Distance as Explanatory Factor for Sexual Health Centre Utilisation in an Infrastructure-Rich Urban Area in the Netherlands: A Population-Based Multilevel Study

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Abstract

Background

The sole sexual health centre (SHC) in the greater Rotterdam area, the Netherlands, is instrumental in finding people unaware of their STI/HIV status. We hypothesized that travel distance to the SHC is inversely associated with SHC utilisation. Insight in area-specific utilisation is needed for potential new outreach policies to enhance STI testing.

Methods

The study population consists of all residents aged 15 to 45 years in the greater Rotterdam area (2015-2017). We linked SHC consultation data from STI tested heterosexual clients to the population registry. The association between SHC utilisation and distance was investigated by multilevel modelling, adjusting for sociodemographic and area-specific determinants. The data was also stratified by age (aged below 25) and migratory background (non-Western), since SHC triage may affect their utilisation. We used straight-line distance between the centroid of the postal code area and SHC address as a proxy for travel distance.

Results

We found large area variation in SHC utilisation (ranged from 1.13 to 48.76 per 1,000 residents). Both individual and area level determinants determine utilisation. Travel distance explained most area variation and was inversely associated with SHC utilisation when adjusted for other sociodemographic and area-specific determinants (odds ratio [OR] per kilometre: 0.95; 95% CI: 0.93-0.96). Similar results were obtained for residents aged below 25 (OR: 0.95; 95% CI: 0.94-0.96), but not for non-Western residents (OR: 0.99; 95% CI: 0.99-1.00).

Conclusion

Living further away from the sole SHC in the greater Rotterdam area decreases utilisation. This provides evidence for local policy to enhance STI testing, for example by offering STI testing services closer to the population.

Background

Early diagnosis and adequate treatment are essential in controlling sexually transmitted infections (STI), including HIV. Many infected people remain untested and untreated. Easier access to testing services and subsequent treatment can improve health outcomes of people with STI, and reducing the risk of transmission (1).

In the Netherlands, STI tests and treatment are mainly provided by general practitioners (GPs) and sexual health centres (SHCs). The SHC is restricted to those considered high risk for STI and those who need sexual health advice the most (e.g. being notified for an STI, having STI symptoms, having a non-Western migratory background, aged below 25), which is assessed through triage (2). Those who do not meet at least one of the SHC triage criteria are advised to visit a GP. In contrast to the GP, SHCs are funded by the government, making it possible to offer tests and treatment free of charge (2). The GP will not charge for an STI consultation, however STI tests are only free of charge if the deductible excess of the health insurance is paid (at least Euro 385) (3).

Financial cost is one of the barriers for healthcare utilisation and testing (4–6). As the SHC service is completely free of charge, financial barriers should not play a major role in approaching an SHC. There are several other barriers (e.g. service access, perceived needs, social-cultural factors) that undermine healthcare utilisation and, hence, testing (4–12). This study is interested in how geographical proximity acts as a barrier to SHC utilisation. Various studies have identified geographical proximity as an important structural factor to explain inequalities in geographically accessibility (13–16). Utilisation of a healthcare service, as a proxy for accessibility, appears to decrease with an increasing travel time or distance (13–16). We could not find any quantitative studies investigating the effect of distance on SHC utilisation in western countries.

Based on the hypothesis that larger travel distance is inversely associated with SHC utilisation, we conducted a population-based study with the aim to determine a possible association between SHC utilisation and travel distance in the greater Rotterdam area. Confirmation of the hypothesis would provide local policy makers with evidence to enhance the (geographical) accessibility to SHC services and thereby increase STI testing and treatment rates.

Methods

Study area and SHC location

This study focuses on the sole SHC located in the city of Rotterdam. This SHC is run by the municipal public health service. The greater Rotterdam area, consisting of the city of Rotterdam and 14 neighbouring municipalities, harbours 1.3 million residents, half of them living in Rotterdam. The river Maas divides both the greater Rotterdam area and the city of Rotterdam into a northern and a southern part. The SHC is situated in the northern part, very close to a bridge connecting the northern and southern part, and with both a subway and tram stop in front of the building.

