance use, violence and sexual abuse in the framework of the syndemic theory.[16] These factors may reinforce one another and increase the health burden in at risk populations, such as MSM.[20,21] The concept of “afflictions” defining a syndemic[16-18] can be extended from just

diseases to risk factors, and other health related conditions.

A syndemic of risky sexual behaviours is a group of co-existing factors that describe the sexual behavioural patterns in a specific population.

One way of exploring this syndemic is to identify subgroups of subjects that share a particular pattern with respect to relevant sexual behavioural variables that potentially interact in the syndemic, to this purpose the technique of cluster analysis was used in this study.

The term cluster in this context is not considered in the epidemiological sense of the term, ie a group that is connected in time and/or place but it was used to identify patterns of current sexual behaviour in Portuguese MSM, and to explore the associations with the self-reported current and past STIs and HIV sero-status.

A better understanding of these relationships can inform the design of combined interventions in MSM to both decrease STI and HIV burden, and improve sexual health.[19]

The aim of this analysis was to identify patterns of current sexual behaviour in MSM, and explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-status.

METHODS

A cross-sectional behavioural survey was conducted in Portugal among MSM as part of the Project PREVIH - HIV/AIDS infection in MSM and Sex Workers: Prevalence, Determinants, Prevention interventions and Access to health (2009-2013). The study used a community-based participatory research approach, engaging a Community Advisory Board (CAB) comprising MSM, representatives of non-governmental and governmental organisations, and academics. The CAB actively participated in the study design, implementation and interpretation of the results.[19, 20]

Sampling, Recruitment and Data Collection

The study population was reached through a venue-based recruitment strategy. Geographic and network mapping was conducted, based on formative research with the CAB, to identify

data collection sites. Recruitment teams of outreach workers and MSM peers systematically approached potential participants at the sites, inviting them for a face-to-face interview. The inclusion criteria were: being at least 18 years and having had sex with a man in the last year. Participants were recruited from gay bars/clubs, cafes, streets in predominantly gay neighbourhoods, local community based organisations and community events. Additionally, the recruited respondents were asked to advertise the study among their social networks and peers.

Anonymity and confidentiality were guaranteed, and informed consent was obtained from all participants. The study was approved by the Ethics Committee for Health of the North Regional Health Administration. The study procedures were revised and approved by the CAB and the project's scientific commission.

Data were collected from January to September 2011 using a structured questionnaire applied by trained peers recruited from community organisation partners. The questionnaire included closed-ended questions on socio-demographics, sexual behaviour, availability/accessibility of STI/HIV services, history of HIV testing, reported HIV status and current/history of other STIs. The questionnaire was developed in collaboration with the community partners and included the indicators of the United Nations General Assembly Special Session on HIV/AIDS (UNGASS).[21] A more detailed description of the sampling, recruitment and data collection can be found elsewhere.[20]

Patient and public involvement

A community-based participatory research approach was used, in which a Community Advisory Board including representatives of non-governmental and governmental organizations, academics, and MSM was formed and actively participated in all phases of the project, as the study design, elaboration of the questionnaire, results interpretation, and discussion. Community partners were also involved in the data collection process.

Statistical Analysis

Data were analysed using hierarchical agglomerative cluster analysis, univariate and bivariate statistics, univariable, multivariate and mixed effect logistic regression analyses and statistical packages SPSS and STATA13 were used.

Figure 1 shows the cascade of the variables included in each step of the cluster analysis from the inclusion of all the variables and with the exclusion of some factors when the inclusion criteria were not met.

Multiple iterations of a hierarchical cluster analysis were used to identify the optimum number of clusters. The clustering was done based on Euclidean distances. Squared Euclidean distances were used to calculate the distance between any two individuals/subjects in the sample; the squared Euclidean distance is defined as the sum of the squared differences between the values for the (six) variables corresponding to these two individuals/subjects. Distances between identified clusters are obtained with the "between-groups linkage" method, i.e. the average of the distances between any two subjects in the corresponding clusters (syntax available as a Supplementary File 1).

In consultation with key persons from the MSM community in Lisbon, the clusters were not labelled because of possible misperception and stigmatisation and will be referred to with a number.

The frequency of the variables self-reported current STI status ('Negative', 'Positive', 'Don't know'), past STI status ('Negative', 'Positive', 'Don't know') and HIV sero-status ('Negative', 'Positive', 'Don't know') in each of the clusters was examined.

