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ORIGINAL RESEARCH

A structural equation model to predict pre-exposure prophylaxis acceptability in men who have sex with men in Leicester, UK

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Objectives
Pre-exposure prophylaxis (PrEP) is an effective HIV prevention tool for high-risk men who have sex with men (MSM). However, acceptability and uptake have been variable. This study explored the factors that predict PrEP acceptability in MSM in Leicester, where HIV prevalence is double the national average.

Methods
A total of 191 HIV-negative MSM completed a cross-sectional survey. Participants provided demographic information, and completed measures of HIV knowledge, perceived HIV risk, engagement in sexual risk behaviour, acquisition of a sexually transmitted infection (STI) in the last 12 months, frequency of HIV testing and PrEP acceptability.

Results
Kruskal–Wallis tests showed statistically significant effects of sexual orientation, education level and income, respectively, on HIV knowledge. Gay-identified individuals possessed greater HIV knowledge than bisexuals. Respondents with General Certificate of Secondary Education (GCSE)-level education had significantly less HIV knowledge than those educated to postgraduate level. Respondents with income of < £10 000 possessed significantly less HIV knowledge than higher income groups. Structural equation modelling showed that the relationship between HIV knowledge and PrEP acceptability was mediated by perceived HIV risk, engagement in sexual risk behaviour, acquisition of an STI in the past 12 months and frequency of HIV testing.

Conclusions
The results reveal socio-economic inequalities in HIV knowledge and HIV testing, and suggest that MSM who have high levels of HIV knowledge and perceived HIV risk and who regularly test for HIV are most likely to endorse PrEP as personally beneficial. HIV knowledge and accurate risk appraisal should be promoted in MSM. The HIV testing context constitutes an ideal context for promoting PrEP to high-risk MSM.

Keywords: acceptability, HIV prevention, men who have sex with men, pre-exposure prophylaxis

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Introduction

Pre-exposure prophylaxis (PrEP) is an effective HIV prevention tool in men who have sex with men (MSM), with > 90% risk reduction for HIV acquisition in those taking it daily [1] or episodically (i.e. before and after sex) [2]. Despite the clinical effectiveness of PrEP, acceptability and uptake among MSM have been variable. It is important to identify and address potential barriers to PrEP among MSM at risk of HIV infection. While there has been some research into PrEP acceptability in MSM in London [3], where awareness, acceptability and uptake are relatively high, no research has focused on MSM in Leicester, which has the highest HIV prevalence of all local authority areas in the East Midlands [4]. Accordingly, this study set out to examine the factors that predict personal acceptability of PrEP in MSM in Leicester.

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Awareness of PrEP is improving in MSM, with rates ranging from 47% in 2008 [5] to 82% in 2017 [6]. PrEP knowledge has been found to be greater among MSM aged > 36 years and those with high levels of health engagement, that is, those who have attended sexual health services or who have been diagnosed with a sexually transmitted infection (STI) in the previous 12 months [7]. This is partly attributable to the fact that education level and knowledge of HIV risk are positively correlated [8]. However, PrEP acceptability is variable among MSM. A recent meta-analysis [9] showed an overall rate of acceptance of PrEP in MSM of 58.7% (95% confidence interval 52.4–63.1%). MSM who were previously unaware of the benefits of PrEP had high levels of acceptability once the prevention tool had been explained to them [10]. HIV testing provides a good opportunity for explaining PrEP to at-risk patients. Among those MSM who were aware of PrEP, knowledge of a high level of efficacy (> 80%) against acquiring HIV increased acceptability of PrEP [11].

Higher educational attainment is a strong proxy for PrEP uptake in MSM—higher rates of PrEP use are observable in those achieving education to a postgraduate level or above [12]. Individuals who are aware of PrEP and who perceive their sexual behaviour as high risk generally identify themselves to a clinician for further advice and support. Self-referral to clinics reflects growing self-efficacy among patients making complex decisions about their health, such as decisions regarding PrEP uptake. In the USA, it was shown that black and Latino MSM were much less likely to refer themselves to a clinic to initiate PrEP [13], indicating less knowledge of the potential benefits of PrEP.

Awareness and acceptance of one's sexual risk behaviour are an important determinant of PrEP uptake. In short, people must view themselves as being at risk of HIV infection in order to take the decision to use PrEP. Increased sexual risk, such as recent condomless anal sex (both receptive and insertive), was a strong predictor of PrEP acceptability in a number of studies [3,6,14]. Perceived HIV infection risk is also an important predictor of adherence to PrEP. However, those MSM who perceive their risk of acquiring HIV to be low, regardless of actual clinical risk, may be less likely to take PrEP [6,13,15].