Data sources and study population

The study population consists of all residents aged 15 to 45 years in the greater Rotterdam area, obtained from the Dutch population registry (Statistics Netherlands). Each person in this registry has a unique citizen service number (BSN). Due to privacy legislation, the BSN is not collected during SHC consultations. Therefore, we matched each SHC consultation record to an arbitrary, unique resident in the population registry by year of consultation, year of birth, sex, grouped migratory background and four-digit postal code (PC). From the SHC consultation database, we only selected the first SHC consultation of each attendee that met the following criteria: a heterosexual man or woman living in the greater Rotterdam area, aged 15 to 45 years, and visiting the SHC in Rotterdam for an STI test. We made this choice because most of the general population is heterosexual and because the proportion and residential distribution of men who have sex with men (MSM) in the general population is unknown. In addition, more than 95% of all SHC heterosexual attendees belong to the age group 15-45 years. We used population registry and SHC consultation data from 2015, 2016 and 2017. Additional data from Statistics Netherlands (degree of urbanisation) and the Netherlands Institute for Social Research (socioeconomic status [SES]) were also linked to the dataset by PC.

Outcome variable

The main outcome of interest was access to the SHC in Rotterdam, operationalised as SHC utilisation. Only residents that match with the SHC consultation database are assumed to have utilised the SHC.

Determinants

Both determinants at individual and PC level are considered (Supplementary Table 1). The individual determinants included sex, age and grouped migratory background. The main determinant of interest on the PC level was travel distance to the SHC. Other PC level determinants included degree of urbanisation, SES, ethnic diversity, and living in the northern or southern part of the greater Rotterdam area. Since travel distance (straight-line and road-network) and travel time were highly correlated (r^2>0.9), straight-line travel distance between the centroid of the PC area and SHC address was used as proxy for travel distance. Ethnic diversity is measured by the Herfindahl-Hirschman Index. The index can be interpreted as the probability that two randomly selected individuals from the same PC area belong to different migratory background groups. We included living in northern or southern part of the area as determinant because we hypothesized that the river Maas, dividing Rotterdam into northern and southern areas, may serve as natural barrier for SHC utilisation.

Statistical analyses

Potential selection bias was assessed by comparing selected consultations for SHC attendees that match the population registry to consultations without match. Only records with complete data for all determinants were included in the analysis. Descriptive analysis was performed to describe the study population and those who utilise the SHC, also including the utilisation rate per 1,000 residents with 95% confidence intervals (CI) for the study population and the STI positivity rate with 95% CI among SHC users. The STI positivity rate is the percentage of SHC users with one or more STI diagnoses (chlamydia, gonorrhoea, infectious syphilis, HIV or infectious hepatitis B), and gives insight into area specific high-risk STI population subgroups. For each PC area we geographically presented the degree of urbanisation, ethnic diversity, and the utilisation rate per 1,000 residents. We also plotted distance against utilisation rate per PC area.

Since the hierarchical structure of our data, residents located within 183 PC areas in 15 municipalities, we conducted multilevel logistic regression analyses. The top level of the hierarchy (municipality) was not modelled, since the small number of municipalities (n=15) produced unreliable estimates, and policy implications would most likely target PC areas. First, a null model (Model 0), only adjusting for year, was constructed to see whether PC variance was significant. Second, univariable models were computed. Third, a model including travel distance and all individual-level determinants was computed (Model 1) to examine the effect of distance on SHC utilisation adjusted for individual-level determinants. The final model (Model 2) included all individual-level and PC level determinants. The contribution in PC area variance was determined for each determinant in Model 2 by removing the determinant and comparing the PC variance with the PC variance of Model 2. Each multilevel model was adjusted for year (2015, 2016, 2017).

Model performance was assessed by the area under the receiver operating characteristics curve (AUC). An AUC value of 1 indicates perfect discriminative ability of the model to classify individuals as (not) visiting the SHC, and 0.5 suggests that the model is equivalent to random guessing. For each model, we also calculated the proportional change in the variance (PCV), with the null model as reference, and the median odds ratio (MOR). The PCV indicates the explained PC area variance by the determinants in the model. The MOR is used for quantifying the magnitude of the effect of clustering, and can be interpreted as the median increase in likelihood of visiting an SHC when moving a person from the PC area with lowest probability of visiting the SHC to a PC with a higher probability of visiting the SHC.

Before the models were constructed, we checked for bivariate Pearson correlation between variables. The correlation ranged from 0.0 to 0.7. Multicollinearity was defined by a variance inflation factor (VIF $\geq$10). No determinants were excluded based on correlation; all variables had a VIF<5.

SHC triage policy does affect the utilisation rate for certain groups for whom triage is performed (aged below 25 and/or having a non-Western migratory background have higher ‘priority’). We, therefore, also performed the same analyses separately for residents aged below 25 and for non-Western migratory background. It was not possible to perform a multilevel analysis for a combined stratification of age and migratory background, since the number of SHC visitors became too small to reliably estimate differences between PC areas.

