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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-033290
Article Type:	Original research
Date Submitted by the Author:	29-Jul-2019
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Keywords:	sexual health, STI, HIV & AIDS < INFECTIOUS DISEASES, SYNDROMIC, MSM

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3 **Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who**  
4 **Have Sex with Men in Portugal**  
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7 **Word count:** 2997  
8  
9

10  
11 **Keywords:** Men who have sex with men, sexually transmitted infections, HIV, sexual  
12 behaviour, cluster analysis, syndemic.  
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18 **Key Messages**  
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20 Six clusters with diverse patterns of sexual behaviours, related to different STI and HIV  
21 vulnerability were found among an MSM population in Portugal  
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26 Factors other than sexual behaviour appear to reinforce the vulnerability to STIs suggesting a  
27 syndemic of STIs, HIV and other adverse conditions  
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32 Future interventions to decrease STI and HIV epidemic in MSM should include syndemic  
33 orientations and be informed by analyses including psychosocial and sexual health indicators  
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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 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

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3 reported and 24% of gonorrhoea diagnoses in Europe.[7] For Portugal this information is  
4 incomplete[8, 9] and in the Portuguese Global AIDS Response Progress Reports there is no  
5 reporting of STI-data among MSM.[10] Underreporting is suggested to be high in Portugal,  
6 and related to the non-detection of syphilis and rectal gonorrhoea due to low rates of STI-  
7 testing and anal exams or swabbing.[11] Currently, in Portugal there are neither separate  
8 HIV/STI-policies for MSM nor specific national STI-testing policies or guidelines.  
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16 Recently, there have been numerous efforts to promote prevention/diagnosis/linkage of  
17 interventions for MSM, mainly organized by the community. CheckpointLX in Lisbon, the first  
18 community-based testing centre for MSM founded in April 2011, encourages combined HIV-  
19 STI testing for MSM.  
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24 The most recent national programme for the prevention and control of HIV/AIDS[12, 13]  
25 included MSM as a target group. Having as first objective to structure the epidemiological  
26 surveillance system for HIV, it encompasses information on other STIs and includes the  
27 screening of STIs as a secondary prevention method for HIV infection.[14, 15]  
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32 STIs and HIV have been researched in conjunction with mental health conditions, substance  
33 use, violence and sexual abuse in the framework of the syndemic theory.[16] These factors  
34 may reinforce one another and increase the health burden in at risk populations, such as  
35 MSM.<sup>20,21</sup> The concept of “afflictions” defining a syndemic[16-18] can be extended from just  
36 diseases to risk factors, and other health related conditions.  
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44 One way of exploring this syndemic is to identify subgroups of subjects that share a particular  
45 pattern with respect to relevant sexual behavioural variables that potentially interact in the  
46 syndemic, to this purpose the technique of cluster analysis was used in this study.  
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50 The term cluster in this context is not considered in the epidemiological sense of the term, ie  
51 a group that is connected in time and/or place but it was used to identify patterns of current  
52 sexual behaviour in Portuguese MSM, and to explore the associations with the self-reported  
53 current and past STIs and HIV sero-status.  
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58 A better understanding of these relationships can inform the design of combined interventions  
59 in MSM to both decrease STI and HIV burden, and improve sexual health.[19]  
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## 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.

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

### 11 12 13 14 **Patient and public involvement**

15 A community-based participatory research approach was used, in which a Community  
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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.

### 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 **Statistical Analysis**

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

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

43 Multiple iterations of a hierarchical cluster analysis were used to identify the optimum number  
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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).

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3 In consultation with key persons from the MSM community in Lisbon, the clusters were not  
4 labelled because of possible misperception and stigmatisation and will be referred to with a  
5 number.  
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9 The frequency of the variables self-reported current STI status ('Negative', 'Positive', 'Don't  
10 know'), past STI status ('Negative', 'Positive', 'Don't know') and HIV sero-status ('Negative',  
11 'Positive', 'Don't know') in each of the clusters was examined.  
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15 The final list of variables included: (1) number of sexual male partners in the last 12 months  
16 (year) expressed as '1', '2-4', '5-12' and '>12'; (2) frequency of visiting gay clubs, bars, discos  
17 (venues) to meet male sexual partners ('Many times', 'Sometimes', 'Rarely' and 'Doesn't visit'),  
18 (3) condom use during the last anal sexual intercourse (AI) with male partner ('yes' and 'no');  
19 (4) alcohol and (5) poppers consumption before or during the last sexual intercourse ('yes'  
20 and 'no'), and (6) age ('18-20', '21-30', '31-40', '41-50' and '>50').  
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24 The variables identified were included as covariates in multivariable logistic regression models  
25 using the variable self-reported current STI status ('Negative' vs. 'Positive'), past STI status  
26 ('Negative' vs. 'Positive') and HIV sero-status ('Negative' vs. 'Positive') as outcomes. In  
27 addition, in regression analysis, the multilevel structure induces correlation among  
28 observations within a cluster and to test the validity of the 6 variables identified, each of them  
29 was used independently as a random effect in mixed-effect logistic regression models.  
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33 The final list of variables identified was considered as potential factors of a pattern of sexual  
34 behaviour in MSM populations.  
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## 48 **RESULTS**

49 A total of 1046 MSM participated in this study. The refusal rate was 23.2% (1362 were  
50 approached). No differences were found between refusals and participants regarding age and  
51 education. Overall, 5.5% self-reported a current STI, 20.5% a previous STI and 9.1% HIV  
52 positive sero-status. The median and mean numbers of male sexual partners in the past year  
53 were 4 and 14.8, respectively. Condom use was reported by 76.2% of participants during their  
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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						Overall
	1	2	3	4	5	6	
<b>Frequency</b>	46	187	206	303	106	66	<b>1046</b>
<b>% of total included in cluster analysis</b>	5.0%	20.2%	22.2%	32.7%	11.4%	7.1%	
<b>Age - range</b>	40-73	18-47	18-49	18-48	18-50	41-78	<b>18-78</b>
<b>Age - mean</b>	47.3	27.8	29.6	27.6	32.8	51.2	<b>30</b>
<b>Age - median</b>	45	27	30	27	32.5	49	<b>31.9</b>
<b>Male sexual partners in the last year</b>	58%	81%	62%	85%	59%	79%	
<b>(% of &gt;12 parnters or % &lt;5 partners)</b>	>12	<5	>12	<5	>12	<5	
<b>Male sexual partners in the last year (median)</b>	20	3	17.5	2	18.5	2	<b>4</b>
<b>Sometimes or often visits gay clubs/bars/discos for finding sexual partners (%)</b>	71.7%	90.4%	94.6%	4.0%	2.8%	1.5%	<b>44.5</b>
<b>Condom use at last AI (%)</b>	82.6%	69.0%	93.7%	66.30%	84.0%	62.1%	<b>76.2</b>

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

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%).

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3 From the 120 participants excluded from the cluster analysis, 1 failed to give his age, 63 did  
4 not answer how many partners they had in the last year, 26 failed to mark the frequency of  
5 their visits to gay venues and 62 did not answer whether they used a condom at last AI.  
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7 Compared to the whole study population, the group of excluded participants was older, had  
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9 less partners, frequented gay venues less frequently, more condom and less alcohol and  
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11 poppers use.  
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16 Figure 2 shows the frequency of reported current STIs, past STIs and HIV sero-status within  
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18 the six clusters. Cluster 1 had the highest rate of self-reported current STIs (17.1%), followed  
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20 by cluster 6 (12.3%) and cluster 5 (11.7%). The other clusters had lower STI rates, ranging  
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22 from 1.8% to 2.8%. The proportion of participants that did not know their current STI-status  
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24 varied from 4.9% in cluster 1 to 17.0% in cluster 5.  
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27 Among the excluded participants that answered the question on reported current STI, the  
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29 prevalence was 10.7% which is more than double the prevalence of the participants included  
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31 in the analysis.  
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34 Cluster 1 reported the highest proportion of self-reported STI history (41.5%) followed by  
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36 cluster 5 (26.1%), cluster 6 (25.5%) and cluster 3 (24.0%).  
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39 The highest prevalence of self-reported HIV was also found within the three clusters (from  
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41 13.0% to 16.7%) with the highest self-reported current and past STIs. Among the excluded  
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43 participants, almost one in five reported being HIV-positive, a higher rate than any of the  
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45 clusters.  
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48 From the regression analyses (Supplementary file), the mixed-effect models performed  
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50 generally better than the multivariable logistic regression. The results presented here are from  
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52 the mixed-effect models after adjusting for the other confounders (in the fixed part of the  
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54 model). For the model on self-reported current STIs, age group and number of male sexual  
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56 partners in the last year were statistically significant random effects. For the model on the self-  
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58 reported previous STI, age group, number of male sexual partners in the last year and condom  
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60 use during the last AI were statistically significant random effects. For the model on the self-

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3 reported positive HIV sero-status, age group, number of male sexual partners in the last year  
4 and frequent visits to gay venues were significant random effects.  
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7 The mixed-effect models, confirmed the role of age, number of sexual partners, condom use  
8 and frequent visits to gay venues as factors that could be used to detect possible clusters in  
9 this MSM population, related to current or past STI diagnosis or HIV sero-status.  
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## 15 **DISCUSSION**

16  
17 The cluster analysis identified six clusters with diverse patterns of sexual behaviours, related  
18 to different STI and HIV vulnerability. In the discussion we further explore the higher STI/HIV  
19 prevalence clusters, using descriptive data (available on request) from variables not included  
20 in the cluster analysis.  
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### 26 **High Risk Pattern - High STI/HIV-vulnerability**

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

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47 Cluster 6 was the oldest cluster, and although except for UAI, it scored low on the other sexual  
48 risk variables but it had the second highest STI-prevalence and the highest HIV prevalence.  
49 Of all the clusters, this group reported the most frequently sex with a transgender partner, with  
50 a woman and with a sex worker. Lastly, compared to the whole sample, the MSM in this cluster  
51 were the least likely to have been reached by an HIV campaign.  
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57 This suggests that cluster 6 contained a group of older MSM that might not identify as gay and  
58 might face a lot of barriers to access reliable information about the risks of their sexual  
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3 behaviours. A previous study from Portugal showed that in this sample of MSM, low self-risk  
4 perception was the major motive of never having been tested for HIV.[22]  
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### 8 9 **Similar Patterns - Different STI/HIV-vulnerability**

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11 Both clusters 5 and 3 represented a sexually active pattern in MSM of the same age range. A  
12 quarter of MSM in both clusters reported past STI diagnoses but MSM in cluster 5 had a higher  
13 proportion of current STI diagnoses, suggesting higher recurrence of STIs, and much higher  
14 self-reported HIV prevalence. However, about the same proportion in each cluster reported  
15 unprotected AI in the last year with a partner whose HIV sero-status was unknown. Contrary  
16 to cluster 3, MSM in cluster 5 almost never visited gay venues and did not drink alcohol at last  
17 AI. It has been demonstrated that the frequency of unprotected intercourse does not solely  
18 explain risk exposure, but having unprotected intercourse within certain high-risk sexual  
19 networks does expose MSM to a heightened risk.[23] This suggests that sexual networks  
20 outside the Portuguese public gay scene are more risky in terms of HIV/STI acquisition.  
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35 The majority of MSM in these clusters was currently not affected by HIV or other STIs and  
36 although they would be categorised as high risk to be infected with STIs and HIV, there are  
37 protective factors, among others shamelessness, social support and self-monitoring, that  
38 might play an important role in HIV/STI prevention interventions but have not been researched  
39 enough.  
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### 48 **Strengths and Limitations**

49 Data on HIV and STI prevalence were self-reported and interviews were not self-administered  
50 but done by community based researchers who were trained to apply the questionnaire. This  
51 might have provoked memory and social desirability bias. There might be a bias as to why  
52 certain questions were not answered, as is suggested by the high self-reported HIV  
53 prevalence in the 'missing' cluster. Due to the intimate and sensitive nature of the study  
54 questionnaire and the stigma associated with risky sexual behaviour and HIV/STI positive  
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3 sero-status, under-reporting in this study was to be expected.  
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5 Careful attention was paid to the process of selection of relevant variables as potential  
6 members of the syndemic of risky sexual behaviours. Although it is difficult to prove that the  
7 group of afflictions identified as one of the common patterns in this MSM population is a  
8 syndemic, its potential is significant.  
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11 The strength of a cluster analysis is that it can intercept groups of homogeneous units in the  
12 population, in terms of a group of relevant variables. However, the results and interpretation  
13 of any cluster analysis depend on several researcher's choices and assumptions, such as that  
14 actual groups exist, the choice of the variables on which the elements in the groups should be  
15 similar, the distance measure, the clustering procedure and the number of clusters.[24, 25]  
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18 The presented clusters describe the study sample population, obtained via venue based  
19 recruitment, and therefore cannot be extrapolated to the whole MSM population.  
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## 24 25 26 27 28 29 30 31 **Conclusions**

32 The main findings are in line with other studies that demonstrated the association between  
33 HIV-infection with higher incidence and prevalence rates for STIs, contributing to the ongoing  
34 transmission among MSM and supporting linked epidemics of STIs and HIV in Portuguese  
35 MSM.[26-28] Interventions for MSM should combine HIV- and comprehensive STI- testing,  
36 including rectal and pharyngeal swabbing.[29]  
37

38  
39 The results suggest some factors not directly linked to sexual behaviour reinforce the  
40 epidemics. Besides a critical need for improved STI symptom recognition, screening and  
41 treatment, future interventions should have a syndemic orientation, unfolding the entire set of  
42 factors that create excess burden of disease, being informed by analyses including  
43 psychosocial variables and sexual health indicators.[30] Capturing concepts of autonomy,  
44 well-being, sexual satisfaction, intimacy and social values in relation to sexuality, health  
45 scientists and other health professionals might start identifying a different set of risk and  
46 protective factors.  
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## 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

## Funding

This study was co-financed by the ADIS/SIDA Program from the National Programme for the Prevention and Control of HIV/AIDS Infection. AG has a PhD grant from Fundação para a Ciência e a Tecnologia (SFRH/BD/84259/2012).