The final list of variables included: (1) number of sexual male partners in the last 12 months (year) expressed as '1', '2-4', '5-12' and '>12'; (2) frequency of visiting gay clubs, bars, discos (venues) to meet male sexual partners ('Many times', 'Sometimes', 'Rarely' and 'Doesn't visit'), (3) condom use during the last anal sexual intercourse (AI) with male partner ('yes' and 'no'); (4) alcohol and (5) poppers consumption before or during the last sexual intercourse ('yes' and 'no'), and (6) age ('18-20', '21-30', '31-40', '41-50' and '>50').

A sensitivity analysis was performed to test the validity of the variables identified through the clustering. The variables identified were included as covariates in multivariable logistic

regression models using the variable self-reported current STI status ('Negative' vs. 'Positive'), previous STI status ('Negative' vs. 'Positive') and HIV sero-status ('Negative' vs. 'Positive') as outcomes. The results of the regression models for current and previous STIs and HIV status can be found as supplementary files. In addition, in regression analysis, the multilevel structure induces correlation among observations within a cluster and to test the validity of the 6 variables identified, each of them was used independently as a random effect in mixed-effect logistic regression models.

The final list of variables identified was considered as potential factors of a pattern of sexual behaviour in MSM populations.

RESULTS

A total of 1046 MSM participated in this study. The refusal rate was 23.2% (1362 were approached). No differences were found between refusals and participants regarding age and education. Overall, 5.5% self-reported a current STI, 20.5% a previous STI and 9.1% HIV positive sero-status. The median and mean numbers of male sexual partners in the past year were 4 and 14.8, respectively. Condom use was reported by 76.2% of participants during their last AI, either receptive or insertive; alcohol and poppers used before or during the last AI was reported by 25.3% and 7.8%, respectively.

The cluster analysis resulted in a 7-cluster solution, but one cluster was discarded as it was too small to be epidemiologically relevant (n=12).

The characteristics of the clusters identified are presented in Table 1.

Table 1: Socio-demographic and behavioural characteristics of the clusters

	Clusters						
	1	2	3	4	5	6	Overall
Frequency	46	187	206	303	106	66	**1046**

% of total included in cluster analysis	5.0%	20.2%	22.2%	32.7%	11.4%	7.1%	
Age - range	40-73	18-47	18-49	18-48	18-50	41-78	**18-78**
Age - mean	47.3	27.8	29.6	27.6	32.8	51.2	**30**
Age - median	45	27	30	27	32.5	49	**31.9**
Male sexual partners in the last year	58%	81%	62%	85%	59%	79%	
(% of >12 parnters or % <5 partners)	>12	<5	>12	<5	>12	<5	
Male sexual partners in the last year (median)	20	3	17.5	2	18.5	2	**4**
Sometimes or often visits gay clubs/bars/discos for finding sexual partners (%)	71.7%	90.4%	94.6%	4.0%	2.8%	1.5%	**44.5**
Condom use at last AI (%)	82.6%	69.0%	93.7%	66.30%	84.0%	62.1%	**76.2**
Use of alcohol before or during last sexual intercourse (%)	30.4%	28.9%	46.1%	18.2%	15.1%	15.2%	**25.3**
Use of poppers before or during last sexual intercourse (%)	13.0%	4.8%	13.1%	3.6%	18.9%	3.0%	**7.8**
Group sex in the past 12 month (%)	53.5%	19.7%	48.0%	8.6%	43.6%	14.1%	**26.2**

Unprotected Anal Intercourse in the last 12 months with a partner whose HIV sero-status was unknown	48.4%	22.2%	25.0%	18.5%	27.5%	18.9%	**23.3**
Sexual intercourse with a transgender partner in the last 12 months	7.1%	4.2%	6.6%	2.1%	1.0%	10.5%	**4.2**
Sexual intercourse with a woman in the last 12 months	12.5%	19.4%	8.0%	10.5%	13.4%	28.1%	**13.2**
Sexual intercourse with a sex worker in the last 12 months	11.6%	3.9%	3.5%	3.0%	4.0%	17.2%	**4.8**

Cluster 1. This is the smallest cluster (n=46) with MSM who were almost all older than 40 years old. They reported relatively more male sexual partners compared to the other clusters (58.7% reported 13 or more partners in the last year), 71.7% sometimes or often visited gay venues.