All statistical analyses were conducted using SPSS (version 26). P-values were 2-sided and P<0.05 was considered statistically significant.

Results

Data selection and matching

For each study year, we included over a half million residents, with 1,582,017 records in total. Of the 19,460 SHC consultations that fulfil the study inclusion criteria, 220 (1.1%) records could not be matched to the population registry. There were no significant differences in individual determinants and triage criteria (e.g. being notified, having STI symptoms) between the matched and non-matched group. Only records with complete data were included in the analysis. In total, 646 records (0.04%) had to be excluded due to unavailability of SES information. This left 1,581,371 resident records with 19,237 SHC consultation record matches for analysis (Table 1).

Study area and study population

Based on the utilisation rate per 1,000 residents, SHC visitors were more often women, below 25 years, non-Western, and living in highly urbanised or low SES areas (Table 1). The straight-line distance from PC area to the SHC ranged from 0.6 km to 41.2 km. In general, the SHC utilisation rate decreased with increasing distance to the SHC (Figure 1D and Table 1). PC areas relatively close to the SHC are also the areas with a higher degree of urbanisation and a more ethnically diverse population (Figure 1A and 1B). The SHC utilisation rate between PC areas ranged from 1.13 to 48.76 per 1,000 residents (Figure 1D).

The overall positivity rate was 21.1% (95% CI: 20.5%-21.7%) among the SHC visitors. In general, the positivity rates for the various subgroups differed little from this overall positivity rate. The positivity rate was lowest for visitors aged 25 years or older (16.8%) and highest for Cape Verdean visitors which also had the highest utilisation rate (31.3%).

Multilevel models for SHC utilisation

Multilevel logistic models for SHC utilisation are presented in Table 2 and Supplementary Table 2. The null model depicted a statistically significant difference in SHC utilisation between PC areas with a PC variance of 0.69 ($p<0.001$). The univariable model with only travel distance accounted for the highest decrease in PC variance in utilising the SHC compared to null model, the PC variance decreased with 70.0% (Supplementary Table 2). After adjusting for travel distance and individual-level determinants (Model 1), the PC variance decreased by 77.5% to 0.15 compared to the null model, as shown in Table 2. Adding other PC area variables to the model (Model 2) explained 87.0% of the PC variance, leaving a MOR of 1.33. In other words, if a resident moved to another PC area with a higher probability of utilising the SHC, the median increase in their odds of utilising the SHC would be 1.3 fold (MOR = 1.33).

In Model 2, which adjusts for individual and PC determinants, living closer to the SHC was associated with SHC utilisation (Table 2). Each kilometre increase was associated with 5% decrease (OR: 0.95; 95% CI: 0.94-0.96) in the odds of utilising the SHC. This means that a person has a 20% lower odds of utilising the SHC (OR: 0.81) when residing at 8.0 kilometres (75^{th} percentile of distance) compared to 4.0 kilometres from the SHC (25^{th} percentile). The ORs of the individual-level variables in Model 2 were similar to the ORs observed in Model 1 (Table 2).

Each variable included in Model 2 decreased PC area variance, ranging from -0.6% for sex to -31.3% for age and -32.8% for travel distance (Table 3). Travel distance and ethnic diversity appeared to be the most important PC determinants in PC area variance decrease in Model 2.

Stratified multilevel models for SHC utilisation

The same analyses were performed for residents aged under 25 (Supplementary Table 3) and for residents with a non-Western migratory background (Supplementary Table 4). Among residents aged below 25, similar results were observed to the overall results (Table 2); the OR for distance was 0.95 (95% CI: 0.94-0.96) in the final model, and the VPC and MOR had a similar pattern with a final MOR of 1.33.

The results for non-Western residents differed from the total population and the residents aged below 25. Univariably (data not shown), distance was statistically significantly associated with SHC utilisation (OR: 0.94; 95% CI: 0.93-0.95), which was not the case in the final model for non-Western residents (OR: 0.99; 95% CI: 0.99-1.00). Only age and migratory background were statistically significant associated in the final model. The PC variance was fully explained for both Model 1 and 2 (PCV=100%), with a corresponding MOR of 1.

Travel distance accounted univariably for the largest decrease in PC variance for both residents aged below 25 and non-Western residents (data not shown). The MOR for the univariable model with travel distance was 1.49 for residents aged below 25 and 1.34 for non-Western residents.