This work was also funded by the UNDP-UNFPA-UNICEF-WHO-World Bank Special Programme of Research, Development and Research Training in Human Reproduction (HRP), a cosponsored programme executed by the World Health Organization (WHO).

## 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

### **Acknowledgements**

The project team is thankful to GHTM – UID/Multi/04413/2013.

The authors would like to thank the project team, namely, Daniel Simões, Gabriela Cohen, Inês Rego, Ricardo Fernandes, Ricardo Rosa and Sara Trindade. The authors are also very grateful to all the community partners of the project. The authors thank all the participants of this study.

### **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.

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3 **Figure 1: Flow-chart of variable selection for the study**  
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5 **Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and**  
6 **HIV positive sero-status in the six clusters**  
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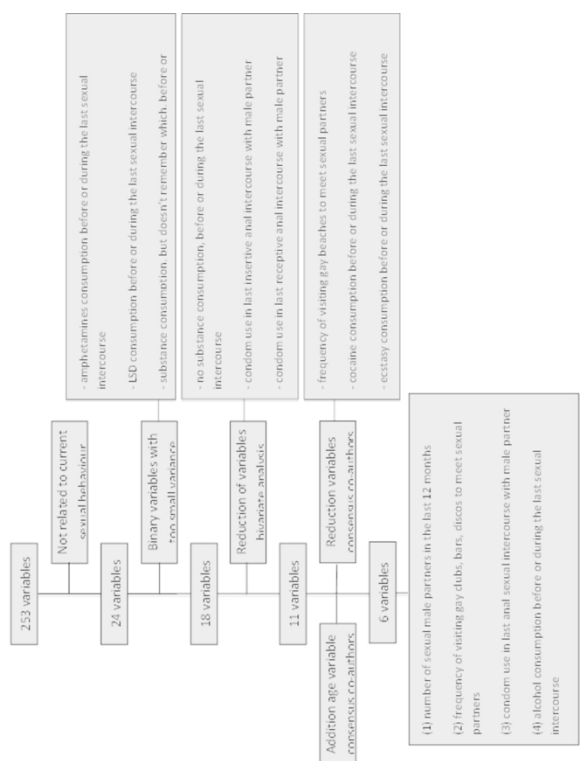


Figure 1: Flow-chart of variable selection for the study

253x190mm (300 x 300 DPI)

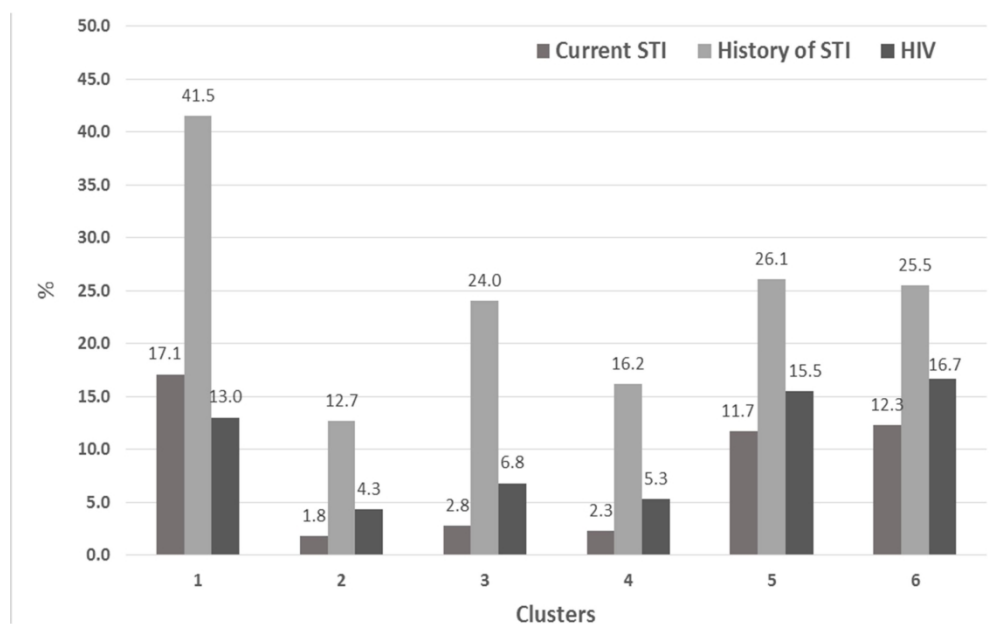


Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

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**SUPPLEMENTARY FILE 1****SPSS SYNTAX FILE USED FOR THE CLUSTER ANALYSIS  
CLUSTER**

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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).
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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	
<b>Age group</b>				
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	<b>3.73</b>	0.052	0.99	14.05
>50	1.18	0.862	0.18	7.78
<b>Number of sexual male partners in the last 12 months</b>				
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
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.13	0.150	0.66	14.79
Rarely	<b>4.38</b>	0.062	0.93	20.72
Doesn't visit	<b>6.06</b>	0.030	1.20	30.76
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.72	0.260	0.67	4.44
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.45</b>	0.081	0.89	6.71
<b>Alcohol use before or during last sex intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
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
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.05	0.158	0.65	14.29
Rarely	<b>4.25</b>	0.066	0.91	19.92
Doesn't visit	<b>6.05</b>	0.029	1.20	30.39
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.70	0.270	0.66	4.37
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	2.32	0.100	0.85	6.30
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.97	0.936	0.44	2.12
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.50</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
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	<b>3.83</b>	0.045	1.03	14.18
>50	1.18	0.864	0.18	7.63
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.00	0.165	0.64	14.16
Rarely	<b>3.84</b>	0.090	0.81	18.27
Doesn't visit	<b>4.78</b>	0.060	0.94	24.35
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.90	0.177	0.75	4.83
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.62</b>	0.057	0.97	7.06
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.97	0.946	0.44	2.13
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.10</b>		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	
<b>Age group</b>				
18-20	ref.			
21-30	1.73	0.470	0.39	7.71
31-40	<b>3.79</b>	0.076	0.87	16.56
41-50	<b>6.58</b>	0.015	1.44	30.01
>50	<b>9.45</b>	0.007	1.86	47.89
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	1.85	0.154	0.79	4.30
5-12	1.40	0.483	0.55	3.58
>12	<b>3.58</b>	0.004	1.50	8.54
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.41</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.35	0.383	0.69	2.63
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.07</b>	0.059	0.97	4.41
<b>Alcohol use before or during last sex intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	1.85	0.153	0.80	4.30
5-12	1.42	0.468	0.55	3.62
>12	<b>3.69</b>	0.003	1.54	8.81
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.42</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.33	0.399	0.68	2.60
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.02</b>	0.067	0.95	4.29
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.66	0.189	0.35	1.23
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.40</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.80	0.439	0.41	8.01
31-40	<b>4.03</b>	0.064	0.92	17.60
41-50	<b>6.93</b>	0.012	1.52	31.56
>50	<b>9.80</b>	0.006	1.94	49.60
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.41</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.45	0.276	0.74	2.81
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.24</b>	0.036	1.05	4.78
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.66	0.197	0.36	1.24
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.14</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.71	0.482	0.38	7.59
31-40	<b>3.72</b>	0.080	0.85	16.22
41-50	<b>6.55</b>	0.015	1.44	29.86
>50	<b>9.43</b>	0.007	1.87	47.53
<b>Number of Partner</b>				
1	ref.			
2-4	1.82	0.165	0.78	4.22
5-12	1.34	0.539	0.53	3.39
>12	<b>3.32</b>	0.006	1.41	7.83
<b>Condom use last sex intercourse</b>				
No	ref.	0.757	0.61	2.00
Yes	1.32	0.411	0.68	2.57
<b>Popper use last sex intercourse</b>				
No	ref.			
Yes	<b>2.05</b>	0.061	0.97	4.35
<b>Alcohol use last sex intercourse</b>				
No	ref.			
Yes	0.63	0.149	0.34	1.18
<b>RANDOM EFFECT</b>				
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners (var)</b>	<b>0.09</b>		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	
<b>Age group</b>				
18-20	ref.			
21-30	1.55	0.313	0.66	3.61
31-40	<b>2.59</b>	0.029	1.10	6.07
41-50	<b>2.96</b>	0.023	1.16	7.54
>50	<b>4.74</b>	0.006	1.56	14.48
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.72	0.289	0.40	1.32
5-12	<b>1.66</b>	0.091	0.92	3.00
>12	<b>2.60</b>	0.002	1.42	4.73
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.48</b>	0.001	0.31	0.75
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.34	0.346	0.73	2.45
<b>Alcohol use before or during last sexual intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.73	0.302	0.40	1.33
5-12	<b>1.67</b>	0.086	0.93	3.01
>12	<b>2.68</b>	0.001	1.47	4.89
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.47</b>	0.001	0.30	0.74
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.34	0.343	0.73	2.44
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.29	0.224	0.85	1.96
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.11</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.56	0.303	0.67	3.64
31-40	<b>2.65</b>	0.024	1.13	6.22
41-50	<b>3.04</b>	0.020	1.20	7.75
>50	<b>4.76</b>	0.006	1.57	14.45
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.50</b>	0.002	0.32	0.78
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.40	0.270	0.77	2.57
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.30	0.219	0.86	1.97
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.19</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.54	0.317	0.66	3.60
31-40	<b>2.59</b>	0.029	1.11	6.06
41-50	<b>2.96</b>	0.023	1.16	7.54
>50	<b>4.78</b>	0.006	1.57	14.52
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.69	0.233	0.38	1.27
5-12	1.56	0.139	0.86	2.83
>12	<b>2.43</b>	0.004	1.32	4.44
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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				
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.35	0.331	0.74	2.46
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.28	0.250	0.84	1.94
<b>RANDOM EFFECT</b>				
<b>Condom use in last sexual intercourse (var)</b>	<b>0.10</b>		0.01	1.21

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60STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	<b>Item No</b>	<b>Recommendation</b>	<b>Reported on page #</b>
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			
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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-033290.R1
Article Type:	Original research
Date Submitted by the Author:	29-Sep-2020
Complete List of Authors:	Blondeel, Karel; WHO, Department of Reproductive Health and Research; Ghent University, Faculty of Medicine and Health Sciences Dias, Sonia; Universidade Nova de Lisboa, Global Health and Tropical Medicine; Universidade Nova de Lisboa, National School of Public Health Furegato, Martina; University of London St George's Molecular and Clinical Sciences Research Institute, Applied Diagnostic Research and Evaluation Unit (ADREU); Public Health England, Blood Safety, Hepatitis, Sexually Transmitted Infections (STI) and HIV Service, National Infection Service Seuc, Armando; Instituto Nacional de Higiene Epidemiología y Microbiología Gama, Ana; Universidade Nova de Lisboa, Global Health and Tropical Medicine, Instituto de Higiene e Medicina Tropical Fuentes, Ricardo; Grupo de Ativistas em Tratamentos Mendão, Luís; Grupo de Ativistas em Tratamentos Temmerman, Marleen; Ghent University, International Centre for Reproductive Health Toskin, Igor; WHO, Department of Reproductive Health and Research; I M Sechenov First Moscow State Medical University
<b>Primary Subject Heading</b>:	Sexual health
Secondary Subject Heading:	Epidemiology, Infectious diseases, HIV/AIDS, Public health
Keywords:	sexual health, STI, HIV & AIDS < INFECTIOUS DISEASES, SYNDROMIC, MSM

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3 1 **Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who**  
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5 2 **Have Sex with Men in Portugal**

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9 32 **Word count:** 2997

10 33

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12  
13 34 **Keywords:** Men who have sex with men, sexually transmitted infections, HIV, sexual  
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15 behaviour, cluster analysis, syndemic.

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20 37 **ABSTRACT**

21 38 **Objectives**

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23  
24 39 Portugal has the highest HIV incidence rate in Western Europe. The proportion assigned to  
25  
26 40 sexual contact between men recently increased to more than 30% of all HIV-infections. Men  
27  
28 41 who have Sex with Men (MSM) are vulnerable to the acquisition of other Sexually Transmitted  
29  
30 42 Infections (STIs), increasing the per-contact risk of HIV-infection. Building on syndemic theory,  
31  
32 43 the aim of this analysis was to identify patterns of current sexual behaviour in MSM, and  
33  
34 44 explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-  
35  
36 45 status.

37 46  
38  
39 46 **Design**

40  
41 47 A cross-sectional behavioural survey was conducted in Portugal among MSM, using a  
42  
43 48 community-based participatory research approach. Hierarchical cluster analysis was used to  
44  
45 49 identify patterns including behavioural and demographic factors.