Eighty-two percent reported condom use during the last AI, however almost half (48.4%) reported unprotected AI in the last year with a partner whose HIV sero-status was unknown. and 53.5% took part in group sex in the last year.

Cluster 2. In this cluster (n=187) MSM in their twenties were highly represented. Compared to the other clusters, they reported relatively fewer male sexual partners (81.3% had less than 5

in the last year), 69% reported condom use during the last AI and 90.4% sometimes or often visited gay venues.

The use of alcohol and poppers during or before the last sexual intercourse was reported by the 28.9% and 4.8% of respondents, respectively.

Cluster 3. This cluster (n=206) included almost exclusively MSM between 20 and 40. They all reported relatively more male partners (61.7% had 13 or more partners in the last year). This cluster showed the highest proportion of condom use during the last AI (93.7%) and of visiting sometimes or often gay venues (94.6%).

The use of alcohol and poppers before or during the last sexual intercourse was reported by 46.1% and 13.1%, respectively.

Cluster 4. This cluster was the largest (n=303) and assembled the highest percentage of people between 18 and 20. They reported relatively few male sexual partners (85.1% had 4 or less partners in the last year), 66% reported condom use at the last AI and just 4% sometimes or often visited gay venues.

Sixty-six percent reported the use of condom during the last AI while 18.2% reported the use of alcohol and 3.6% reported the use of poppers during or before the last sexual intercourse.

Cluster 5. Mostly MSM in their thirties populated this cluster (n=106). Compared to the other clusters, they reported relatively more male sexual partners, (58.5% had 13 or more in the last year), 84% reported condom use during the last AI and only a small proportion visited sometimes or often gay venues.

Eighty-four percent reported the use of condom during the last AI while 15.1% used alcohol before or during the last sexual intercourse and 18.9% used poppers.

Cluster 6. This cluster (n=66) consisted of exclusively MSM older than 40 years. Over three-quarter reported 4 or less partners in the last year and only 1.5% reported to have attended gay venues. Of all clusters, they reported the lowest condom use during the last AI (62.1%) and only marginally use alcohol (15.2%) or poppers (3.0%) before or during the last sexual intercourse.

Of all the clusters, this group reported the most frequently sex with a transgender partner, with a woman and with a sex worker (10.5%, 28.1% and 17.2%, respectively).

From the 120 participants excluded from the cluster analysis, 1 failed to give his age, 63 did not answer how many partners they had in the last year, 26 failed to mark the frequency of their visits to gay venues and 62 did not answer whether they used a condom at last AI. Compared to the whole study population, the group of excluded participants was older, had less partners, frequented gay venues less frequently, more condom and less alcohol and poppers use.

Figure 2 shows the frequency of reported current STIs, past STIs and HIV sero-status within the six clusters. Cluster 1 had the highest rate of self-reported current STIs (17.1%), followed by cluster 6 (12.3%) and cluster 5 (11.7%). The other clusters had lower STI rates, ranging from 1.8% to 2.8%. The proportion of participants that did not know their current STI-status varied from 4.9% in cluster 1 to 17.0% in cluster 5.

Among the excluded participants that answered the question on reported current STI, the prevalence was 10.7% which is more than double the prevalence of the participants included in the analysis.

Cluster 1 reported the highest proportion of self-reported STI history (41.5%) followed by cluster 5 (26.1%), cluster 6 (25.5%) and cluster 3 (24.0%).

The highest prevalence of self-reported HIV was also found within the three clusters (from 13.0% to 16.7%) with the highest self-reported current and past STIs. Among the excluded participants, almost one in five reported being HIV-positive, a higher rate than any of the clusters.

From the sensitivity analysis, the mixed-effect models performed generally better than the multivariable logistic regression. The results presented here are from the mixed-effect models after adjusting for the other confounders (in the fixed part of the model). For the model on self-reported current STIs (Supplementary File 2) age group and number of male sexual partners in the last year were statistically significant random effects. For the model on the self-reported

previous STI (Supplementary File 3), age group, number of male sexual partners in the last year and condom use during the last AI were statistically significant random effects. For the model on the self-reported positive HIV sero-status (Supplementary File 4), age group, number of male sexual partners in the last year and frequent visits to gay venues were significant random effects.