Model performance

The AUC improved from 0.505 in the null model to 0.819 in final Model 2, reflecting a good discriminative ability of SHC utilisation (Table 2). As shown in Table 3, age had the largest added value in model performance, since the AUC decreased most when age was removed from Model 2 (AUC=0.714). Distance was the second-best determinant in model performance (AUC=0.802), together with individual migratory background and postal level ethnic diversity (for both AUC=0.803). The discriminative ability of both the final model among residents aged below 25 and among non-Western residents was less compared to the overall model, with respectively an AUC of 0.733 and an AUC of 0.775.

Discussion

Our analysis confirmed the hypothesis that larger travel distance is inversely associated with SHC utilisation in the greater Rotterdam area. The distance decline is independent of age and migratory background. Of all variables included in the final model, travel distance accounted for the largest decrease in PC area variance.

The results of our study are consistent with other literature (13–16). However, these studies are not specifically for SHC utilisation and many of these studies are not in Western infrastructure-rich urban areas, like the Netherlands. We found the same distance effect for people aged below 25, but not for people with a non-Western migratory background. Possible explanations are related to the provider, the client and area (demographic) characteristics. Triage is probably the most important explanation on provider side, because prioritisation makes SHC consultation generally more accessible for people with a migratory background. Residential location is not an SHC triage criterion, however migratory status is prioritised above the under 25 years old criterium since migrants' STI positivity is generally higher (2, 17, 18). Difference in utilisation seems not to be affected by other triage criteria than age and migratory background; no difference was observed with other prioritised triage criteria, i.e. being notified or having symptoms.

An explanation on client side is self-selection or (non) familiarity, to explain the difference in distance effect. Those living further may be more critical on their perceived STI risk, since it takes more effort to visit the SHC. From the literature it is known that a higher risk perception is positively associated with STI testing (11, 19–21). It may be that the anonymous consultation and free of charge services offered by the SHC are more important for migrants to counterbalance the distance (22, 23). Previous research showed that more distant healthcare facilities may actually be preferred for stigmatized health conditions (24, 25). It is known that migrants perceive more shame and stigma related to STIs (5, 26). Also, perceived issues with confidentiality and privacy at the GP may play a role in choosing anonymous STI testing at the SHC (4, 27).

Another explanation for the difference in distance effect could be a difference in sociodemographic distribution among PC areas or on non-measured determinants. Migrants may reside generally further away from the SHC or at places with good public transport access compared to youngsters, affecting the UR. From additional analysis we could conclude that migratory groups with a high utilisation rate in our study (Antillean, Surinamese or Sub-Sahara African), reside all over the region without clear 'migrant neighbourhoods'. Turks and Moroccans tend to reside slightly more remote from the SHC and show more area clustering.

We were able to explain a substantial proportion of the variance between PC areas. In the overall model, the PC variance in SHC utilisation decreased with 87.0%. Distance explained most decrease in PC variance. Distance had also the second-best added value (together with individual migratory background and postal level ethnic diversity) in model performance, after age. Since age and migratory background are already part of the triage policy, this finding strongly suggests introducing policy measures that decrease the access inequality between areas caused by distance, for example by using a mobile clinic, an additional location, or community-based testing in more remote areas. Despite increasing the access by lowering the physical distance, a MOR of 1.33 in the final model still indicates a substantial difference between PC areas in SHC utilisation even when other individual and area determinants are similar. This implies that we did not model all (area) determinants explaining geographical differences in utilisation.

Strengths and limitations

Strengths of this study are firstly that this appears to be the first large-scale study linking SHC consultation data to population data to investigate SHC utilisation in high-income areas. Secondly, we used multiple data sources for the fullest possible set of determinants. Thirdly, our multilevel approach allows the simultaneous examination of factors at different levels, in our case individual and PC area. Therefore, we were able to demonstrate the importance of area level determinants, which is often lacking in other studies. Finally, we carefully considered our distance measure. We calculated multiple measures for proximity, which were all highly correlated ($r^2 > 0.9$). Other studies also found that straight-line distance is an adequate proxy for road network distance and travel time in more urban areas (28–31).