46 50  
47 50 **Results**

48  
49 51 The analysis resulted in 6 clusters. Three clusters showed higher rates of current STI  
50  
51 52 diagnosis (ranging from 11.7% to 17.1%), past STI diagnosis (ranging from 25.5% to 41.5%)  
52  
53 53 and HIV positive sero-status (ranging from 13.0% to 16.7%). From the three clusters scoring  
54  
55 54 lower on current and past STI and HIV diagnoses, one was characterized by a high number  
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57 55 of sexual partners (62% had more than 12 partners in the last year), a high proportion (94.6%)  
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3 56 of frequent visits to gay venues to meet sexual partners and high alcohol use (46.1%). The  
4  
5 57 other two clusters scored lower on high risk sexual behaviour.  
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## 7 58 **Conclusion**

9 59 Factors other than sexual behaviour appear to reinforce the vulnerability to STIs and HIV of  
10  
11 60 some MSM in this study, suggesting a syndemic of STIs, HIV and other adverse conditions.  
12  
13 61 More research is needed to better understand the drivers of the STI/HIV epidemic in  
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15 62 Portuguese MSM, using a concept that goes beyond risk behaviour, to develop effective  
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17 63 combination prevention interventions.  
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## 22 66 **Strengths and limitations of this study**

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25 67 • Hierarchical cluster analysis was used to identify behavioural patterns among MSM  
26  
27 68 participating in a behavioural survey in Portugal
- 28  
29 69 • The main findings from the cluster analysis are in line with the literature supporting  
30  
31 70 linked epidemics of STIs and HIV in Portuguese MSM
- 32  
33 71 • Using a syndemic approach it was possible to identify that factors not directly linked to  
34  
35 72 sexual behaviour are linked to these epidemics
- 36  
37 73 • The outcomes of this analysis relate to the study sample population and cannot be  
38  
39 74 generalised to the wider MSM population
- 40  
41 75 • We acknowledged that the reliance on self-reported STI and HIV outcomes is a  
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43 76 weakness that may have caused social desirability bias  
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## 50 78 **INTRODUCTION**

51  
52 79 Portugal had the highest rate of new HIV diagnoses in Western Europe in 2013.[1] Initially the  
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54 80 Portuguese HIV-epidemic was predominantly prevalent in people who inject drugs (PWID),  
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56 81 but since 2003 most of the reported infections are associated with sexual transmission.[2] In  
57  
58 82 2013, of all new HIV-infections occurring in Portugal, 30.3% were assigned to sexual contact  
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3 83 between men.[3] The estimated percentage of Portuguese men who have sex with men  
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5 84 (MSM) living with HIV was 10% in 2011, manifold the 0.6% estimate for Portuguese adults  
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7 85 aged 15 to 49.[4] The median age at HIV diagnosis due to transmission among homosexual  
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9 86 men has declined from 35 in 2007 to 32 in 2012, unlike the increasing trend due to  
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11 87 transmission among heterosexual persons.[5]  
12  
13 88 MSM are also vulnerable to the acquisition of other sexually transmitted infections (STIs),  
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15 89 some of which increase the per-contact risk of HIV-infection. The European MSM Internet  
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17 90 Survey (EMIS) showed that 14.5% of MSM across Europe self-reported a history of  
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19 91 gonorrhoea diagnoses, 13.4% of anal/genital warts, 8.6% of syphilis, 8.1% of chlamydial  
20  
21 92 infection and 3.6% of anal/genital herpes.[6] MSM account for almost 50% of all syphilis cases  
22  
23 93 reported and 24% of gonorrhoea diagnoses in Europe.[7] For Portugal this information is  
24  
25 94 incomplete[8, 9] and in the Portuguese Global AIDS Response Progress Reports there is no  
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27 95 reporting of STI-data among MSM.[10] Underreporting is suggested to be high in Portugal,  
28  
29 96 and related to the non-detection of syphilis and rectal gonorrhoea due to low rates of STI-  
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31 97 testing and anal exams or swabbing.[11] Currently, in Portugal there are neither separate  
32  
33 98 HIV/STI-policies for MSM nor specific national STI-testing policies or guidelines.  
34  
35 99 Recently, there have been numerous efforts to promote prevention/diagnosis/linkage of  
36  
37 100 interventions for MSM, mainly organized by the community. CheckpointLX in Lisbon, the first  
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39 101 community-based testing centre for MSM founded in April 2011, encourages combined HIV-  
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41 102 STI testing for MSM.  
42  
43 103 The most recent national programme for the prevention and control of HIV/AIDS[12, 13]  
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45 104 included MSM as a target group. Having as first objective to structure the epidemiological  
46  
47 105 surveillance system for HIV, it encompasses information on other STIs and includes the  
48  
49 106 screening of STIs as a secondary prevention method for HIV infection.[14, 15]  
50  
51 107 STIs and HIV have been researched in conjunction with mental health conditions, substance  
52  
53 108 use, violence and sexual abuse in the framework of the syndemic theory.[16] These factors  
54  
55 109 may reinforce one another and increase the health burden in at risk populations, such as  
56  
57 110 MSM.<sup>20,21</sup> The concept of “afflictions” defining a syndemic[16-18] can be extended from just

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3 111 diseases to risk factors, and other health related conditions.  
4

5 112 A syndemic of risky sexual behaviours is a group of co-existing factors that describe the sexual  
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7 113 behavioural patterns in a specific population.  
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9 114 One way of exploring this syndemic is to identify subgroups of subjects that share a particular  
10  
11 115 pattern with respect to relevant sexual behavioural variables that potentially interact in the  
12  
13 116 syndemic, to this purpose the technique of cluster analysis was used in this study.  
14

15 117 The term cluster in this context is not considered in the epidemiological sense of the term, ie  
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17 118 a group that is connected in time and/or place but it was used to identify patterns of current  
18  
19 119 sexual behaviour in Portuguese MSM, and to explore the associations with the self-reported  
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21 120 current and past STIs and HIV sero-status.  
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24 121 A better understanding of these relationships can inform the design of combined interventions  
25  
26 122 in MSM to both decrease STI and HIV burden, and improve sexual health.[19]  
27

28 123 The aim of this analysis was to identify patterns of current sexual behaviour in MSM, and  
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30 124 explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-  
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32 125 status.  
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## 36 127 **METHODS**

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38  
39 128 A cross-sectional behavioural survey was conducted in Portugal among MSM as part of the  
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41 129 Project PREVIH - HIV/AIDS infection in MSM and Sex Workers: Prevalence, Determinants,  
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43 130 Prevention interventions and Access to health (2009-2013). The study used a community-  
44  
45 131 based participatory research approach, engaging a Community Advisory Board (CAB)  
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47 132 comprising MSM, representatives of non-governmental and governmental organisations, and  
48  
49 133 academics. The CAB actively participated in the study design, implementation and  
50  
51 134 interpretation of the results.[19, 20]  
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53 135

## 54 136 **Sampling, Recruitment and Data Collection**

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56  
57 137 The study population was reached through a venue-based recruitment strategy. Geographic  
58  
59 138 and network mapping was conducted, based on formative research with the CAB, to identify

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3 139 data collection sites. Recruitment teams of outreach workers and MSM peers systematically  
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5 140 approached potential participants at the sites, inviting them for a face-to-face interview. The  
6  
7 141 inclusion criteria were: being at least 18 years and having had sex with a man in the last year.  
8  
9 142 Participants were recruited from gay bars/clubs, cafes, streets in predominantly gay  
10  
11 143 neighbourhoods, local community based organisations and community events. Additionally,  
12  
13 144 the recruited respondents were asked to advertise the study among their social networks and  
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15 145 peers.

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18 146 Anonymity and confidentiality were guaranteed, and informed consent was obtained from all  
19  
20 147 participants. The study was approved by the Ethics Committee for Health of the North  
21  
22 148 Regional Health Administration. The study procedures were revised and approved by the CAB  
23  
24 149 and the project's scientific commission.

25  
26 150 Data were collected from January to September 2011 using a structured questionnaire applied  
27  
28 151 by trained peers recruited from community organisation partners. The questionnaire included  
29  
30 152 closed-ended questions on socio-demographics, sexual behaviour, availability/accessibility of  
31  
32 153 STI/HIV services, history of HIV testing, reported HIV status and current/history of other STIs.  
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34 154 The questionnaire was developed in collaboration with the community partners and included  
35  
36 155 the indicators of the United Nations General Assembly Special Session on HIV/AIDS  
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38 156 (UNGASS).[21] A more detailed description of the sampling, recruitment and data collection  
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40 157 can be found elsewhere.[20]

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#### 44 45 159 **Patient and public involvement**

46  
47 160 A community-based participatory research approach was used, in which a Community  
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49 161 Advisory Board including representatives of non-governmental and governmental  
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51 162 organizations, academics, and MSM was formed and actively participated in all phases of the  
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53 163 project, as the study design, elaboration of the questionnaire, results interpretation, and  
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55 164 discussion. Community partners were also involved in the data collection process.

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#### 59 60 166 **Statistical Analysis**

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3 167 Data were analysed using hierarchical agglomerative cluster analysis, univariate and bivariate  
4  
5 168 statistics, univariable, multivariate and mixed effect logistic regression analyses and statistical  
6  
7 169 packages SPSS and STATA13 were used.  
8

9 170 Figure 1 shows the cascade of the variables included in each step of the cluster analysis from  
10  
11 171 the inclusion of all the variables and with the exclusion of some factors when the inclusion  
12  
13 172 criteria were not met.  
14

15 173 Multiple iterations of a hierarchical cluster analysis were used to identify the optimum number  
16  
17 174 of clusters. The clustering was done based on Euclidean distances. Squared Euclidean  
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19 175 distances were used to calculate the distance between any two individuals/subjects in the  
20  
21 176 sample; the squared Euclidean distance is defined as the sum of the squared differences  
22  
23 177 between the values for the (six) variables corresponding to these two individuals/subjects.  
24  
25 178 Distances between identified clusters are obtained with the “between-groups linkage” method,  
26  
27 179 i.e. the average of the distances between any two subjects in the corresponding clusters  
28  
29 180 (syntax available as a supplementary file).  
30  
31

32 181 In consultation with key persons from the MSM community in Lisbon, the clusters were not  
33  
34 182 labelled because of possible misperception and stigmatisation and will be referred to with a  
35  
36 183 number.  
37

38 184 The frequency of the variables self-reported current STI status ('Negative', 'Positive', 'Don't  
39  
40 185 know'), past STI status ('Negative', 'Positive', 'Don't know') and HIV sero-status ('Negative',  
41  
42 186 'Positive', 'Don't know') in each of the clusters was examined.  
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45 187 The final list of variables included: (1) number of sexual male partners in the last 12 months  
46  
47 188 (year) expressed as '1', '2-4', '5-12' and '>12'; (2) frequency of visiting gay clubs, bars, discos  
48  
49 189 (venues) to meet male sexual partners ('Many times', 'Sometimes', 'Rarely' and 'Doesn't visit'),  
50  
51 190 (3) condom use during the last anal sexual intercourse (AI) with male partner ('yes' and 'no');  
52  
53 191 (4) alcohol and (5) poppers consumption before or during the last sexual intercourse ('yes'  
54  
55 192 and 'no'), and (6) age ('18-20', '21-30', '31-40', '41-50' and '>50').  
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58 193 A sensitivity analysis was performed to test the validity of the variables identified through the  
59  
60 194 clustering. The variables identified were included as covariates in multivariable logistic



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3 195 regression models using the variable self-reported current STI status ('Negative' vs. 'Positive'),  
4  
5 196 past STI status ('Negative' vs. 'Positive') and HIV sero-status ('Negative' vs. 'Positive') as  
6  
7 197 outcomes. The results of the regression models can be found as supplementary files. In  
8  
9 198 addition, in regression analysis, the multilevel structure induces correlation among  
10  
11 199 observations within a cluster and to test the validity of the 6 variables identified, each of them  
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13 200 was used independently as a random effect in mixed-effect logistic regression models.  
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15 201 The final list of variables identified was considered as potential factors of a pattern of sexual  
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17 202 behaviour in MSM populations.  
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20

## 21 204 **RESULTS**

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24 205 A total of 1046 MSM participated in this study. The refusal rate was 23.2% (1362 were  
25  
26 206 approached). No differences were found between refusals and participants regarding age and  
27  
28 207 education. Overall, 5.5% self-reported a current STI, 20.5% a previous STI and 9.1% HIV  
29  
30 208 positive sero-status. The median and mean numbers of male sexual partners in the past year  
31  
32 209 were 4 and 14.8, respectively. Condom use was reported by 76.2% of participants during their  
33  
34 210 last AI, either receptive or insertive; alcohol and poppers used before or during the last AI was  
35  
36 211 reported by 25.3% and 7.8%, respectively.

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38  
39 212 The cluster analysis resulted in a 7-cluster solution, but one cluster was discarded as it was  
40  
41 213 too small to be epidemiologically relevant (n=12).

42  
43 214 The characteristics of the clusters identified are presented in Table 1.  
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45 215

46

47 216 **Table 1: Socio-demographic and behavioural characteristics of the clusters**

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



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

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

217

218 Cluster 1. This is the smallest cluster (n=46) with MSM who were almost all older than 40  
 219 years old. They reported relatively more male sexual partners compared to the other clusters  
 220 (58.7% reported 13 or more partners in the last year), 71.7% sometimes or often visited gay  
 221 venues.