The mixed-effect models, confirmed the role of age, number of sexual partners, condom use and frequent visits to gay venues as factors that could be used to detect possible clusters in this MSM population, related to current or past STI diagnosis or HIV sero-status.

DISCUSSION

The cluster analysis identified six clusters with diverse patterns of sexual behaviours, related to different STI and HIV vulnerability.

High Risk Pattern - High STI/HIV-vulnerability

Cluster 1 seems to be characterized by this pattern: it presents the highest STI rates and high number of partners and a high proportion of at risk sexual behaviours such as group sex and unprotected sex with a partner whose HIV sero-status was unknown. This is in line with previous studies demonstrating that relationships in which condomless sex happens, are multiple, overlapping and sequential, resulting in a high-risk level for STIs and HIV.{Singer, 2006 #119;Ferrer, 2015 #212}

Seemingly Low Risk Pattern - High STI/HIV-vulnerability

Cluster 6 was the oldest cluster, and although except for UAI, it scored low on the other sexual risk variables, but it had the second highest STI-prevalence and the highest HIV prevalence. They reported having sexual intercourses with transgender partners, women and sex workers. This suggests that cluster 6 contained a group of older MSM that might not identify as gay and might face a lot of barriers to access reliable information about the risks of their sexual

behaviours. A previous study from Portugal showed that in this sample of MSM, low self-risk perception was the major motive of never having been tested for HIV.[22]

Similar Patterns - Different STI/HIV-vulnerability

Both clusters 5 and 3 represented a sexually active pattern in MSM of the same age range. A quarter of MSM in both clusters reported past STI diagnoses but MSM in cluster 5 had a higher proportion of current STI diagnoses, suggesting higher recurrence of STIs, and much higher self-reported HIV prevalence. However, about the same proportion in each cluster reported unprotected AI in the last year with a partner whose HIV sero-status was unknown. Contrary to cluster 3, MSM in cluster 5 almost never visited gay venues and did not drink alcohol at last AI. It has been demonstrated that the frequency of unprotected intercourse does not solely explain risk exposure, but having unprotected intercourse within certain high-risk sexual networks does expose MSM to a heightened risk.[23]

The majority of MSM in these clusters was currently not affected by HIV or other STIs and although they would be categorised as high risk to be infected with STIs and HIV, there are protective factors, among others shamelessness, social support and self-monitoring, that might play an important role in HIV/STI prevention interventions but have not been researched enough.

Strengths and Limitations

Data on HIV and STI prevalence were self-reported and interviews were not self-administered but done by community-based researchers who were trained to apply the questionnaire. This might have provoked memory and social desirability bias. There might be a bias as to why certain questions were not answered, as is suggested by the high self- reported HIV prevalence in the 'missing' cluster. Due to the intimate and sensitive nature of the study questionnaire and the stigma associated with risky sexual behaviour and HIV/STI positive sero-status, under-reporting in this study was to be expected.

The strength of a cluster analysis is that it can intercept groups of homogeneous units in the population, in terms of a group of relevant variables. However, the results and interpretation of any cluster analysis depend on several researcher's choices and assumptions, such as that actual groups exist, the choice of the variables on which the elements in the groups should be similar, the distance measure, the clustering procedure and the number of clusters.[24, 25] The presented clusters describe the study sample population, obtained via venue-based recruitment, and therefore cannot be extrapolated to the whole MSM population.

Conclusions

Though results of our analysis reconfirm that the number of partners and condom use are important factors in HIV and STI transmission, they also suggest other factors such as sexual networks and risk perception are at play. Although it is difficult to prove that the group of afflictions identified as one of the common patterns in this MSM population is a syndemic, its potential is significant. The findings are also in line with previous studies that demonstrated the association between HIV-infection and higher incidence and prevalence rates of other STIs, supporting linked epidemics of STIs and HIV in Portuguese MSM.[26-28] Interventions for MSM should combine HIV- and STI- testing, and for some of the clusters identified in our analysis, should be comprehensive, including rectal and pharyngeal swabbing to screen for asymptomatic gonorrhoea and chlamydia, especially considering the current challenges with antimicrobial resistance.[29]

It should be mentioned that, the information on the natural history of these asymptomatic infections is scarce, and the public health benefit and the risks associated with the wide roll-out of this screening strategy remain unclear.