A recent study of HIV-negative MSM attending sexual health clinics in the UK showed that 64% of the sample perceived PrEP as personally beneficial, and that PrEP acceptability was predicted by awareness of HIV risk and the perception that PrEP is effective [6]. Yet, in the UK, there are still significant psychosocial barriers to accessing PrEP, including uncertainty around the effectiveness of the drug, side effects and toxicities, and the social stigma associated with taking it [10]. Although PrEP uptake among MSM in London is relatively high, this may not be the case in other parts of the UK [10,14]. At the end of 2016, a 40% drop in HIV incidence in London was reported and this was attributed to the combined effect of early initiation of antiretroviral therapy (ART) and PrEP uptake in at-risk MSM [16]. However, such a drop in new HIV transmissions has not been observed in other major UK cities. The City of Leicester in the English East Midlands has nearly twice the prevalence of HIV infection compared with the national average (3.9/1000 versus 2.3/1000, respectively) in all at-risk groups [4]. PrEP may be an effective tool for preventing new cases of HIV infection. This study aimed to improve knowledge of the factors that may increase PrEP acceptability among those MSM who could benefit from it.

Hypotheses

Hypothesis 1. According to previous research, we expect socio-economic and demographic variables to have an impact on HIV knowledge (and associated risk factors), with lower income and lower educational attainment predicting less HIV knowledge in MSM than higher income and higher educational levels.

Hypothesis 2. HIV knowledge will predict the variance in perceived HIV risk, as accurate knowledge enables individuals to be aware of their risk of infection.

Hypothesis 3. Engagement in sexual risk behaviour will predict the variance in having STIs in the past 12 months and in the frequency of HIV testing.

Hypothesis 4. HIV testing, as a vehicle for learning about PrEP in the context of sexual risk behaviour, will predict the variance in PrEP acceptability.

Methods

Participants

A total of 191 HIV-negative MSM in Leicester were recruited on Grindr, the geospatial gay social networking application. The mean age of participants was 33.6 years [standard deviation (SD) 11.2 years]. Seventy-four per cent of participants reported white British ethnicity, 9% South Asian ethnicity and 8% white other ethnicity. Seventy-four per cent of participants self-identified as gay and 23% as bisexual. Twenty-two per cent of participants reported an income < £10 000; 37% £10 000–24 999, 18% £25 000–34 999, 8% £35 000–44 999, 6% £45 000–54 999 and 6% > £55 000. Respondents who reported having sex with other men were included in the analysis.

Measures

Participants completed a cross-sectional survey tapping into key demographic factors (e.g. age, ethnicity, education

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level and income), HIV knowledge, engagement in sexual risk behaviours, perceived HIV risk, acquisition of an STI in the past 12 months, frequency of HIV testing and PrEP acceptability. HIV knowledge was measured using an adapted version of the 18-item HIV Knowledge Questionnaire [17], including items such as 'A man can get HIV if he has condomless anal sex with another man who has HIV'. The higher the score, the more HIV knowledge, as a score of 1 is given whenever the participant provides a correct response. The Cronbach alpha score for this scale was 0.60, which suggested acceptable reliability. Engagement in sexual risk behaviour was measured by computing the scores of three items measuring the frequency of cruising, using geospatial applications and using gay saunas to find sexual partners. The scale included items such as 'In the past month, how often have you had sex with other men you met on the Internet or a mobile application (e.g. Grindr)?' Participants had to respond on a Likert scale ranging from 1 (never) to 6 (every day). The Cronbach alpha for this scale was 0.59, which was acceptable given that there were only three items. Perceived HIV risk was measured using the HIV Perceived Risk Scale [18]. This scale is composed of eight items and contains items such as 'There is a chance, no matter how small, I could get HIV'. Participants have to respond in terms of how much they agree with the statements on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The Cronbach alpha for this scale was 0.76, suggesting good internal consistency. Acquisition of an STI in the past 12 months was measured using one item: 'In the last 12 months, have you been diagnosed with any sexually transmitted infections (STIs)?' This variable was dummy coded to facilitate analyses. Frequency of HIV testing was measured using one item: 'How often do you get tested for HIV?' Participants had to respond on a Likert scale ranging from 1 (every 3 months) to 5 (never). PrEP acceptability was measured using the item 'Pre-exposure prophylaxis is a one-pill-a-day treatment for preventing HIV infection, which has been shown to be highly effective. To what extent do you think pre-exposure prophylaxis (PrEP) could be of benefit to you personally?' Participants had to respond on a Likert scale ranging from 1 (not at all) to 5 (very much). A higher score indicated a higher level for each variable except for the frequency of HIV testing, where a higher score indicated less frequent HIV testing.