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

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

1  
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3 229 The use of alcohol and poppers during or before the last sexual intercourse was reported by  
4  
5 230 the 28.9% and 4.8% of respondents, respectively.  
6

7 231 Cluster 3. This cluster (n=206) included almost exclusively MSM between 20 and 40. They all  
8  
9 232 reported relatively more male partners (61.7% had 13 or more partners in the last year). This  
10  
11 233 cluster showed the highest proportion of condom use during the last AI (93.7%) and of visiting  
12  
13 234 sometimes or often gay venues (94.6%).  
14

15 235 The use of alcohol and poppers before or during the last sexual intercourse was reported by  
16  
17 236 46.1% and 13.1%, respectively.  
18

19 237 Cluster 4. This cluster was the largest (n=303) and assembled the highest percentage of  
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21 238 people between 18 and 20. They reported relatively few male sexual partners (85.1% had 4  
22  
23 239 or less partners in the last year), 66% reported condom use at the last AI and just 4%  
24  
25 240 sometimes or often visited gay venues.  
26

27 241 Sixty-six percent reported the use of condom during the last AI while 18.2% reported the use  
28  
29 242 of alcohol and 3.6% reported the use of poppers during or before the last sexual intercourse.  
30

31 243 Cluster 5. Mostly MSM in their thirties populated this cluster (n=106). Compared to the other  
32  
33 244 clusters, they reported relatively more male sexual partners, (58.5% had 13 or more in the last  
34  
35 245 year), 84% reported condom use during the last AI and only a small proportion visited  
36  
37 246 sometimes or often gay venues.  
38

39 247 Eighty-four percent reported the use of condom during the last AI while 15.1% used alcohol  
40  
41 248 before or during the last sexual intercourse and 18.9% used poppers.  
42

43 249 Cluster 6. This cluster (n=66) consisted of exclusively MSM older than 40 years. Over three-  
44  
45 250 quarter reported 4 or less partners in the last year and only 1.5% reported to have attended  
46  
47 251 gay venues. Of all clusters, they reported the lowest condom use during the last AI (62.1%)  
48  
49 252 and only marginally use alcohol (15.2%) or poppers (3.0%) before or during the last sexual  
50  
51 253 intercourse.  
52

53 254 Of all the clusters, this group reported the most frequently sex with a transgender partner, with  
54  
55 255 a woman and with a sex worker (10.5%, 28.1% and 17.2%, respectively).  
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3 257 From the 120 participants excluded from the cluster analysis, 1 failed to give his age, 63 did  
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5 258 not answer how many partners they had in the last year, 26 failed to mark the frequency of  
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7 259 their visits to gay venues and 62 did not answer whether they used a condom at last AI.  
8  
9 260 Compared to the whole study population, the group of excluded participants was older, had  
10  
11 261 less partners, frequented gay venues less frequently, more condom and less alcohol and  
12  
13 262 poppers use.

15 263 Figure 2 shows the frequency of reported current STIs, past STIs and HIV sero-status within  
16  
17 264 the six clusters. Cluster 1 had the highest rate of self-reported current STIs (17.1%), followed  
18  
19 265 by cluster 6 (12.3%) and cluster 5 (11.7%). The other clusters had lower STI rates, ranging  
20  
21 266 from 1.8% to 2.8%. The proportion of participants that did not know their current STI-status  
22  
23 267 varied from 4.9% in cluster 1 to 17.0% in cluster 5.

24  
25 268 Among the excluded participants that answered the question on reported current STI, the  
26  
27 269 prevalence was 10.7% which is more than double the prevalence of the participants included  
28  
29 270 in the analysis.

30  
31 271 Cluster 1 reported the highest proportion of self-reported STI history (41.5%) followed by  
32  
33 272 cluster 5 (26.1%), cluster 6 (25.5%) and cluster 3 (24.0%).

34  
35 273 The highest prevalence of self-reported HIV was also found within the three clusters (from  
36  
37 274 13.0% to 16.7%) with the highest self-reported current and past STIs. Among the excluded  
38  
39 275 participants, almost one in five reported being HIV-positive, a higher rate than any of the  
40  
41 276 clusters.

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43 277 From the sensitivity analysis (Supplementary file), the mixed-effect models performed  
44  
45 278 generally better than the multivariable logistic regression. The results presented here are from  
46  
47 279 the mixed-effect models after adjusting for the other confounders (in the fixed part of the  
48  
49 280 model). For the model on self-reported current STIs, age group and number of male sexual  
50  
51 281 partners in the last year were statistically significant random effects. For the model on the self-  
52  
53 282 reported previous STI, age group, number of male sexual partners in the last year and condom  
54  
55 283 use during the last AI were statistically significant random effects. For the model on the self-  
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3 284 reported positive HIV sero-status, age group, number of male sexual partners in the last year  
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5 285 and frequent visits to gay venues were significant random effects.  
6

7 286 The mixed-effect models, confirmed the role of age, number of sexual partners, condom use  
8  
9 287 and frequent visits to gay venues as factors that could be used to detect possible clusters in  
10  
11 288 this MSM population, related to current or past STI diagnosis or HIV sero-status.  
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## 15 290 **DISCUSSION**

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18 291 The cluster analysis identified six clusters with diverse patterns of sexual behaviours, related  
19  
20 292 to different STI and HIV vulnerability. In the discussion we further explore the higher STI/HIV  
21  
22 293 prevalence clusters, using descriptive data (available on request) from variables not included  
23  
24 294 in the cluster analysis.  
25

26 295

### 27 28 296 **High Risk Pattern - High STI/HIV-vulnerability**

29  
30 297 Cluster 1 well represents this pattern: it presents the highest STI rates and high number of  
31  
32 298 partners and a high proportion of at risk sexual behaviours such as group sex and unprotected  
33  
34 299 sex with a partner whose HIV sero-status was unknown .. This is in line with previous studies  
35  
36 300 demonstrating that relationships in which condomless sex happens, are multiple, overlapping  
37  
38 301 and sequential, resulting in a high-risk level for STIs and HIV. {Singer, 2006 #119; Ferrer, 2015  
39  
40 302 #212}  
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43 303

### 44 45 304 **Seemingly Low Risk Pattern - High STI/HIV-vulnerability**

46  
47 305 Cluster 6 was the oldest cluster, and although except for UAI, it scored low on the other sexual  
48  
49 306 risk variables but it had the second highest STI-prevalence and the highest HIV prevalence.  
50  
51 307 They reported having sexual intercourses with transgender partners, women and sex workers.  
52  
53 308 This suggests that cluster 6 contained a group of older MSM that might not identify as gay and  
54  
55 309 might face a lot of barriers to access reliable information about the risks of their sexual  
56  
57 310 behaviours. A previous study from Portugal showed that in this sample of MSM, low self-risk  
58  
59 311 perception was the major motive of never having been tested for HIV.[22]  
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3 3124  
5 313 **Similar Patterns - Different STI/HIV-vulnerability**6  
7 314 Both clusters 5 and 3 represented a sexually active pattern in MSM of the same age range. A8  
9 315 quarter of MSM in both clusters reported past STI diagnoses but MSM in cluster 5 had a higher10  
11 316 proportion of current STI diagnoses, suggesting higher recurrence of STIs, and much higher12  
13 317 self-reported HIV prevalence. However, about the same proportion in each cluster reported14  
15 318 unprotected AI in the last year with a partner whose HIV sero-status was unknown. Contrary16  
17 319 to cluster 3, MSM in cluster 5 almost never visited gay venues and did not drink alcohol at last18  
19 320 AI. It has been demonstrated that the frequency of unprotected intercourse does not solely20  
21 321 explain risk exposure, but having unprotected intercourse within certain high-risk sexual22  
23 322 networks does expose MSM to a heightened risk.[23]24  
25 32326  
27 324 The majority of MSM in these clusters were currently not affected by HIV or other STIs and28  
29 325 although they would be categorised as high risk to be infected with STIs and HIV, there are30  
31 326 protective factors, among others shamelessness, social support and self-monitoring, that32  
33 327 might play an important role in HIV/STI prevention interventions but have not been researched34  
35 328 enough.36  
37 32938  
39 330 **Strengths and Limitations**40  
41 331 Data on HIV and STI prevalence were self-reported and interviews were not self-administered42  
43 332 but done by community based researchers who were trained to apply the questionnaire. This44  
45 333 might have provoked memory and social desirability bias. There might be a bias as to why46  
47 334 certain questions were not answered, as is suggested by the high self-reported HIV48  
49 335 prevalence in the 'missing' cluster. Due to the intimate and sensitive nature of the study50  
51 336 questionnaire and the stigma associated with risky sexual behaviour and HIV/STI positive52  
53 337 sero-status, under-reporting in this study was to be expected.54  
55 33856  
57 339 The strength of a cluster analysis is that it can intercept groups of homogeneous units in the

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3 340 population, in terms of a group of relevant variables. However, the results and interpretation  
4  
5 341 of any cluster analysis depend on several researcher's choices and assumptions, such as that  
6  
7 342 actual groups exist, the choice of the variables on which the elements in the groups should be  
8  
9 343 similar, the distance measure, the clustering procedure and the number of clusters.[24, 25]  
10  
11 344 The presented clusters describe the study sample population, obtained via venue based  
12  
13 345 recruitment, and therefore cannot be extrapolated to the whole MSM population.  
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15  
16 346

## 17 347 **Conclusions**

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19  
20 348 The main findings are in line with other studies that demonstrated the association between  
21  
22 349 HIV-infection with higher incidence and prevalence rates for STIs, contributing to the ongoing  
23  
24 350 transmission among MSM and supporting linked epidemics of STIs and HIV in Portuguese  
25  
26 351 MSM.[26-28] Interventions for MSM should combine HIV- and comprehensive STI- testing,  
27  
28 352 including rectal and pharyngeal swabbing.[29]

29  
30 353 However, the information on the natural history of these asymptomatic infections is scarce,  
31  
32 354 and it remains unclear the public health benefit and the risks are associated with the  
33  
34 355 implementation of this screening strategy.

35  
36 356 The results also suggest some factors not directly linked to sexual behaviour reinforce the  
37  
38 357 epidemics.

39  
40 358 Although it is difficult to prove that the group of afflictions identified as one of the common  
41  
42 359 patterns in this MSM population is a syndemic, its potential is significant.

43  
44 360 Besides a critical need for improved STI symptom recognition, screening and treatment, future  
45  
46 361 interventions should have a syndemic orientation, unfolding the entire set of factors that create  
47  
48 362 excess burden of disease, being informed by analyses including psychosocial variables and  
49  
50 363 sexual health indicators.[30] Capturing concepts of autonomy, well-being, sexual satisfaction,  
51  
52 364 intimacy and social values in relation to sexuality, health scientists and other health  
53  
54 365 professionals might start identifying a different set of risk and protective factors.  
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3 368 **Contributions**  
4

5 369 SD, AG, RF and LM were involved in the design and conducting of the survey. AS, IT and KB  
6  
7 370 chose the main directions for data analysis and participated in the interpretation of results. AS,  
8  
9 371 MF and KB performed the statistical analyses. KB, IT, MF, SD, AS, MT, AG collaborated in  
10  
11 372 the writing of the manuscript. RF and LM complemented the manuscript with contextual data.  
12  
13 373 KB, SD, MF, AS, AG, RF, LM, MT and IT revised the manuscript before submission. All  
14  
15 374 authors approved the final manuscript submitted  
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19  
20 376 **Funding**  
21

22 377 No funding to report for this submission  
23  
24 378

25  
26 379 **Competing interests**  
27

28 380 None of the authors have conflicts of interest to declare.  
29  
30 381

31  
32 382 **Ethics Approval**  
33

34 383 This article does not contain any studies with animals performed by any of the authors. All  
35  
36 384 procedures performed involving human participants in this study were in accordance with the  
37  
38 385 ethical standards of the institutional and/or national research committee and with the 1964  
39  
40 386 Helsinki declaration and its later amendments or comparable ethical standards. The study was  
41  
42 387 approved by the Ethics Committee for Health of the North Regional Health Administration.  
43  
44 388 Informed consent was obtained from all individual participants included in the study.  
45  
46 389 The ethics committee approval number is No.18.09CES.  
47  
48 390

49  
50 391 **Data sharing statement**  
51

52 392 No additional data available  
53  
54 393

55  
56 394 **Patient consent for publication**  
57

58 395 Informed consent was obtained from all individual participants included in this study  
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5 397 **Acknowledgements**  
6

7 398 The project team is thankful to GHTM – UID/Multi/04413/2013.  
8

9 399 The authors would like to thank the project team, namely, Daniel Simões, Gabriela Cohen,  
10  
11 400 Inês Rego, Ricardo Fernandes, Ricardo Rosa and Sara Trindade. The authors are also very  
12  
13 401 grateful to all the community partners of the project. The authors thank all the participants of  
14  
15 402 this study.  
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18 403  
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20 404 **Disclaimer**  
21

22 405 The authors are staff members of the World Health Organization. The authors alone are  
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24 406 responsible for the views expressed in this publication and they do not necessarily represent  
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26 407 the views, decisions or policies of the World Health Organization.  
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408 **Figure 1: Flow-chart of variable selection for the study**