Finally, the authors recommend future research and interventions to have a syndemic orientation to minimize excess burden of disease in MSM. Capturing concepts of autonomy, well-being, sexual satisfaction, intimacy and social values in relation to sexuality, might unfold a different set of risk and protective factors for a healthy sexual life.

Contributions

SD, AG, RF and LM were involved in the design and conducting of the survey. AS, IT and KB chose the main directions for data analysis and participated in the interpretation of results. AS, MF and KB performed the statistical analyses. KB, IT, MF, SD, AS, MT, AG collaborated in the writing of the manuscript. RF and LM complemented the manuscript with contextual data. KB, SD, MF, AS, AG, RF, LM, MT and IT revised the manuscript before submission. All authors approved the final manuscript submitted

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Competing interests

None of the authors have conflicts of interest to declare.

Ethics Approval

This article does not contain any studies with animals performed by any of the authors. All procedures performed involving human participants in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by the Ethics Committee for Health of the North Regional Health Administration. Informed consent was obtained from all individual participants included in the study.

The ethics committee approval number is No.18.09CES.

Data sharing statement

The data that support the findings of this study are available on request from the corresponding author MF

Patient consent for publication

Informed consent was obtained from all individual participants included in this study

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Disclaimer

The authors are staff members of the World Health Organization. The authors alone are responsible for the views expressed in this publication and they do not necessarily represent the views, decisions or policies of the World Health Organization.

Figure 1: Flow-chart of variable selection for the study

Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

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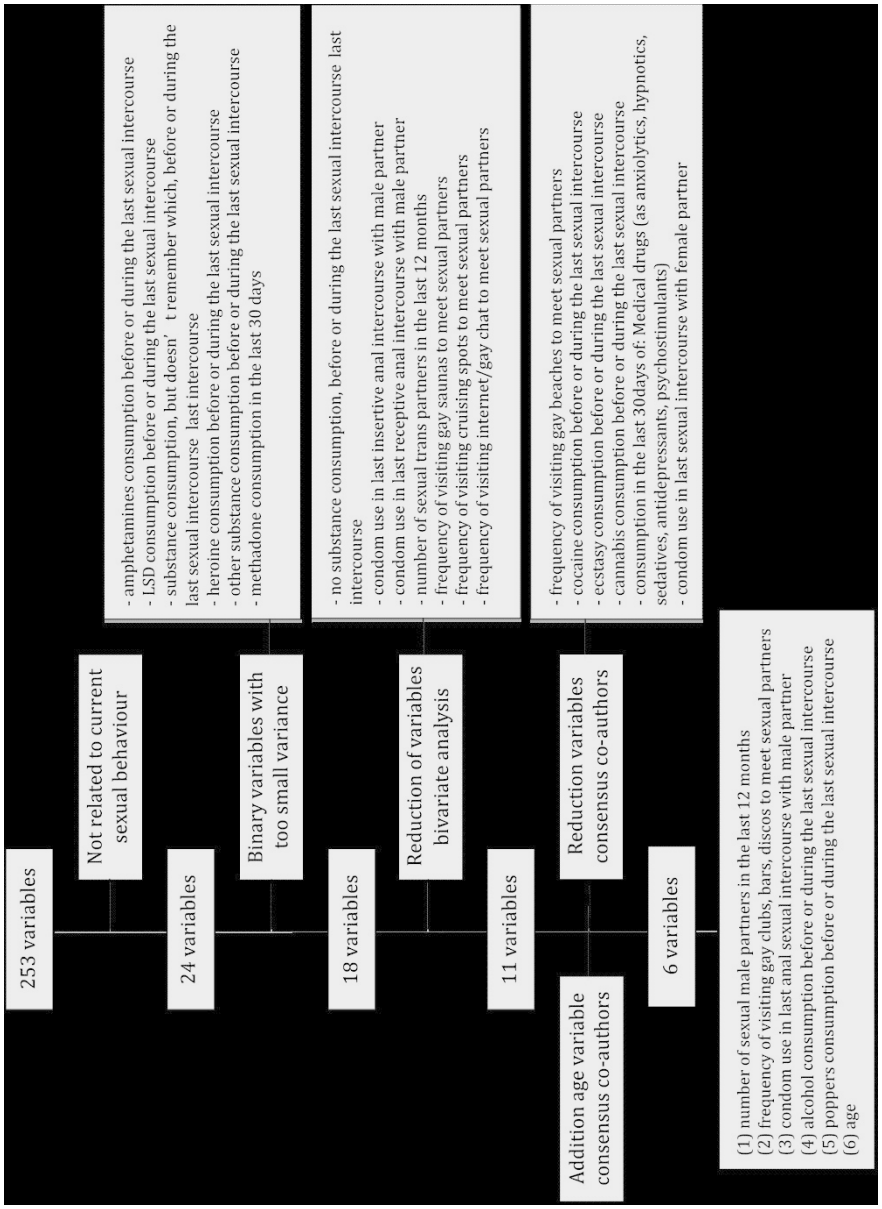