Results

Tests of normality

Several variables were not normally distributed. Kolmogorov–Smirnov tests showed that the following variables were not normally distributed: PrEP acceptability [$D(182) = 2.38$; $P < 0.001$]; HIV knowledge [$D(169) = 2.12$; $P < 0.001$]; engagement in sexual risk behaviours [$D(184) = 3.86$; $P < 0.001$]; frequency of HIV testing [$D(184) = -3.24$; $P = 0.001$]; and having acquired STIs in the past 12 months [$D(181) = 7.04$; $P < 0.001$]. Therefore, nonparametric tests were used in this study. Data were analysed using the Kruskal–Wallis and Mann–Whitney tests, Spearman's rho correlations and structural equation modelling. For all information concerning the descriptives of the main variables, please see Table 1.

Impact of self-reported sexual orientation on key variables

A nonparametric Mann–Whitney test showed no statistically significant differences between self-reported sexual orientation categories (gay versus bisexual) for perceived HIV risk ($U = -0.90$; $P = 0.37$), engagement in sexual risk behaviours ($U = -0.52$; $P = 0.60$), PrEP benefit ($U = -0.82$; $P = 0.42$) and the frequency of HIV testing ($U = -0.97$; $P = 0.34$). In contrast, there was a statistically significant difference between gay and bisexual people for HIV knowledge ($U = -2.57$; $P = 0.010$), with self-reported gay people having a higher mean score for HIV knowledge (11.83; SD 1.90) than bisexual people (10.92; SD 2.058). Sexual orientation was therefore included in the model.

Impact of ethnicity on key variables

A nonparametric Kruskal–Wallis test showed no statistically significant effect of ethnicity on perceived HIV risk [$H(2) = 6.10$; $P = 0.52$], engagement in sexual risky behaviours [$H(2) = 8.94$; $P = 0.26$], PrEP benefit [$H(2) = 6.52$; $P = 0.48$], HIV knowledge [$H(2) = 6.53$; $P = 0.48$] and the frequency of HIV testing [$H(2) = 4.53$; $P = 0.71$]. Therefore, ethnicity was not included in the model.

Impact of education level on key variables

Of the 191 participants, 33 reported GCSE/O Level education (17%); 49 reported having completed A Levels (26%); 45 reported having obtained a university degree (24%); 46 reported having a postgraduate degree (24%) and 17 reported another type of education (9%). Kruskal–Wallis tests were performed to evaluate the impact of level of education on key variables of interest. There was a statistically significant effect of education level only on HIV knowledge [$H(4) = 12.59$; $P = 0.013$], with people who reported having completed GCSE/O Level education showing statistically significantly less HIV knowledge

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Table 1 Descriptives for the main variables and socio-economic and demographic characteristics of participants in this study

Variable	Mean	SD	Minimum	Maximum		
HIV knowledge	11.59 (median = 12)	1.97	5	14		
Perceived HIV risk	22.17 (median = 22)	4.97	10	34		
Frequency of HIV testing	3.10 (median = 3)	1.39	1	5		
PrEP acceptability	3.13 (median = 3)	1.42	1	5		
Engagement in sexual risk behaviour	4.32 (median = 4)	1.89	1	4		
Socio-economic variables and demographics						
Age (years)	33.56 (median = 31)	1.83	15	68		
Variable % (*n*)						
Education level	GCSE/O Levels, 17% (33)	A Levels, 26% (49)	Undergraduate degree, 24% (45)	Postgraduate degree, 24% (46)	Other, 9% (17)	
Ethnicity	White British, 74% (141)	South Asian, 9% (26)	White Other, 8% (24)			
Income	< £10 000, 22% (42)	£10 000–£24 999, 37% (71)	£25 000–£34 999, 18% (35)	£35 000–£44 999, 8% (15)	£45 000–£54 999, 6% (12)	> £55 000, 6% (12)
Sexual orientation	Gay, 74% (141)	Bisexual, 23% (50)				
Having an STI in the past 12 months	Yes, 12% (22)	No, 83% (159)				

PrEP, pre-exposure prophylaxis; SD, standard deviation; STI, sexually transmitted infection.