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

For peer review only

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27 482 *Recommendations For Indicators*, 2013: pp. A7-A8.  
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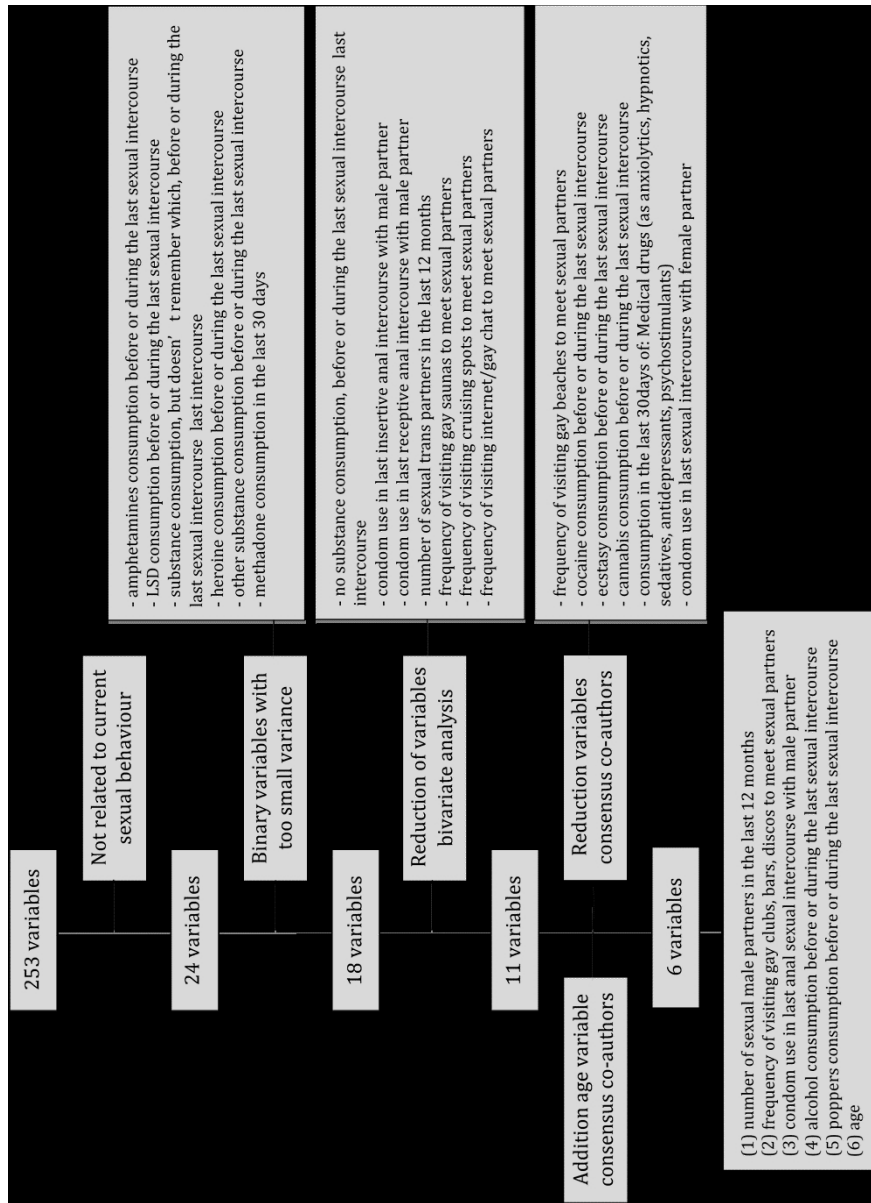


Figure 1: Cascade inclusion variables in cluster analysis

352x483mm (72 x 72 DPI)

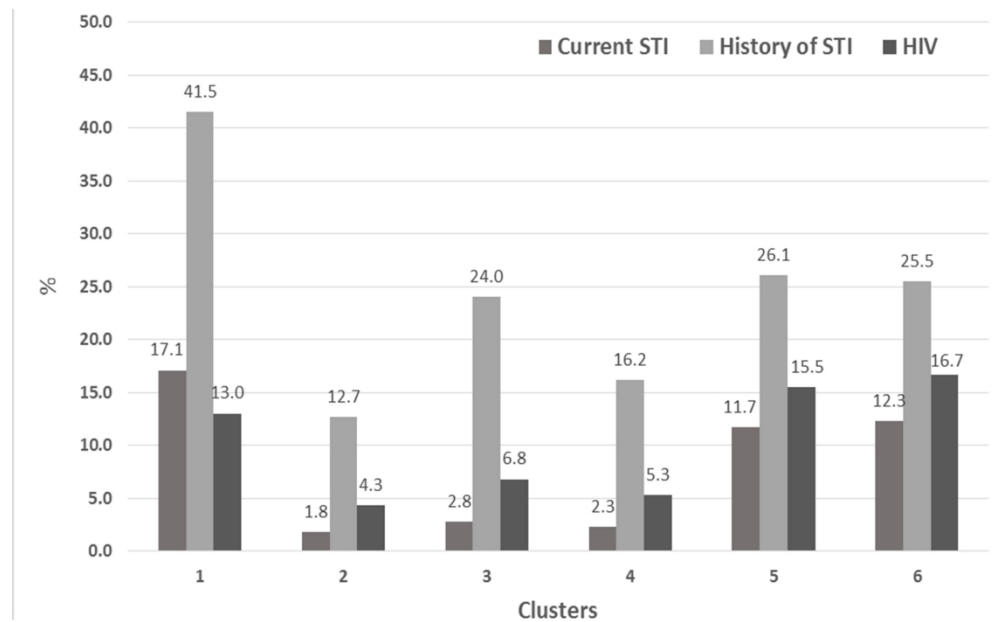


Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive serostatus in the six clusters

254x190mm (307 x 307 DPI)