Figure 1: Flow-chart of variable selection for the study

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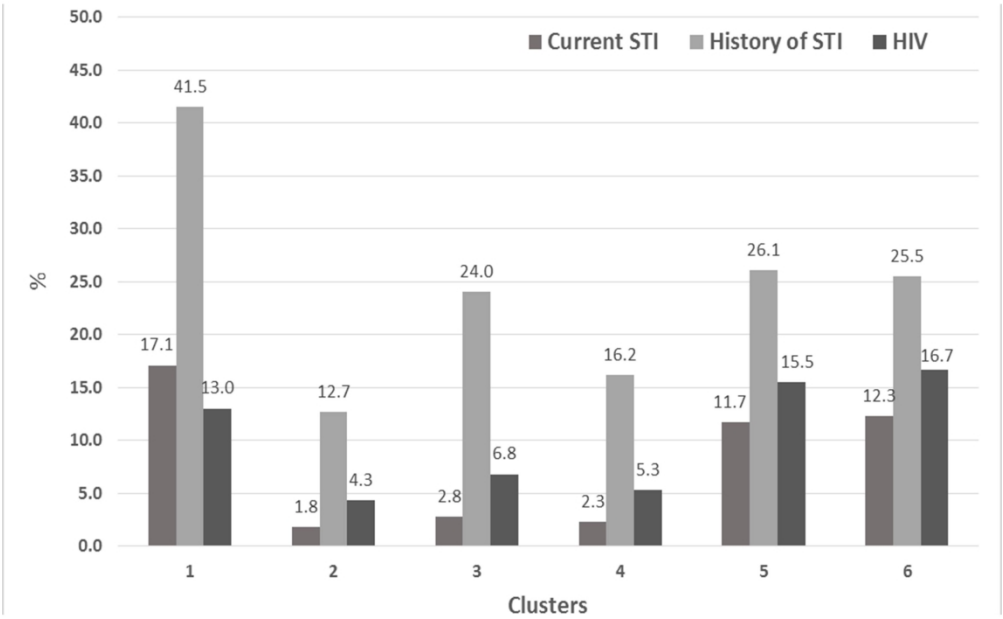

Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

254x190mm (307 x 307 DPI)

Supplementary material 1. SPSS Syntax file used for the cluster analysis

```
CLUSTER
Age_REC_5cat_2
SexMen_number_REC_4cat
MCLUB
REC_CondomLast_Male
SubsSex_Alc
SubsSex_Pop
/METHOD BAVERAGE
/MEASURE=SEUCLID
/PRINT SCHEDULE CLUSTER(4,9)
/PRINT DISTANCE
/PLOT VICICLE
/SAVE CLUSTER(4,9).
```

Tab. 1b Adjusted Odds Ratios from a multivariable logistic regression for self-reported current STI (diagnosed positive)

Current STI	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	0.39	0.192	0.10	1.60
31-40	0.89	0.866	0.24	3.37
41-50	**3.73**	0.052	0.99	14.05
>50	1.18	0.862	0.18	7.78
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.59	0.399	0.18	2.00
5-12	2.26	0.126	0.80	6.41
>12	1.79	0.297	0.60	5.38
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.13	0.150	0.66	14.79
Rarely	**4.38**	0.062	0.93	20.72
Doesn't visit	**6.06**	0.030	1.20	30.76
Condom use in last sex intercourse				
No	ref.			
Yes	1.72	0.260	0.67	4.44
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.45**	0.081	0.89	6.71
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.98	0.955	0.44	2.15

Tab. 2b Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported current STI (diagnosed positive) with age group as a random effect