The major limitation of the study is that we are not able to quantify the clinical significance of lower utilisation rate among more remote areas from the SHC. If residents in these areas have a lower STI risk and are not visiting the SHC, or instead visiting the GP, this is less severe than high STI risk residents not visiting both SHC and GP. Similarly, we do not know if residents close to the SHC are utilising it as needed. Based on the STI positivity by distance, it can be argued that persons with a high risk find their way to the SHC by mechanisms such as triage and self-selection, as explained earlier. On the other hand, the STI positivity for those living further away is not lower, while the SHC utilisation rate is. Since it is very unlikely that the distance effect only applies to low STI risk individuals, the SHC does not reach everyone that should be reached. To better interpret these results, and to develop an optimal strategy for local STI testing services, further research is needed to address the role of the GP. Another limitation is that we are not able to completely correct for triage effect. We have no information on triage criteria for all residents, or more specifically, for those who are rejected for an SHC consultation based on triage or limited consultation availability. Insight in the rejected individuals would give more insight in the 'real' SHC accessibility and missed opportunities. We know that almost everyone who attempts to make a consultation at the SHC in Rotterdam has at least one triage criterion (unpublished data). From this same work, it was also concluded that a significant proportion high-risk people were refused due to limited consultation availability. Finally, we assigned the same distance to the SHC for all residents in one PC area. A more individual calculation of distance was not possible since anonymous consultation data only contain four-digit PCs. Nevertheless, several studies have shown that centroid distance is an acceptable proxy measure (32, 33).

Conclusion

Our findings are relevant for local policy as we demonstrate that distance is a significant barrier for STI testing at the sole SHC in this infrastructure-rich urban area. Minimising travel distance, e.g. by using mobile clinics or community-based testing, in more remote areas, could be a strategy to reduce area differences in STI testing. Different strategies may be considered for different subgroups.

Abbreviations

AUC Area under the receiver operating characteristics curve

BSN Citizen service number

CI Confidence interval

GP General practitioner

HIV Human immunodeficiency virus

IQR Interquartile range

Km kilometres

MOR Median odds ratio

MSM Men who have sex with men

No Number

OR Odds ratio

PC Postal code

PCV Proportional change in the variance

REF Reference

SES Socioeconomic status

SHC Sexual health centre

STI Sexually transmitted infection

VIF Variance inflation factor

Declarations

Ethical approval

No ethical approval was needed under prevailing laws in the Netherlands as this study is a retrospective observational study using anonymous data only (as stated by the National Central Committee for Human Studies: www.ccmo.nl and in the conduct of good behaviour in research www.federa.org).

Consent for publication

Not applicable.

Availability of data and material

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

Declaration of competing interests

The authors declare that they have no competing interests.

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Authors’ contributions
DT initiated the study, analysed and interpreted the data and drafted the manuscript. HG and BM initiated the study, helped interpreting the data and revised the manuscript. DN advised in the statically analysis, its interpretation, and revised the manuscript. JHR helped interpreting the data and revised the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1. Profile of the study population[a] (2015-2017)

Characteristic	Total population		SHC visitors		Utilisation rate per 1,000 residents (95% CI)		STI positivity rate SHC visitors (95% CI)[b]	
	No.	%	No.	%				
Total	1581371		19237		12.2	(12.1 - 12.2)	21.1%	(20.5% - 21.7%)
2015	526590	33.3%	6505	33.8%	12.4	(12.3 - 12.4)	20.4%	(19.4% - 21.3%)
2016	526649	33.3%	6203	32.2%	11.8	(11.7 – 11.8)	20.9%	(19.9% - 21.9%)
2017	528132	33.4%	6529	33.9%	12.4	(12.3 – 12.5)	22.1%	(21.1% - 23.1%)
Sex								
Male	788641	49.9%	8408	43.7%	10.7	(10.6 - 10.7)	21.5%	(20.6% - 22.4%)
Female	792730	50.1%	10829	56.3%	13.7	(13.6 - 13.7)	20.8%	(20.1% - 21.6%)
Age								
<25 years	477768	30.2%	13352	69.4%	27.9	(27.9 - 28.0)	23.0%	(22.3% - 23.8%)
≥25 years	1103603	69.8%	5885	30.6%	5.3	(5.3 - 5.4)	16.8%	(15.8% - 17.7%)
Median (IQR)	30	(23-38)	22	(20-26)				
Migratory background								
Native Dutch	862245	54.5%	8910	46.3%	10.3	(10.3 - 10.4)	19.4%	(18.6% - 20.3%)
Other Western	133271	8.4%	1600	8.3%	12.0	(11.8 - 12.2)	18.5%	(16.7% -