(mean score 10.89; SD 2.0) than participants who reported having a postgraduate degree (mean score 12.20; SD 1.26).

Impact of income on key variables

Of the 191 participants, there were 42 individuals who reported an income of < £10 000 (22%), 71 who reported an income of between £10 000 and £24 999 (37%), 35 who reported an income of between £25 000 and £34 999 (18%), 15 who reported an income of between £35 000 and £44 999 (8%), 12 who reported an income of between £45 000 and £54 999 (6%) and 12 who reported an income of > £55 000 (6%). Kruskal–Wallis tests showed that there was a statistically significant impact of income on HIV knowledge [$H(5) = 18.71$; $P = 0.002$] and on the frequency of HIV testing [$H(5) = 13.81$; $P = 0.017$].

Participants who reported an income of < £10 000 showed statistically significantly less HIV knowledge (mean score 11.00; SD 1.93) than the higher income groups [mean score 12.23 (SD 1.88) for those who reported an income between £25 000 and £34 999; mean score 12.47 (SD 0.99) for those who reported an income between £35 000 and £44 999; mean score 12.50 (SD 1.26) for those who reported an income between £45 000 and £54 999; mean score 12.36 (SD 1.56) for those who reported an income > £55 000]. Additionally, participants who reported an income between £10 000 and £24 999 reported more frequent HIV testing (mean score 2.74; SD 1.27) than those who reported an income < £10 000 (mean score 3.50; SD 1.47) and those who reported incomes between £45 000 and £54 999 (mean score 3.67; SD 1.50) and > £55 000 (mean score 3.67; SD 1.44).

Impact of age on key variables

The mean age of this sample of 191 individuals was 33.56 years (SD 11.83 years), with a minimum age of 15 years and a maximum age of 68 years. Age was also normally distributed, presenting a skewness value of 0.64. A multivariate general linear model showed that age did not impact on the variables of interest [$F(1) = 2.66$; $P = 0.11$ for HIV knowledge; $F(1) = 2.26$; $P = 0.14$ for perceived HIV risk; $F(1) = 0.51$; $P = 0.48$ for frequency of HIV testing; $F(1) = 3.79$; $P = 0.053$ for engagement in sexual risk behaviours; and $F(1) = 0.18$; $P = 0.67$ for PrEP acceptability]. Age was not therefore included in the model.

Correlations

Engaging frequently in actual risky sexual behaviour was positively associated with perceived HIV risk ($r = 0.44$; $P < 0.001$), which suggested that participants were aware that engaging in risky sexual behaviours is associated with being at risk of HIV infection. Moreover, frequent engagement in sexual risk behaviour was positively associated with having reported an STI in the past 12 months ($r = 0.24$; $P = 0.001$), suggesting a connection between engagement sexual risk behaviour and the acquisition of STIs. Correlations also suggested that the more participants perceived PrEP as beneficial, the more likely it was that they were frequently engaging in actual risky sexual behaviour ($r = 0.23$; $P = 0.002$). Moreover, the higher the perceived HIV risk, the more participants reported PrEP as being beneficial for them ($r = 0.36$; $P < 0.001$). This seemed to suggest that participants see benefits in using

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PrEP as a remedy for engaging in actual risky sexual behaviour and when they perceive that they are at risk of HIV infection. Also, PrEP benefit was moderately and positively associated with HIV knowledge ($r = 0.18$; $P = 0.022$), suggesting therefore that the more you know about HIV, the more likely you are to perceive PrEP as being beneficial.

Frequent HIV testing was also positively correlated with perceived HIV risk ($r = 0.21$; $P = 0.008$), with engagement in sexual risk behaviour ($r = 0.28$; $P = 0.001$), with PrEP acceptability ($r = 0.22$; $P = 0.003$), with more HIV knowledge ($r = 0.16$; $P = 0.037$) and with having STIs in the past 12 months ($r = 0.27$; $P < 0.001$).