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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).
```

peer review only

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	
<b>Age group</b>				
18-20	ref.			
21-30	1.55	0.313	0.66	3.61
31-40	<b>2.59</b>	0.029	1.10	6.07
41-50	<b>2.96</b>	0.023	1.16	7.54
>50	<b>4.74</b>	0.006	1.56	14.48
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.72	0.289	0.40	1.32
5-12	<b>1.66</b>	0.091	0.92	3.00
>12	<b>2.60</b>	0.002	1.42	4.73
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.48</b>	0.001	0.31	0.75
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.34	0.346	0.73	2.45
<b>Alcohol use before or during last sexual intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.73	0.302	0.40	1.33
5-12	<b>1.67</b>	0.086	0.93	3.01
>12	<b>2.68</b>	0.001	1.47	4.89
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.47</b>	0.001	0.30	0.74
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.34	0.343	0.73	2.44
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.29	0.224	0.85	1.96
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.11</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.56	0.303	0.67	3.64
31-40	<b>2.65</b>	0.024	1.13	6.22
41-50	<b>3.04</b>	0.020	1.20	7.75
>50	<b>4.76</b>	0.006	1.57	14.45
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.50</b>	0.002	0.32	0.78
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.40	0.270	0.77	2.57
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.30	0.219	0.86	1.97
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.19</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.54	0.317	0.66	3.60
31-40	<b>2.59</b>	0.029	1.11	6.06
41-50	<b>2.96</b>	0.023	1.16	7.54
>50	<b>4.78</b>	0.006	1.57	14.52
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.69	0.233	0.38	1.27
5-12	1.56	0.139	0.86	2.83
>12	<b>2.43</b>	0.004	1.32	4.44
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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				
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.35	0.331	0.74	2.46
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.28	0.250	0.84	1.94
<b>RANDOM EFFECT</b>				
<b>Condom use in last sexual intercourse (var)</b>	<b>0.10</b>		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	
<b>Age group</b>				
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	<b>3.73</b>	0.052	0.99	14.05
>50	1.18	0.862	0.18	7.78
<b>Number of sexual male partners in the last 12 months</b>				
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
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.13	0.150	0.66	14.79
Rarely	<b>4.38</b>	0.062	0.93	20.72
Doesn't visit	<b>6.06</b>	0.030	1.20	30.76
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.72	0.260	0.67	4.44
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.45</b>	0.081	0.89	6.71
<b>Alcohol use before or during last sex intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
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
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.05	0.158	0.65	14.29
Rarely	<b>4.25</b>	0.066	0.91	19.92
Doesn't visit	<b>6.05</b>	0.029	1.20	30.39
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.70	0.270	0.66	4.37
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	2.32	0.100	0.85	6.30
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.97	0.936	0.44	2.12
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.50</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
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	<b>3.83</b>	0.045	1.03	14.18
>50	1.18	0.864	0.18	7.63
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.00	0.165	0.64	14.16
Rarely	<b>3.84</b>	0.090	0.81	18.27
Doesn't visit	<b>4.78</b>	0.060	0.94	24.35
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.90	0.177	0.75	4.83
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.62</b>	0.057	0.97	7.06
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.97	0.946	0.44	2.13
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.10</b>		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	
<b>Age group</b>				
18-20	ref.			
21-30	1.73	0.470	0.39	7.71
31-40	<b>3.79</b>	0.076	0.87	16.56
41-50	<b>6.58</b>	0.015	1.44	30.01
>50	<b>9.45</b>	0.007	1.86	47.89
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	1.85	0.154	0.79	4.30
5-12	1.40	0.483	0.55	3.58
>12	<b>3.58</b>	0.004	1.50	8.54
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.41</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.35	0.383	0.69	2.63
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.07</b>	0.059	0.97	4.41
<b>Alcohol use before or during last sex intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	1.85	0.153	0.80	4.30
5-12	1.42	0.468	0.55	3.62
>12	<b>3.69</b>	0.003	1.54	8.81
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.42</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.33	0.399	0.68	2.60
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.02</b>	0.067	0.95	4.29
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.66	0.189	0.35	1.23
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.40</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.80	0.439	0.41	8.01
31-40	<b>4.03</b>	0.064	0.92	17.60
41-50	<b>6.93</b>	0.012	1.52	31.56
>50	<b>9.80</b>	0.006	1.94	49.60
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.41</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.45	0.276	0.74	2.81
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.24</b>	0.036	1.05	4.78
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.66	0.197	0.36	1.24
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.14</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.71	0.482	0.38	7.59
31-40	<b>3.72</b>	0.080	0.85	16.22
41-50	<b>6.55</b>	0.015	1.44	29.86
>50	<b>9.43</b>	0.007	1.87	47.53
<b>Number of Partner</b>				
1	ref.			
2-4	1.82	0.165	0.78	4.22
5-12	1.34	0.539	0.53	3.39
>12	<b>3.32</b>	0.006	1.41	7.83
<b>Condom use last sex intercourse</b>				
No	ref.	0.757	0.61	2.00
Yes	1.32	0.411	0.68	2.57
<b>Popper use last sex intercourse</b>				
No	ref.			
Yes	<b>2.05</b>	0.061	0.97	4.35
<b>Alcohol use last sex intercourse</b>				
No	ref.			
Yes	0.63	0.149	0.34	1.18
<b>RANDOM EFFECT</b>				
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners (var)</b>	<b>0.09</b>		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 #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			
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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-033290.R2
Article Type:	Original research
Date Submitted by the Author:	11-Dec-2020
Complete List of Authors:	Blondeel, Karel; WHO, Department of Reproductive Health and Research; Ghent University, Faculty of Medicine and Health Sciences Dias, Sonia; Universidade Nova de Lisboa, Global Health and Tropical Medicine; Universidade Nova de Lisboa, National School of Public Health Furegato, Martina; University of London St George's Molecular and Clinical Sciences Research Institute, Applied Diagnostic Research and Evaluation Unit (ADREU); Public Health England, Blood Safety, Hepatitis, Sexually Transmitted Infections (STI) and HIV Service, National Infection Service Seuc, Armando; Instituto Nacional de Higiene Epidemiología y Microbiología Gama, Ana; Universidade Nova de Lisboa, Global Health and Tropical Medicine, Instituto de Higiene e Medicina Tropical Fuentes, Ricardo; Grupo de Ativistas em Tratamentos Mendão, Luís; Grupo de Ativistas em Tratamentos Temmerman, Marleen; Ghent University, International Centre for Reproductive Health Toskin, Igor; WHO, Department of Reproductive Health and Research; I M Sechenov First Moscow State Medical University
<b>Primary Subject Heading</b>:	Sexual health
Secondary Subject Heading:	Epidemiology, Infectious diseases, HIV/AIDS, Public health
Keywords:	sexual health, STI, HIV & AIDS < INFECTIOUS DISEASES, SYNDROMIC, MSM

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3 1 **Sexual behaviour patterns and STI risk: results of a cluster analysis among Men Who**  
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5 2 **Have Sex with Men in Portugal**

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8  
9 32 **Word count:** 3267

10 33

11  
12  
13 34 **Keywords:** Men who have sex with men, sexually transmitted infections, HIV, sexual  
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15 behaviour, cluster analysis, syndemic.

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19  
20 37 **ABSTRACT**

21  
22 38 **Objectives**

23  
24 39 Portugal has the highest HIV incidence rate in Western Europe. The proportion assigned to  
25  
26 40 sexual contact between men recently increased to more than 30% of all HIV-infections. Men  
27  
28 41 who have Sex with Men (MSM) are vulnerable to the acquisition of other Sexually Transmitted  
29  
30 42 Infections (STIs), increasing the per-contact risk of HIV-infection. Building on syndemic theory,  
31  
32 43 the aim of this analysis was to identify patterns of current sexual behaviour in MSM, and  
33  
34 44 explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-  
35  
36 45 status.

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38  
39 46 **Design**

40  
41 47 A cross-sectional behavioural survey was conducted in Portugal among MSM, using a  
42  
43 48 community-based participatory research approach. Hierarchical cluster analysis was used to  
44  
45 49 identify patterns including behavioural and demographic factors.

46  
47 50 **Results**

48  
49 51 The analysis resulted in 6 clusters. Three clusters showed higher rates of current STI  
50  
51 52 diagnosis (ranging from 11.7% to 17.1%), past STI diagnosis (ranging from 25.5% to 41.5%)  
52  
53 53 and HIV positive sero-status (ranging from 13.0% to 16.7%). From the three clusters scoring  
54  
55 54 lower on current and past STI and HIV diagnoses, one was characterized by a high number  
56  
57 55 of sexual partners (62% had more than 12 partners in the last year), a high proportion (94.6%)  
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3 56 of frequent visits to gay venues to meet sexual partners and high alcohol use (46.1%). The  
4  
5 57 other two clusters scored lower on high risk sexual behaviour.  
6

## 7 58 **Conclusion**

9 59 Factors other than sexual behaviour appear to reinforce the vulnerability to STIs and HIV of  
10  
11 60 some MSM in this study, suggesting a syndemic of STIs, HIV and other adverse conditions.  
12  
13 61 More research is needed to better understand the drivers of the STI/HIV epidemic in  
14  
15 62 Portuguese MSM, using a concept that goes beyond risk behaviour, to develop effective  
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17 63 combination prevention interventions.  
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## 22 66 **Strengths and limitations of this study**

- 23  
24  
25 67 • Hierarchical cluster analysis was used to identify behavioural patterns among MSM  
26  
27 68 participating in a behavioural survey in Portugal
- 28  
29 69 • The main findings from the cluster analysis are in line with the literature supporting  
30  
31 70 linked epidemics of STIs and HIV in Portuguese MSM
- 32  
33 71 • Using a syndemic approach it was possible to identify that factors not directly linked to  
34  
35 72 sexual behaviour are linked to these epidemics
- 36  
37 73 • The outcomes of this analysis relate to the study sample population and cannot be  
38  
39 74 generalised to the wider MSM population
- 40  
41 75 • We acknowledged that the reliance on self-reported STI and HIV outcomes is a  
42  
43 76 weakness that may have caused social desirability bias  
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## 50 78 **INTRODUCTION**

51  
52 79 Portugal had the highest rate of new HIV diagnoses in Western Europe in 2013.[1] Initially the  
53  
54 80 Portuguese HIV-epidemic was predominantly prevalent in people who inject drugs (PWID),  
55  
56 81 but since 2003 most of the reported infections are associated with sexual transmission.[2] In  
57  
58 82 2013, of all new HIV-infections occurring in Portugal, 30.3% were assigned to sexual contact  
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3 83 between men.[3] The estimated percentage of Portuguese men who have sex with men  
4  
5 84 (MSM) living with HIV was 10% in 2011, manifold the 0.6% estimate for Portuguese adults  
6  
7 85 aged 15 to 49.[4] The median age at HIV diagnosis due to transmission among homosexual  
8  
9 86 men has declined from 35 in 2007 to 32 in 2012, unlike the increasing trend due to  
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11 87 transmission among heterosexual persons.[5]  
12  
13 88 MSM are also vulnerable to the acquisition of other sexually transmitted infections (STIs),  
14  
15 89 some of which increase the per-contact risk of HIV-infection. The European MSM Internet  
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17 90 Survey (EMIS) showed that 14.5% of MSM across Europe self-reported a history of  
18  
19 91 gonorrhoea diagnoses, 13.4% of anal/genital warts, 8.6% of syphilis, 8.1% of chlamydial  
20  
21 92 infection and 3.6% of anal/genital herpes.[6] MSM account for almost 50% of all syphilis cases  
22  
23 93 reported and 24% of gonorrhoea diagnoses in Europe.[7] For Portugal this information is  
24  
25 94 incomplete[8, 9] and in the Portuguese Global AIDS Response Progress Reports there is no  
26  
27 95 reporting of STI-data among MSM.[10] Underreporting is suggested to be high in Portugal,  
28  
29 96 and related to the non-detection of syphilis and rectal gonorrhoea due to low rates of STI-  
30  
31 97 testing and anal exams or swabbing.[11] Currently, in Portugal there are neither separate  
32  
33 98 HIV/STI-policies for MSM nor specific national STI-testing policies or guidelines.  
34  
35 99 Recently, there have been numerous efforts to promote prevention/diagnosis/linkage of  
36  
37 100 interventions for MSM, mainly organized by the community. CheckpointLX in Lisbon, the first  
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39 101 community-based testing centre for MSM founded in April 2011, encourages combined HIV-  
40  
41 102 STI testing for MSM.  
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43 103 The most recent national programme for the prevention and control of HIV/AIDS[12, 13]  
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45 104 included MSM as a target group. Having as first objective to structure the epidemiological  
46  
47 105 surveillance system for HIV, it encompasses information on other STIs and includes the  
48  
49 106 screening of STIs as a secondary prevention method for HIV infection.[14, 15]  
50  
51 107 STIs and HIV have been researched in conjunction with mental health conditions, substance  
52  
53 108 use, violence and sexual abuse in the framework of the syndemic theory.[16] These factors  
54  
55 109 may reinforce one another and increase the health burden in at risk populations, such as  
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57 110 MSM.<sup>20,21</sup> The concept of “afflictions” defining a syndemic[16-18] can be extended from just

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2  
3 111 diseases to risk factors, and other health related conditions.  
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5 112 A syndemic of risky sexual behaviours is a group of co-existing factors that describe the sexual  
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7 113 behavioural patterns in a specific population.  
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9 114 One way of exploring this syndemic is to identify subgroups of subjects that share a particular  
10  
11 115 pattern with respect to relevant sexual behavioural variables that potentially interact in the  
12  
13 116 syndemic, to this purpose the technique of cluster analysis was used in this study.  
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15 117 The term cluster in this context is not considered in the epidemiological sense of the term, ie  
16  
17 118 a group that is connected in time and/or place but it was used to identify patterns of current  
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19 119 sexual behaviour in Portuguese MSM, and to explore the associations with the self-reported  
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21 120 current and past STIs and HIV sero-status.  
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23

24 121 A better understanding of these relationships can inform the design of combined interventions  
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26 122 in MSM to both decrease STI and HIV burden, and improve sexual health.[19]  
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28 123 The aim of this analysis was to identify patterns of current sexual behaviour in MSM, and  
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30 124 explore their relationship with self-reported current, past STI diagnoses and HIV positive sero-  
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32 125 status.  
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## 36 127 **METHODS**

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39 128 A cross-sectional behavioural survey was conducted in Portugal among MSM as part of the  
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41 129 Project PREVIH - HIV/AIDS infection in MSM and Sex Workers: Prevalence, Determinants,  
42  
43 130 Prevention interventions and Access to health (2009-2013). The study used a community-  
44  
45 131 based participatory research approach, engaging a Community Advisory Board (CAB)  
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47 132 comprising MSM, representatives of non-governmental and governmental organisations, and  
48  
49 133 academics. The CAB actively participated in the study design, implementation and  
50  
51 134 interpretation of the results.[19, 20]  
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## 54 136 **Sampling, Recruitment and Data Collection**

55  
56  
57 137 The study population was reached through a venue-based recruitment strategy. Geographic  
58  
59 138 and network mapping was conducted, based on formative research with the CAB, to identify

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3 139 data collection sites. Recruitment teams of outreach workers and MSM peers systematically  
4  
5 140 approached potential participants at the sites, inviting them for a face-to-face interview. The  
6  
7 141 inclusion criteria were: being at least 18 years and having had sex with a man in the last year.  
8  
9 142 Participants were recruited from gay bars/clubs, cafes, streets in predominantly gay  
10  
11 143 neighbourhoods, local community based organisations and community events. Additionally,  
12  
13 144 the recruited respondents were asked to advertise the study among their social networks and  
14  
15 145 peers.

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17  
18 146 Anonymity and confidentiality were guaranteed, and informed consent was obtained from all  
19  
20 147 participants. The study was approved by the Ethics Committee for Health of the North  
21  
22 148 Regional Health Administration. The study procedures were revised and approved by the CAB  
23  
24 149 and the project's scientific commission.

25  
26 150 Data were collected from January to September 2011 using a structured questionnaire applied  
27  
28 151 by trained peers recruited from community organisation partners. The questionnaire included  
29  
30 152 closed-ended questions on socio-demographics, sexual behaviour, availability/accessibility of  
31  
32 153 STI/HIV services, history of HIV testing, reported HIV status and current/history of other STIs.  
33  
34 154 The questionnaire was developed in collaboration with the community partners and included  
35  
36 155 the indicators of the United Nations General Assembly Special Session on HIV/AIDS  
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38 156 (UNGASS).[21] A more detailed description of the sampling, recruitment and data collection  
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40  
41 157 can be found elsewhere.[20]

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#### 44 45 159 **Patient and public involvement**

46  
47 160 A community-based participatory research approach was used, in which a Community  
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49 161 Advisory Board including representatives of non-governmental and governmental  
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51 162 organizations, academics, and MSM was formed and actively participated in all phases of the  
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53 163 project, as the study design, elaboration of the questionnaire, results interpretation, and  
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55 164 discussion. Community partners were also involved in the data collection process.

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#### 58 59 60 166 **Statistical Analysis**

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3 167 Data were analysed using hierarchical agglomerative cluster analysis, univariate and bivariate  
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5 168 statistics, univariable, multivariate and mixed effect logistic regression analyses and statistical  
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7 169 packages SPSS and STATA13 were used.  
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9 170 Figure 1 shows the cascade of the variables included in each step of the cluster analysis from  
10  
11 171 the inclusion of all the variables and with the exclusion of some factors when the inclusion  
12  
13 172 criteria were not met.  
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15 173 Multiple iterations of a hierarchical cluster analysis were used to identify the optimum number  
16  
17 174 of clusters. The clustering was done based on Euclidean distances. Squared Euclidean  
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19 175 distances were used to calculate the distance between any two individuals/subjects in the  
20  
21 176 sample; the squared Euclidean distance is defined as the sum of the squared differences  
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23 177 between the values for the (six) variables corresponding to these two individuals/subjects.  
24  
25 178 Distances between identified clusters are obtained with the “between-groups linkage” method,  
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27 179 i.e. the average of the distances between any two subjects in the corresponding clusters  
28  
29 180 (syntax available as a Supplementary File 1).  
30  