Current STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.59	0.391	0.18	1.97
5-12	2.25	0.125	0.80	6.36
>12	1.85	0.269	0.62	5.52
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.05	0.158	0.65	14.29
Rarely	**4.25**	0.066	0.91	19.92
Doesn't visit	**6.05**	0.029	1.20	30.39
Condom use in last sex intercourse				
No	ref.			
Yes	1.70	0.270	0.66	4.37
Popper use before or during last sex intercourse				
No	ref.			
Yes	2.32	0.100	0.85	6.30
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.97	0.936	0.44	2.12
RANDOM EFFECT				
AGE GROUP (var)	**0.50**		0.10	2.43

Tab. 3b Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported current STI (diagnosed positive) with number of sexual male partners in the last 12 months as a random effect

Current STI	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	0.39	0.185	0.10	1.57
31-40	0.93	0.909	0.25	3.45
41-50	**3.83**	0.045	1.03	14.18
>50	1.18	0.864	0.18	7.63
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	3.00	0.165	0.64	14.16
Rarely	**3.84**	0.090	0.81	18.27
Doesn't visit	**4.78**	0.060	0.94	24.35
Condom use in last sex intercourse				
No	ref.			
Yes	1.90	0.177	0.75	4.83
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.62**	0.057	0.97	7.06
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.97	0.946	0.44	2.13
	RANDOM EFFECT			
Number of sexual male partners in the last 12 months (var)	**0.10**		0.00	2.90

Tab. 1a Adjusted Odds Ratios from a multivariable logistic regression for self-reported previous STI (diagnosed positive)

Previous STI	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	1.55	0.313	0.66	3.61
31-40	**2.59**	0.029	1.10	6.07
41-50	**2.96**	0.023	1.16	7.54
>50	**4.74**	0.006	1.56	14.48
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.72	0.289	0.40	1.32
5-12	**1.66**	0.091	0.92	3.00
>12	**2.60**	0.002	1.42	4.73
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.09	0.776	0.60	1.98
Rarely	1.52	0.173	0.83	2.79
Doesn't visit	0.98	0.955	0.48	2.01
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.48**	0.001	0.31	0.75
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.34	0.346	0.73	2.45
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.29	0.237	0.85	1.95

Tab. 2a Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with age group as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.73	0.302	0.40	1.33
5-12	**1.67**	0.086	0.93	3.01
>12	**2.68**	0.001	1.47	4.89
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.10	0.750	0.61	2.00
Rarely	1.55	0.156	0.85	2.83
Doesn't visit	1.02	0.953	0.50	2.09
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.47**	0.001	0.30	0.74
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.34	0.343	0.73	2.44
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.29	0.224	0.85	1.96
RANDOM EFFECT				
AGE GROUP (var)	**0.11**		0.01	1.18

Tab. 3a Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with number of sexual male partners in the last 12 months as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.56	0.303	0.67	3.64
31-40	**2.65**	0.024	1.13	6.22
41-50	**3.04**	0.020	1.20	7.75
>50	**4.76**	0.006	1.57	14.45
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	1.08	0.806	0.59	1.96
Rarely	1.47	0.216	0.80	2.68
Doesn't visit	0.91	0.794	0.44	1.86
Condom use in last sexual intercourse				
No	ref.			
Yes	**0.50**	0.002	0.32	0.78
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.40	0.270	0.77	2.57
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.30	0.219	0.86	1.97
	RANDOM EFFECT			
Number of sexual male partners in the last 12 months (var)	**0.19**		0.03	1.04

Tab. 4a Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported previous STI (diagnosed positive) with condom use in last sexual intercourse as a random effect

Previous STI	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Age group				
18-20	ref.			
21-30	1.54	0.317	0.66	3.60
31-40	**2.59**	0.029	1.11	6.06
41-50	**2.96**	0.023	1.16	7.54
>50	**4.78**	0.006	1.57	14.52
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	0.69	0.233	0.38	1.27
5-12	1.56	0.139	0.86	2.83
>12	**2.43**	0.004	1.32	4.44
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	1.10	0.757	0.61	2.00
Sometimes	1.54	0.165	0.84	2.81
Rarely	0.99	0.970	0.48	2.02
Doesn't visit				
Popper use before or during last sexual intercourse				
No	ref.			
Yes	1.35	0.331	0.74	2.46
Alcohol use before or during last sexual intercourse				
No	ref.			
Yes	1.28	0.250	0.84	1.94
RANDOM EFFECT				
Condom use in last sexual intercourse (var)	**0.10**		0.01	1.21