Structural equation model

Correlations suggested that HIV knowledge and HIV perceived risk were associated with engagement in sexual risk behaviour, which in turn was associated with testing frequently for HIV and having reported an STI in the past 12 months and with seeing the benefit of PrEP. Moreover, educational level, income and sexual orientation all had a statistically significant effect on HIV knowledge. Transformations were applied to all nonnormally distributed variables, resulting in normal distributions. Assumptions of linearity (normal probability plot), homoscedasticity (plot of residuals versus predicted value), independence (Durbin–Watson statistic) of residuals, the presence of outliers (Cook's distance <1 except for one value) and multicollinearity (Variance Inflation Factor (VIF) < 2) were also tested and no major problems were found. Therefore, a structural equation model was constructed to examine the relationship between, on the one hand, socio-economic and demographic variables (e.g. education level, income and sexual orientation) and, on the other hand, HIV knowledge and PrEP acceptability (as the dependent variable), with perceived HIV risk, engagement in sexual risk behaviours, having had STIs in the past 12 months, and the frequency of HIV testing as mediators. The model was statistically significant with $\chi^2 = 64.030$ (df = 28; $n = 191$; $P < 0.001$). The model fit was also good with a Confirmatory Fit Index (CFI) of 0.67 and an Root Mean Square Error of Approximation (RMSEA) of 0.08. As observed previously in nonparametric analyses, education, income and sexual orientation statistically significantly predicted the variance in HIV knowledge, with education showing a $\beta = 0.18$ ($P = 0.012$), income a $\beta = 0.23$ ($P = 0.002$) and sexual orientation a $\beta = -0.17$ ($P = 0.016$) for HIV knowledge. HIV knowledge also significantly predicted the variance in perceived HIV risk, with a $\beta = 0.19$ ($P = 0.017$). There was a significant pathway with perceived HIV risk mediating the impact of HIV knowledge on engagement in sexual risk behaviours ($\beta = 0.32$; $P < 0.001$). This suggested that, in order for HIV knowledge to impact actual sexual risk behaviour, MSM must perceive themselves to be at risk. The model then suggested that engagement in sexual risk behaviours had a statistically significant impact on having an STI in the past 12 months ($\beta = 0.33$; $P < 0.001$) and on the frequency of HIV testing ($\beta = 0.22$; $P = 0.002$). As expected, frequent engagement in sexual risk behaviour led to a higher frequency of STIs in the past 12 months and a higher frequency of HIV testing. Also, frequent HIV testing significantly predicted the variance in PrEP acceptability ($\beta = 0.21$; $P = 0.004$). This suggests that the frequency of HIV testing is associated with perceiving PrEP as being beneficial as a remedial response to sexual risk behaviour (Fig. 1).

Discussion

The structural equation model presented in this article demonstrates the mediating pathways through which HIV knowledge and PrEP acceptability are related. HIV knowledge is an important predictor of PrEP acceptability, as awareness and understanding of HIV disease and the associated risk factors are crucial determinants of taking action to reduce one's risk of acquiring HIV. Consistent with previous studies [12,13], our study shows that there are significant demographic and socio-economic differences in HIV knowledge. Those MSM who self-identified as gay possessed higher levels of HIV knowledge than those who self-identified as bisexual, possibly because of the visibility of HIV prevention messages in gay venues and social settings. After all, HIV prevention campaigns have largely targeted gay men as a high-risk group. Conversely, self-identified bisexual men may be less aware of HIV and therefore possess less knowledge of the disease and its risk factors. Consistent with previous research into PrEP knowledge [12], we found that higher educational attainment was associated with greater HIV knowledge. Those with a postgraduate qualification were more likely to be informed about HIV. An additional socio-economic variable—income—was significantly associated with increased HIV knowledge —those MSM with the lowest income levels also possessed the least HIV knowledge. These data suggest that HIV awareness-raising campaigns must target self-identified bisexual MSM and other self-identified nongay MSM, in addition to self-identified gay individuals, and those of lower socio-economic status (defined in terms of educational attainment and income). As there is research that suggests that MSM from ethnic minorities, for example