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32 181 In consultation with key persons from the MSM community in Lisbon, the clusters were not  
33  
34 182 labelled because of possible misperception and stigmatisation and will be referred to with a  
35  
36 183 number.  
37

38 184 The frequency of the variables self-reported current STI status ('Negative', 'Positive', 'Don't  
39  
40 185 know'), past STI status ('Negative', 'Positive', 'Don't know') and HIV sero-status ('Negative',  
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42 186 'Positive', 'Don't know') in each of the clusters was examined.  
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45 187 The final list of variables included: (1) number of sexual male partners in the last 12 months  
46  
47 188 (year) expressed as '1', '2-4', '5-12' and '>12'; (2) frequency of visiting gay clubs, bars, discos  
48  
49 189 (venues) to meet male sexual partners ('Many times', 'Sometimes', 'Rarely' and 'Doesn't visit'),  
50  
51 190 (3) condom use during the last anal sexual intercourse (AI) with male partner ('yes' and 'no');  
52  
53 191 (4) alcohol and (5) poppers consumption before or during the last sexual intercourse ('yes'  
54  
55 192 and 'no'), and (6) age ('18-20', '21-30', '31-40', '41-50' and '>50').  
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58 193 A sensitivity analysis was performed to test the validity of the variables identified through the  
59  
60 194 clustering. The variables identified were included as covariates in multivariable logistic

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3 195 regression models using the variable self-reported current STI status ('Negative' vs. 'Positive'),  
4  
5 196 previous STI status ('Negative' vs. 'Positive') and HIV sero-status ('Negative' vs. 'Positive') as  
6  
7 197 outcomes. The results of the regression models for current and previous STIs and HIV status  
8  
9 198 can be found as supplementary files. In addition, in regression analysis, the multilevel  
10  
11 199 structure induces correlation among observations within a cluster and to test the validity of the  
12  
13 200 6 variables identified, each of them was used independently as a random effect in mixed-effect  
14  
15 201 logistic regression models.

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18 202 The final list of variables identified was considered as potential factors of a pattern of sexual  
19  
20 203 behaviour in MSM populations.

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## 23 24 205 **RESULTS**

25  
26 206 A total of 1046 MSM participated in this study. The refusal rate was 23.2% (1362 were  
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28 207 approached). No differences were found between refusals and participants regarding age and  
29  
30 208 education. Overall, 5.5% self-reported a current STI, 20.5% a previous STI and 9.1% HIV  
31  
32 209 positive sero-status. The median and mean numbers of male sexual partners in the past year  
33  
34 210 were 4 and 14.8, respectively. Condom use was reported by 76.2% of participants during their  
35  
36 211 last AI, either receptive or insertive; alcohol and poppers used before or during the last AI was  
37  
38 212 reported by 25.3% and 7.8%, respectively.

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40  
41 213 The cluster analysis resulted in a 7-cluster solution, but one cluster was discarded as it was  
42  
43 214 too small to be epidemiologically relevant (n=12).

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45 215 The characteristics of the clusters identified are presented in Table 1.

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49 217 **Table 1: Socio-demographic and behavioural characteristics of the clusters**

	Clusters						
	1	2	3	4	5	6	Overall
<b>Frequency</b>	46	187	206	303	106	66	<b>1046</b>

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

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

218

219 Cluster 1. This is the smallest cluster (n=46) with MSM who were almost all older than 40  
 220 years old. They reported relatively more male sexual partners compared to the other clusters  
 221 (58.7% reported 13 or more partners in the last year), 71.7% sometimes or often visited gay  
 222 venues.

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

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



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3 228 in the last year), 69% reported condom use during the last AI and 90.4% sometimes or often  
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5 229 visited gay venues.

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7 230 The use of alcohol and poppers during or before the last sexual intercourse was reported by  
8  
9 231 the 28.9% and 4.8% of respondents, respectively.

10  
11 232 Cluster 3. This cluster (n=206) included almost exclusively MSM between 20 and 40. They all  
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13 233 reported relatively more male partners (61.7% had 13 or more partners in the last year). This  
14  
15 234 cluster showed the highest proportion of condom use during the last AI (93.7%) and of visiting  
16  
17 235 sometimes or often gay venues (94.6%).

18  
19 236 The use of alcohol and poppers before or during the last sexual intercourse was reported by  
20  
21 237 46.1% and 13.1%, respectively.

22  
23 238 Cluster 4. This cluster was the largest (n=303) and assembled the highest percentage of  
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25 239 people between 18 and 20. They reported relatively few male sexual partners (85.1% had 4  
26  
27 240 or less partners in the last year), 66% reported condom use at the last AI and just 4%  
28  
29 241 sometimes or often visited gay venues.

30  
31 242 Sixty-six percent reported the use of condom during the last AI while 18.2% reported the use  
32  
33 243 of alcohol and 3.6% reported the use of poppers during or before the last sexual intercourse.

34  
35 244 Cluster 5. Mostly MSM in their thirties populated this cluster (n=106). Compared to the other  
36  
37 245 clusters, they reported relatively more male sexual partners, (58.5% had 13 or more in the last  
38  
39 246 year), 84% reported condom use during the last AI and only a small proportion visited  
40  
41 247 sometimes or often gay venues.

42  
43 248 Eighty-four percent reported the use of condom during the last AI while 15.1% used alcohol  
44  
45 249 before or during the last sexual intercourse and 18.9% used poppers.

46  
47 250 Cluster 6. This cluster (n=66) consisted of exclusively MSM older than 40 years. Over three-  
48  
49 251 quarter reported 4 or less partners in the last year and only 1.5% reported to have attended  
50  
51 252 gay venues. Of all clusters, they reported the lowest condom use during the last AI (62.1%)  
52  
53 253 and only marginally use alcohol (15.2%) or poppers (3.0%) before or during the last sexual  
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55 254 intercourse.  
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3 255 Of all the clusters, this group reported the most frequently sex with a transgender partner, with  
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5 256 a woman and with a sex worker (10.5%, 28.1% and 17.2%, respectively).  
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9 258 From the 120 participants excluded from the cluster analysis, 1 failed to give his age, 63 did  
10  
11 259 not answer how many partners they had in the last year, 26 failed to mark the frequency of  
12  
13 260 their visits to gay venues and 62 did not answer whether they used a condom at last AI.

14  
15 261 Compared to the whole study population, the group of excluded participants was older, had  
16  
17 262 less partners, frequented gay venues less frequently, more condom and less alcohol and  
18  
19 263 poppers use.  
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21  
22 264 Figure 2 shows the frequency of reported current STIs, past STIs and HIV sero-status within  
23  
24 265 the six clusters. Cluster 1 had the highest rate of self-reported current STIs (17.1%), followed  
25  
26 266 by cluster 6 (12.3%) and cluster 5 (11.7%). The other clusters had lower STI rates, ranging  
27  
28 267 from 1.8% to 2.8%. The proportion of participants that did not know their current STI-status  
29  
30 268 varied from 4.9% in cluster 1 to 17.0% in cluster 5.

31  
32 269 Among the excluded participants that answered the question on reported current STI, the  
33  
34 270 prevalence was 10.7% which is more than double the prevalence of the participants included  
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36 271 in the analysis.  
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38  
39 272 Cluster 1 reported the highest proportion of self-reported STI history (41.5%) followed by  
40  
41 273 cluster 5 (26.1%), cluster 6 (25.5%) and cluster 3 (24.0%).  
42

43 274 The highest prevalence of self-reported HIV was also found within the three clusters (from  
44  
45 275 13.0% to 16.7%) with the highest self-reported current and past STIs. Among the excluded  
46  
47 276 participants, almost one in five reported being HIV-positive, a higher rate than any of the  
48  
49 277 clusters.  
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51 278 From the sensitivity analysis, the mixed-effect models performed generally better than the  
52  
53 279 multivariable logistic regression. The results presented here are from the mixed-effect models  
54  
55 280 after adjusting for the other confounders (in the fixed part of the model). For the model on self-  
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57 281 reported current STIs (Supplementary File 2) age group and number of male sexual partners  
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59 282 in the last year were statistically significant random effects. For the model on the self-reported  
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3 283 previous STI (Supplementary File 3), age group, number of male sexual partners in the last  
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5 284 year and condom use during the last AI were statistically significant random effects. For the  
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7 285 model on the self-reported positive HIV sero-status (Supplementary File 4), age group,  
8  
9 286 number of male sexual partners in the last year and frequent visits to gay venues were  
10  
11 287 significant random effects.

12  
13 288 The mixed-effect models, confirmed the role of age, number of sexual partners, condom use  
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15 289 and frequent visits to gay venues as factors that could be used to detect possible clusters in  
16  
17 290 this MSM population, related to current or past STI diagnosis or HIV sero-status.  
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## 21 292 **DISCUSSION**

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24 293 The cluster analysis identified six clusters with diverse patterns of sexual behaviours, related  
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26 294 to different STI and HIV vulnerability.  
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### 29 30 31 296 **High Risk Pattern - High STI/HIV-vulnerability**

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33 297 Cluster 1 seems to be characterized by this pattern: it presents the highest STI rates and high  
34  
35 298 number of partners and a high proportion of at risk sexual behaviours such as group sex and  
36  
37 299 unprotected sex with a partner whose HIV sero-status was unknown. This is in line with  
38  
39 300 previous studies demonstrating that relationships in which condomless sex happens, are  
40  
41 301 multiple, overlapping and sequential, resulting in a high-risk level for STIs and HIV. {Singer,  
42  
43 302 2006 #119; Ferrer, 2015 #212}

44 303

### 45 46 47 304 **Seemingly Low Risk Pattern - High STI/HIV-vulnerability**

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49 305 Cluster 6 was the oldest cluster, and although except for UAI, it scored low on the other sexual  
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51 306 risk variables, but it had the second highest STI-prevalence and the highest HIV prevalence.  
52  
53 307 They reported having sexual intercourses with transgender partners, women and sex workers.  
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55 308 This suggests that cluster 6 contained a group of older MSM that might not identify as gay and  
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57 309 might face a lot of barriers to access reliable information about the risks of their sexual  
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3 310 behaviours. A previous study from Portugal showed that in this sample of MSM, low self-risk  
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5 311 perception was the major motive of never having been tested for HIV.[22]  
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9 313 **Similar Patterns - Different STI/HIV-vulnerability**

11 314 Both clusters 5 and 3 represented a sexually active pattern in MSM of the same age range. A  
12  
13 315 quarter of MSM in both clusters reported past STI diagnoses but MSM in cluster 5 had a higher  
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15 316 proportion of current STI diagnoses, suggesting higher recurrence of STIs, and much higher  
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17 317 self-reported HIV prevalence. However, about the same proportion in each cluster reported  
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19 318 unprotected AI in the last year with a partner whose HIV sero-status was unknown. Contrary  
20  
21 319 to cluster 3, MSM in cluster 5 almost never visited gay venues and did not drink alcohol at last  
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23 320 AI. It has been demonstrated that the frequency of unprotected intercourse does not solely  
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25 321 explain risk exposure, but having unprotected intercourse within certain high-risk sexual  
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27 322 networks does expose MSM to a heightened risk.[23]  
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30 323

32 324 The majority of MSM in these clusters was currently not affected by HIV or other STIs and  
33  
34 325 although they would be categorised as high risk to be infected with STIs and HIV, there are  
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36 326 protective factors, among others shamelessness, social support and self-monitoring, that  
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38 327 might play an important role in HIV/STI prevention interventions but have not been researched  
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40 328 enough.  
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45 330 **Strengths and Limitations**

47 331 Data on HIV and STI prevalence were self-reported and interviews were not self-administered  
48  
49 332 but done by community-based researchers who were trained to apply the questionnaire. This  
50  
51 333 might have provoked memory and social desirability bias. There might be a bias as to why  
52  
53 334 certain questions were not answered, as is suggested by the high self-reported HIV  
54  
55 335 prevalence in the 'missing' cluster. Due to the intimate and sensitive nature of the study  
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57 336 questionnaire and the stigma associated with risky sexual behaviour and HIV/STI positive  
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59 337 sero-status, under-reporting in this study was to be expected.  
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5 339 The strength of a cluster analysis is that it can intercept groups of homogeneous units in the  
6  
7 340 population, in terms of a group of relevant variables. However, the results and interpretation  
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9 341 of any cluster analysis depend on several researcher's choices and assumptions, such as that  
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11 342 actual groups exist, the choice of the variables on which the elements in the groups should be  
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13 343 similar, the distance measure, the clustering procedure and the number of clusters.[24, 25]

14  
15 344 The presented clusters describe the study sample population, obtained via venue-based  
16  
17 345 recruitment, and therefore cannot be extrapolated to the whole MSM population.  
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## 21 347 **Conclusions**

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24 348 Though results of our analysis reconfirm that the number of partners and condom use are  
25  
26 349 important factors in HIV and STI transmission, they also suggest other factors such as sexual  
27  
28 350 networks and risk perception are at play. Although it is difficult to prove that the group of  
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30 351 afflictions identified as one of the common patterns in this MSM population is a syndemic, its  
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32 352 potential is significant. The findings are also in line with previous studies that demonstrated  
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34 353 the association between HIV-infection and higher incidence and prevalence rates of other  
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36 354 STIs, supporting linked epidemics of STIs and HIV in Portuguese MSM.[26-28] Interventions  
37  
38 355 for MSM should combine HIV- and STI- testing, and for some of the clusters identified in our  
39  
40 356 analysis, should be comprehensive, including rectal and pharyngeal swabbing to screen for  
41  
42 357 asymptomatic gonorrhoea and chlamydia, especially considering the current challenges with  
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44 358 antimicrobial resistance.[29]

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46  
47 359 It should be mentioned that, the information on the natural history of these asymptomatic  
48  
49 360 infections is scarce, and the public health benefit and the risks associated with the wide roll-  
50  
51 361 out of this screening strategy remain unclear.

52  
53 362 Finally, the authors recommend future research and interventions to have a syndemic  
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55 363 orientation to minimize excess burden of disease in MSM. Capturing concepts of autonomy,  
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57 364 well-being, sexual satisfaction, intimacy and social values in relation to sexuality, might unfold  
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59 365 a different set of risk and protective factors for a healthy sexual life.  
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7 368 **Contributions**8  
9 369 SD, AG, RF and LM were involved in the design and conducting of the survey. AS, IT and KB10  
11 370 chose the main directions for data analysis and participated in the interpretation of results. AS,12  
13 371 MF and KB performed the statistical analyses. KB, IT, MF, SD, AS, MT, AG collaborated in14  
15 372 the writing of the manuscript. RF and LM complemented the manuscript with contextual data.16  
17 373 KB, SD, MF, AS, AG, RF, LM, MT and IT revised the manuscript before submission. All18  
19 374 authors approved the final manuscript submitted20  
21 37522  
23 376 **Funding**24  
25 377 No funding to report for this submission26  
27 37828  
29 379 **Competing interests**30  
31 380 None of the authors have conflicts of interest to declare.32  
33 38134  
35 382 **Ethics Approval**36  
37 383 This article does not contain any studies with animals performed by any of the authors. All38  
39 384 procedures performed involving human participants in this study were in accordance with the40  
41 385 ethical standards of the institutional and/or national research committee and with the 196442  
43 386 Helsinki declaration and its later amendments or comparable ethical standards. The study was44  
45 387 approved by the Ethics Committee for Health of the North Regional Health Administration.46  
47 388 Informed consent was obtained from all individual participants included in the study.48  
49 389 The ethics committee approval number is No.18.09CES.50  
51 39052  
53 391 **Data sharing statement**54  
55 392 The data that support the findings of this study are available on request from the corresponding56  
57 393 author MF

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5 395 **Patient consent for publication**  
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7 396 Informed consent was obtained from all individual participants included in this study  
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11 398 **Acknowledgements**  
12

13 399 The project team is thankful to GHTM – UID/Multi/04413/2013.  
14

15 400 The authors would like to thank the project team, namely, Daniel Simões, Gabriela Cohen,  
16

17 401 Inês Rego, Ricardo Fernandes, Ricardo Rosa and Sara Trindade. The authors are also very  
18

19 402 grateful to all the community partners of the project. The authors thank all the participants of  
20

21 403 this study.  
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26 405 **Disclaimer**  
27

28 406 The authors are staff members of the World Health Organization. The authors alone are  
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30 407 responsible for the views expressed in this publication and they do not necessarily represent  
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32 408 the views, decisions or policies of the World Health Organization.  
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409 **Figure 1: Flow-chart of variable selection for the study**

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

For peer review only



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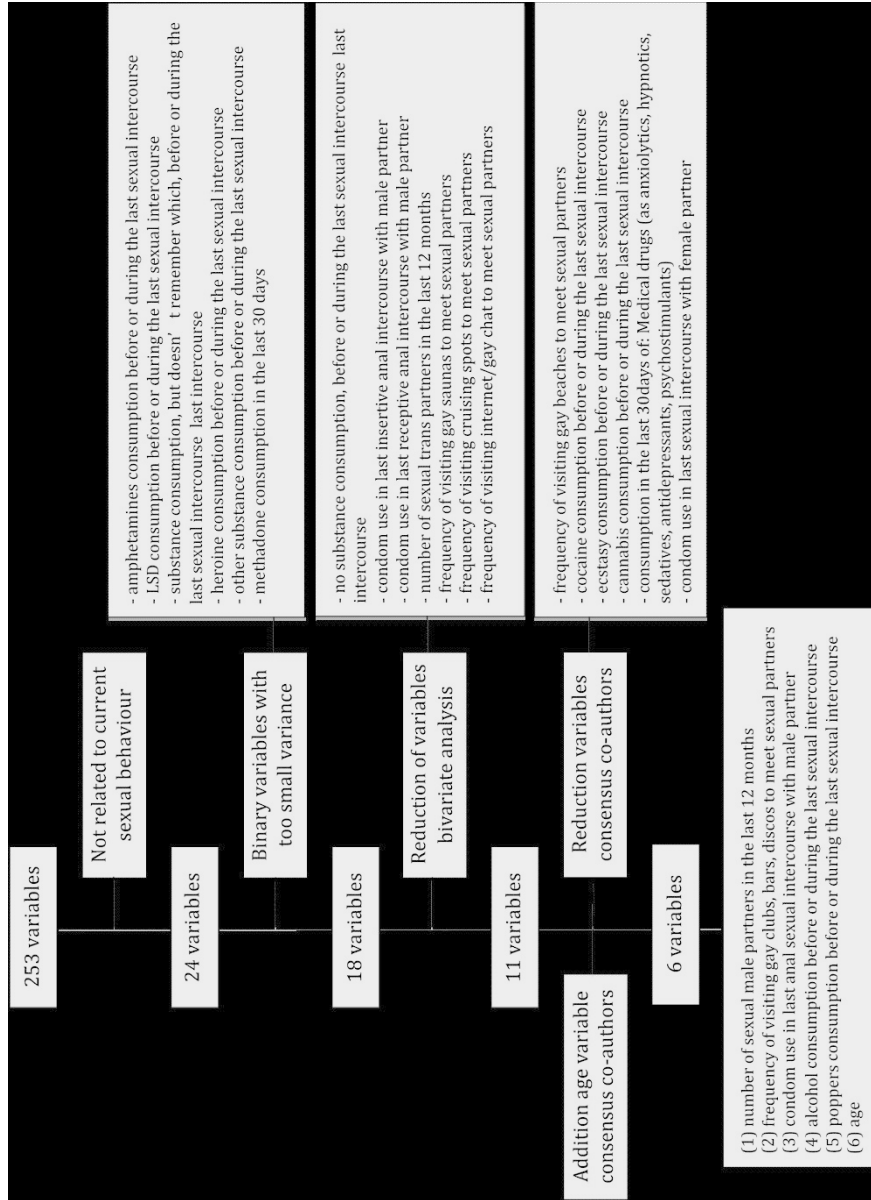


Figure 1: Flow-chart of variable selection for the study

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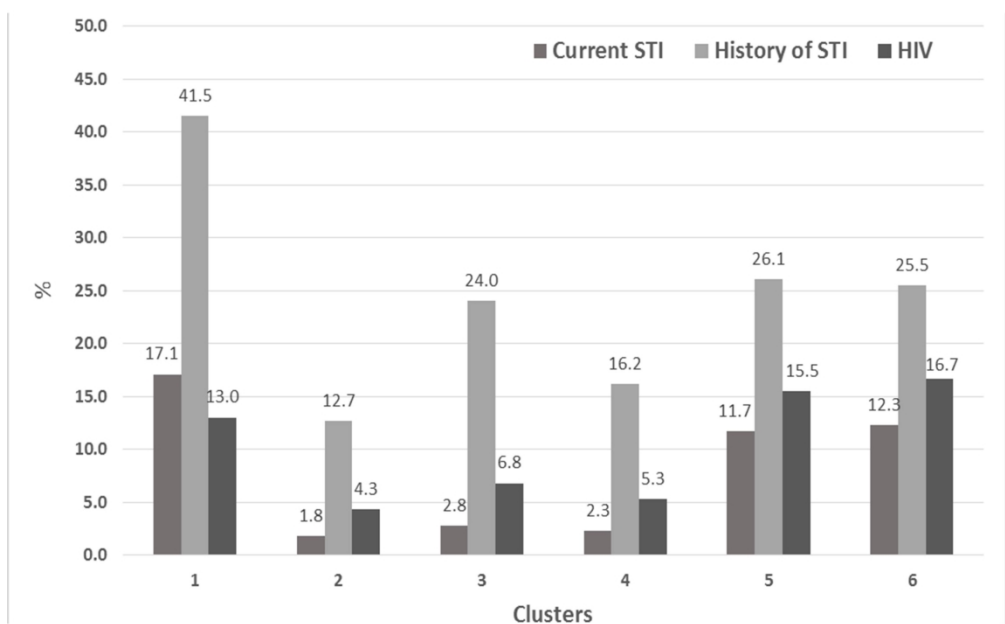


Figure 2: Percentages of reported current STI diagnosis, history of STI diagnosis and HIV positive sero-status in the six clusters

254x190mm (307 x 307 DPI)

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