								20.5%)
Dutch Antillean	58318	3.7%	1885	9.8%	32.3	(31.8 - 32.8)	25.8%	(23.9% - 27.8%)
Surinamese	108221	6.8%	2295	11.9%	21.2	(20.9 - 21.5)	23.1%	(21.4% - 24.9%)
Turkish	115626	7.3%	652	3.4%	5.6	(5.4 - 5.9)	18.7%	(15.9% - 21.8%)
Moroccan	82248	5.2%	829	4.3%	10.1	(9.7 - 10.4)	22.3%	(19.6% - 25.2%)
Other non-Western	104179	6.6%	1269	6.6%	12.2	(11.9 - 12.5)	19.1%	(17.1% - 21.4%)
Sub-Sahara African[c]	32095	2.0%	566	2.9%	17.6	(16.7 - 18.5)	19.6%	(16.5% - 23.0%)
Cape Verdean	27857	1.8%	972	5.1%	34.9	(33.8 - 35.9)	31.3%	(28.4% - 34.2%)
Middle East European	57311	3.6%	259	1.3%	4.5	(4.0 - 5.0)	20.5%	(15.9% - 25.7%)
Non-Western migratory background								
No	978014	61.8%	10393	54.0%	10.6	(10.6 - 10.7)	19.4%	(18.6% - 20.2%)
Yes	603357	38.2%	8844	46.0%	14.7	(14.6 - 14.7)	23.2%	(22.3% - 24.0%)
Degree of urbanisation[d]								
Very high	846248	53.5%	14757	76.7%	17.4	(17.4 - 17.5)	20.9%	(20.2% - 21.6%)
High	432442	27.3%	3289	17.1%	7.6	(7.5 - 7.7)	21.6%	(20.3% - 23.1%)
Moderate	192545	12.2%	821	4.3%	4.3	(4.1 - 4.4)	22.0%	(19.3% - 25.0%)
Low	72162	4.6%	281	1.5%	3.9	(3.5 - 4.3)	23.1%	(18.5%

								- 28.3%)
Very low	37974	2.4%	89	0.5%	2.3	(1.6 - 3.1)	23.6%	(15.7% - 33.2%)
Socioeconomic status[d]								
High	278543	17.6%	3220	16.7%	11.6	(11.5 - 11.7)	18.7%	(17.3% - 20.0%)
Average	711066	45.0%	6734	35.0%	9.5	(9.4 - 9.5)	21.2%	(20.3% - 22.2%)
Low	591762	37.4%	9283	48.3%	15.7	(15.6 - 15.7)	21.9%	(21.1% - 22.8%)
Travel distance to SHC[d]								
<5 km	641744	40.6%	12832	66.7%	20.0	(19.9 - 20.0)	20.7%	(20.0% - 21.4%)
5-10 km	586150	37.1%	4779	24.8%	8.2	(8.1 - 8.2)	22.0%	(20.9% - 23.2%)
≥10 km	353477	22.4%	1626	8.5%	4.6	(4.5 - 4.7)	22.0%	(20.0% - 24.0%)
Median (IQR)	6.1	(2.9-9.9)	3.0	(2.1-6.1)				
Northern or southern side of the river Maas[d]								
North	912135	57.7%	13521	70.3%	14.8	(14.8 - 14.9)	20.1%	(19.4% - 20.8%)
South	669236	42.3%	5716	29.7%	8.5	(8.5 - 8.6)	23.6%	(22.5% - 24.7%)

Data are presented as No. (%) unless otherwise indicated.

Abbreviations: CI, confidence interval; IQR, interquartile range; km, kilometres; no, number; SHC, sexual health centre; STI, sexually transmitted infection.

[a] Complete case analysis included three years together (2015, 2016, 2017). For persons who utilise the SHC in Rotterdam, we selected for each year only the first record that fulfilled the inclusion criteria (living

in the greater Rotterdam area, aged 15 to 45 years, tested for any STI).

[b] STI positivity rate is the percentage of SHC users with a positive STI test (chlamydia, gonorrhoea, infectious syphilis, HIV or infectious hepatitis B). To identify STI positivity we considered all SHC records that fulfilled the inclusion criteria for SHC utilisation per year.

[c] Sub-Sahara African without Cape Verdean.

[d] Based on four-digit postal code.

Table 2. Multilevel logistic models for SHC utilisation[a]						
Determinant	Model 0[b]		Model 1		Model 2	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Year						
2015	REF		REF		REF	
2016	0.95	(0.92 - 0.98)	0.94	(0.92 - 0.97)	0.94	(0.92 - 0.97)
2017	0.99	(0.96 - 1.03)	0.99	(0.95 - 1.02)	0.99	(0.95 - 1.02)
Individual level						
Sex						
Male			REF		REF	
Female			1.29	(1.24 - 1.34)	1.29	(1.24 - 1.34)
Age in years						
15-19			0.53	(0.49 - 0.58)	0.53	(0.49 - 0.58)
20-24			REF		REF	
25-29			0.31	(0.28 - 0.34)	0.31	(0.28 - 0.34)
30-34			0.15	(0.13 - 0.17)	0.15	(0.13 - 0.17)
35-39			0.08	(0.07 - 0.09)	0.08	(0.07 - 0.09)
≥40			0.04	(0.03 - 0.05)	0.04	(0.03 - 0.05)
Migratory background						
Native Dutch			REF		REF	
Other western			0.85	(0.69 - 1.04)	0.84	(0.69 - 1.04)
Dutch Antillean			2.08	(1.79 - 2.40)	2.06	(1.79 - 2.40)
Surinamese			1.60	(1.39 - 1.85)	1.59	(1.39 - 1.84)