Tab. 1c Adjusted Odds Ratios from a multivariable logistic regression for self-reported HIV positive serostatus

HIV positive serostatus	Odds Ratio	p-value	95% CI	
Age group				
18-20	ref.			
21-30	1.73	0.470	0.39	7.71
31-40	**3.79**	0.076	0.87	16.56
41-50	**6.58**	0.015	1.44	30.01
>50	**9.45**	0.007	1.86	47.89
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	1.85	0.154	0.79	4.30
5-12	1.40	0.483	0.55	3.58
>12	**3.58**	0.004	1.50	8.54
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.41**	0.039	0.18	0.95
Rarely	1.15	0.720	0.54	2.42
Doesn't visit	1.02	0.963	0.43	2.42
Condom use in last sex intercourse				
No	ref.			
Yes	1.35	0.383	0.69	2.63
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.07**	0.059	0.97	4.41
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.186	0.35	1.23

Tab. 2c Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with age group as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
FIXED EFFECT				
Number of sexual male partners in the last 12 months				
1	ref.			
2-4	1.85	0.153	0.80	4.30
5-12	1.42	0.468	0.55	3.62
>12	**3.69**	0.003	1.54	8.81
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.42**	0.045	0.18	0.98
Rarely	1.18	0.661	0.56	2.50
Doesn't visit	1.09	0.842	0.46	2.58
Condom use in last sex intercourse				
No	ref.			
Yes	1.33	0.399	0.68	2.60
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.02**	0.067	0.95	4.29
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.189	0.35	1.23
RANDOM EFFECT				
AGE GROUP (var)	**0.40**		0.07	2.42

Tab. 3c Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with number of sexual male partners in the last 12 months as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.80	0.439	0.41	8.01
31-40	**4.03**	0.064	0.92	17.60
41-50	**6.93**	0.012	1.52	31.56
>50	**9.80**	0.006	1.94	49.60
Frequency of visiting gay clubs, bars, discos to meet sexual partners				
Many times	ref.			
Sometimes	**0.41**	0.038	0.18	0.95
Rarely	1.10	0.796	0.52	2.33
Doesn't visit	0.91	0.824	0.38	2.14
Condom use in last sex intercourse				
No	ref.			
Yes	1.45	0.276	0.74	2.81
Popper use before or during last sex intercourse				
No	ref.			
Yes	**2.24**	0.036	1.05	4.78
Alcohol use before or during last sex intercourse				
No	ref.			
Yes	0.66	0.197	0.36	1.24
	RANDOM EFFECT			
Number of sexual male partners in the last 12 months (var)	**0.14**		0.02	1.21

Tab. 4c Adjusted Odds Ratios from a multivariable MIXED EFFECT logistic regression for self-reported HIV positive serostatus with frequency of visiting gay clubs, bars, discos to meet sexual partners as a random effect

HIV positive serostatus	Odds Ratio	p-value	95% CI	
	FIXED EFFECT			
Age group				
18-20	ref.			
21-30	1.71	0.482	0.38	7.59
31-40	**3.72**	0.080	0.85	16.22
41-50	**6.55**	0.015	1.44	29.86
>50	**9.43**	0.007	1.87	47.53
Number of Partner				
1	ref.			
2-4	1.82	0.165	0.78	4.22
5-12	1.34	0.539	0.53	3.39
>12	**3.32**	0.006	1.41	7.83
Condom use last sex intercourse				
No	ref.	0.757	0.61	2.00
Yes	1.32	0.411	0.68	2.57
Popper use last sex intercourse				
No	ref.			
Yes	**2.05**	0.061	0.97	4.35
Alcohol use last sex intercourse				
No	ref.			
Yes	0.63	0.149	0.34	1.18
	RANDOM EFFECT			
Frequency of visiting gay clubs, bars, discos to meet sexual partners (var)	**0.09**		0.01	1.02

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7
Bias	9	Describe any efforts to address potential sources of bias	7
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	Figure 1 (pag 7)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8-9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear	8-10

		which confounders were adjusted for and why they were included	
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.