```
1  
2  
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5 CLUSTER  
6 Age_REC_5cat_2  
7 SexMen_number_REC_4cat  
8 MCLUB  
9 REC_CondomLast_Male  
10 SubsSex_Alc  
11 SubsSex_Pop  
12 /METHOD BAVERAGE  
13 /MEASURE=SEUCLID  
14 /PRINT SCHEDULE CLUSTER(4,9)  
15 /PRINT DISTANCE  
16 /PLOT VICICLE  
17 /SAVE CLUSTER(4,9).  
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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	
<b>Age group</b>				
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	<b>3.73</b>	0.052	0.99	14.05
>50	1.18	0.862	0.18	7.78
<b>Number of sexual male partners in the last 12 months</b>				
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
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.13	0.150	0.66	14.79
Rarely	<b>4.38</b>	0.062	0.93	20.72
Doesn't visit	<b>6.06</b>	0.030	1.20	30.76
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.72	0.260	0.67	4.44
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.45</b>	0.081	0.89	6.71
<b>Alcohol use before or during last sex intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
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
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.05	0.158	0.65	14.29
Rarely	<b>4.25</b>	0.066	0.91	19.92
Doesn't visit	<b>6.05</b>	0.029	1.20	30.39
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.70	0.270	0.66	4.37
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	2.32	0.100	0.85	6.30
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.97	0.936	0.44	2.12
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.50</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
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	<b>3.83</b>	0.045	1.03	14.18
>50	1.18	0.864	0.18	7.63
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	3.00	0.165	0.64	14.16
Rarely	<b>3.84</b>	0.090	0.81	18.27
Doesn't visit	<b>4.78</b>	0.060	0.94	24.35
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.90	0.177	0.75	4.83
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.62</b>	0.057	0.97	7.06
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.97	0.946	0.44	2.13
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.10</b>		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	
<b>Age group</b>				
18-20	ref.			
21-30	1.55	0.313	0.66	3.61
31-40	<b>2.59</b>	0.029	1.10	6.07
41-50	<b>2.96</b>	0.023	1.16	7.54
>50	<b>4.74</b>	0.006	1.56	14.48
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.72	0.289	0.40	1.32
5-12	<b>1.66</b>	0.091	0.92	3.00
>12	<b>2.60</b>	0.002	1.42	4.73
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.48</b>	0.001	0.31	0.75
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.34	0.346	0.73	2.45
<b>Alcohol use before or during last sexual intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.73	0.302	0.40	1.33
5-12	<b>1.67</b>	0.086	0.93	3.01
>12	<b>2.68</b>	0.001	1.47	4.89
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.47</b>	0.001	0.30	0.74
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.34	0.343	0.73	2.44
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.29	0.224	0.85	1.96
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.11</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.56	0.303	0.67	3.64
31-40	<b>2.65</b>	0.024	1.13	6.22
41-50	<b>3.04</b>	0.020	1.20	7.75
>50	<b>4.76</b>	0.006	1.57	14.45
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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
<b>Condom use in last sexual intercourse</b>				
No	ref.			
Yes	<b>0.50</b>	0.002	0.32	0.78
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.40	0.270	0.77	2.57
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.30	0.219	0.86	1.97
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.19</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.54	0.317	0.66	3.60
31-40	<b>2.59</b>	0.029	1.11	6.06
41-50	<b>2.96</b>	0.023	1.16	7.54
>50	<b>4.78</b>	0.006	1.57	14.52
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	0.69	0.233	0.38	1.27
5-12	1.56	0.139	0.86	2.83
>12	<b>2.43</b>	0.004	1.32	4.44
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
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				
<b>Popper use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.35	0.331	0.74	2.46
<b>Alcohol use before or during last sexual intercourse</b>				
No	ref.			
Yes	1.28	0.250	0.84	1.94
<b>RANDOM EFFECT</b>				
<b>Condom use in last sexual intercourse (var)</b>	<b>0.10</b>		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	
<b>Age group</b>				
18-20	ref.			
21-30	1.73	0.470	0.39	7.71
31-40	<b>3.79</b>	0.076	0.87	16.56
41-50	<b>6.58</b>	0.015	1.44	30.01
>50	<b>9.45</b>	0.007	1.86	47.89
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	1.85	0.154	0.79	4.30
5-12	1.40	0.483	0.55	3.58
>12	<b>3.58</b>	0.004	1.50	8.54
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.41</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.35	0.383	0.69	2.63
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.07</b>	0.059	0.97	4.41
<b>Alcohol use before or during last sex intercourse</b>				
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	
<b>FIXED EFFECT</b>				
<b>Number of sexual male partners in the last 12 months</b>				
1	ref.			
2-4	1.85	0.153	0.80	4.30
5-12	1.42	0.468	0.55	3.62
>12	<b>3.69</b>	0.003	1.54	8.81
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.42</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.33	0.399	0.68	2.60
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.02</b>	0.067	0.95	4.29
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.66	0.189	0.35	1.23
<b>RANDOM EFFECT</b>				
<b>AGE GROUP (var)</b>	<b>0.40</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.80	0.439	0.41	8.01
31-40	<b>4.03</b>	0.064	0.92	17.60
41-50	<b>6.93</b>	0.012	1.52	31.56
>50	<b>9.80</b>	0.006	1.94	49.60
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners</b>				
Many times	ref.			
Sometimes	<b>0.41</b>	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
<b>Condom use in last sex intercourse</b>				
No	ref.			
Yes	1.45	0.276	0.74	2.81
<b>Popper use before or during last sex intercourse</b>				
No	ref.			
Yes	<b>2.24</b>	0.036	1.05	4.78
<b>Alcohol use before or during last sex intercourse</b>				
No	ref.			
Yes	0.66	0.197	0.36	1.24
<b>RANDOM EFFECT</b>				
<b>Number of sexual male partners in the last 12 months (var)</b>	<b>0.14</b>		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	
<b>FIXED EFFECT</b>				
<b>Age group</b>				
18-20	ref.			
21-30	1.71	0.482	0.38	7.59
31-40	<b>3.72</b>	0.080	0.85	16.22
41-50	<b>6.55</b>	0.015	1.44	29.86
>50	<b>9.43</b>	0.007	1.87	47.53
<b>Number of Partner</b>				
1	ref.			
2-4	1.82	0.165	0.78	4.22
5-12	1.34	0.539	0.53	3.39
>12	<b>3.32</b>	0.006	1.41	7.83
<b>Condom use last sex intercourse</b>				
No	ref.	0.757	0.61	2.00
Yes	1.32	0.411	0.68	2.57
<b>Popper use last sex intercourse</b>				
No	ref.			
Yes	<b>2.05</b>	0.061	0.97	4.35
<b>Alcohol use last sex intercourse</b>				
No	ref.			
Yes	0.63	0.149	0.34	1.18
<b>RANDOM EFFECT</b>				
<b>Frequency of visiting gay clubs, bars, discos to meet sexual partners (var)</b>	<b>0.09</b>		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 #
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			
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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).