Turkish	0.38	(0.32 - 0.47)	0.38	(0.32 - 0.46)
Moroccan	0.59	(0.48 - 0.72)	0.58	(0.48 - 0.72)
Other non-western	0.81	(0.67 - 0.98)	0.81	(0.67 - 0.98)
Sub-Sahara African[c]	1.26	(1.05 - 1.51)	1.25	(1.04 - 1.50)
Cape Verdean	2.20	(1.85 - 2.61)	2.18	(1.84 - 2.60)
Central and Eastern European	0.37	(0.30 - 0.46)	0.36	(0.29 - 0.45)
Postal code level				
Degree of urbanisation				
Very high			REF	
High			0.73	(0.63 - 0.85)
Moderate			0.69	(0.53 - 0.89)
Low			0.70	(0.53 - 0.93)
Very low			0.65	(0.46 - 0.93)
Socioeconomic status				
High			REF	
Average			0.87	(0.73 - 1.03)
Low			0.81	(0.64 - 1.02)
Ethnic diversity				
Low			REF	
Medium			1.37	(1.15 - 1.63)
High			1.81	(1.39 - 2.37)
Travel distance to SHC in km (continuous)	0.92	(0.91 - 0.93)	0.95	(0.94 - 0.96)

Northern or southern part of river Maas						
North					REF	
South					0.92	(0.84 - 1.01)
Additional information						
Measures of variation		**P-value**		**P-value**		**P-value**
Postal code level variance	0.69	<0.001	0.15	<0.001	0.09	<0.001
PCV (%)	REF[d]		77.5%		87.0%	
MOR	2.20		1.45		1.33	
Model performance						
AUC	0.505		0.816		0.819	

Abbreviations: AUC, area under the receiver operating characteristics curve; CI, confidence interval; km, kilometres; MOR, median odds ratio; OR, odds ratio; PCV, proportional change in variance; REF, reference; SHC, sexual health centre.

[a] SHC utilisation is defined as at least one SHC visit that fulfilled the inclusion criteria (living in the greater Rotterdam area, aged 15 to 45 years, tested for any STI). For each year we only included the first record that met the inclusion criteria during the study period (2015-2017). The model for SHC utilisation includes 1581371 persons.

[b] Model 0 is a null model in which only levels are defined; this model does not contain any individual or postal code level determinants.

[c] Sub-Sahara African without Cape Verdean.

[d] Reference for Model 1 and Model 2.

Table 3. Change in postal code variance in SHC utilisation[a.b] and AUC upon removing determinant from Model 2

Ranking	Determinant	Level of determinant	% change in PC variance without determinant[c]	AUC
1	Travel distance to SHC in km	Postal code	-32.8%	0.802
2	Age	Individual	-31.3%	0.714
3	Ethnic diversity	Postal code	-16.0%	0.803
4	Degree of urbanisation	Postal code	-12.4%	0.818
5	Migratory background	Individual	-4.8%	0.803
6	Socioeconomic status	Postal code	-3.0%	0.819
7	Northern or southern part of river Maas	Postal code	-1.7%	0.819
8	Sex	Individual	-0.6%	0.818

Abbreviations: AUC, area under the receiver operating characteristics curve; km, kilometre; PC, postal code; SHC, sexual health centre.

[a] SHC utilisation is defined as at least one SHC visit that fulfilled the inclusion criteria (living in the greater Rotterdam area, aged 15 to 45 years, tested for any STI). For each year we only included the first record that met the inclusion criteria during the study period (2015-2017). The model for SHC utilisation includes 1581371 persons.

[b] Ranked based on contribution to postal code variance.

[c] Complete model (Model 2, Table 2) as reference.

Figures

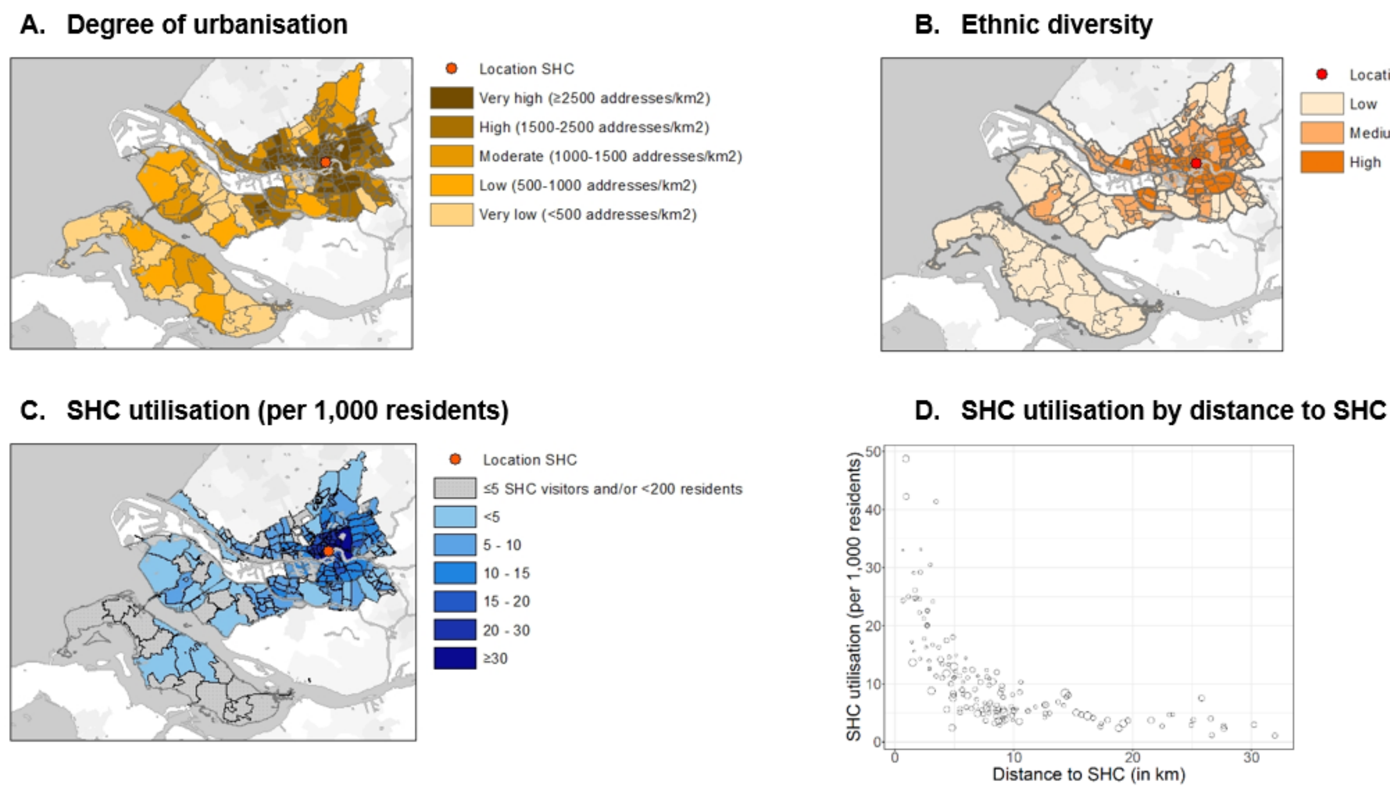

Figure 1

Degree of urbanisationa, ethnic diversityb, SHC utilisationc and SHC utilisation by distance to SHCd Abbreviations: km, kilometre; SHC, sexual health centre. The basemap (Figure 1A, 1B, 1C) is created with publicly available data from Statistics Netherlands. The data presented in these maps are based on publicly available data (Figure 1A) or data generated in this study (Figure 1B and 1C). a Degree of urbanisation of each postal code is the classification of the number of addresses/km2, presented in five categories. b Level of postal area ethnic diversity ranging from 0 to 1, divided in tertiles; a higher index score reflects more ethnic diversity. The index was based on 10 migratory background groups: native Dutch, other western residents, Dutch Antillean, Surinamese, Turkish, Moroccans, other non-western residents, Sub-Sahara African (without Cape Verdean), Cape Verdean, and Central and Eastern European. c For SHC utilisation per postal code we selected only the first record that fulfilled the inclusion criteria (living in the greater Rotterdam area, aged 15 to 45 years, tested for any STI) for each individual per year (2015-2017). d Each dot represents a postal code area. The size of the dots indicate uncertainty; the smaller the dot, the more residents in the postal code area. Postal code areas with ≤5 SHC visitors and/or <200 residents are excluded. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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- 20201002SupplementaryTablesMSutilisationBMCHSRPDF.pdf