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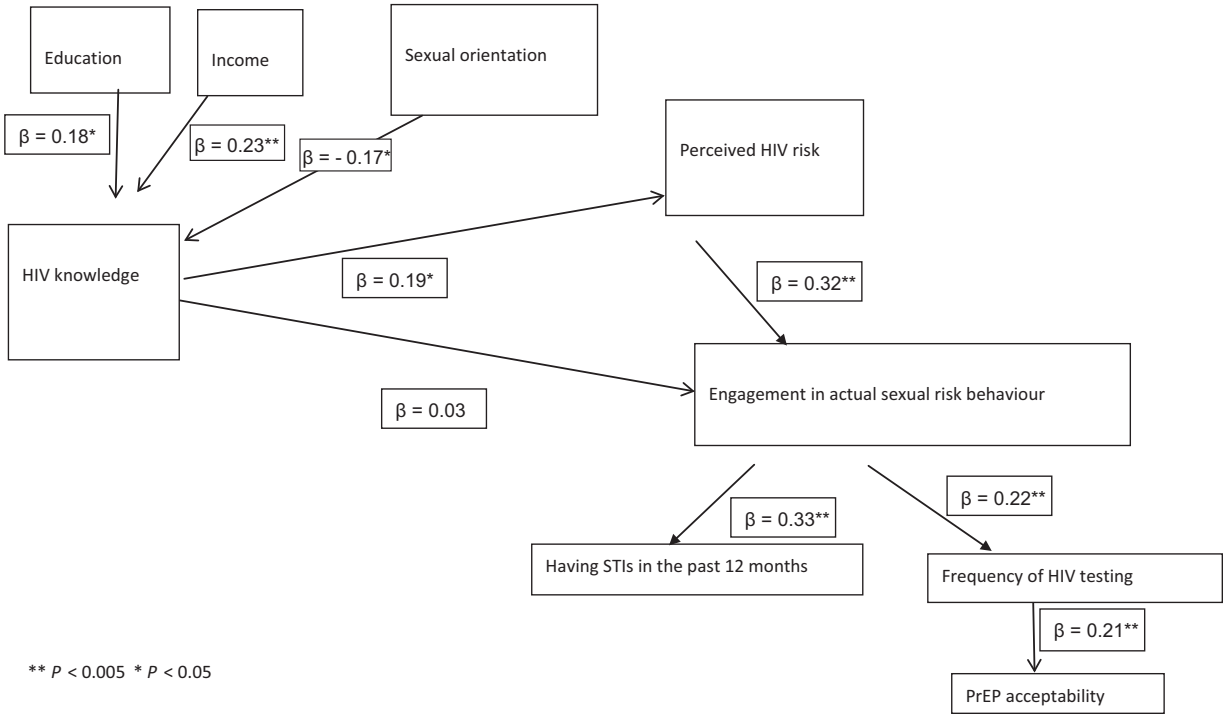

Fig. 1 Pathway model of the relationship between HIV knowledge and pre-exposure prophylaxis (PrEP) acceptability and its mediators. STI, sexually transmitted infection.

black and Latino individuals, do not engage sufficiently with sexual health services and consequently show less PrEP acceptability [19], this raises the question as to whether ethnic minorities from Leicester in our study would also benefit from tailored PrEP awareness campaigns. Although ethnicity did not have an impact on HIV knowledge or PrEP acceptability in our study, it is noteworthy that the study sample was composed principally of white British participants. Thus, future studies of PrEP acceptability in Leicester should target MSM of other ethnic and religious backgrounds to capture their views of PrEP, sexual health and risk behaviours. It is suggested that the demographics of the MSM and their socio-economic status, sexual orientation and cultural and religious specificities should be taken into account when designing and promoting campaigns to increase PrEP awareness and acceptance. Key figures within these communities will need to contribute to such campaigns to complement awareness-raising underway in gay venues and sexual health services. Moreover, it appears that pedagogical contexts, such as schools and universities, are ideal contexts for delivering HIV awareness and that efforts to do so should be increased in order to optimize knowledge in at-risk groups. For those MSM with low levels of educational engagement and income—a subgroup at particularly high risk of HIV infection—campaigns are needed to reach them in local youth groups and social clubs, ideally in conjunction with local social services.

The structural equation model showed that HIV knowledge predicted perceived HIV risk which in turn predicted engagement in sexual risk behaviours. These relationships demonstrate that HIV knowledge facilitates accurate HIV risk appraisals in MSM, confirmed by the fact that those MSM who perceived themselves to be at risk of HIV infection were actually reporting risky behaviour. In previous research in black and minority ethnic (BME) MSM, for instance, it has been shown that HIV risk appraisals may be inaccurate if they are not accompanied by high levels of HIV knowledge [10]. According to the structural equation model, engagement in sexual risk behaviour in turn predicted the acquisition of an STI in the past 12 months, as is to be expected given that the reported behaviour is risky, and with frequency of HIV testing. Public Health England recommends that MSM at risk of HIV infection are tested every 3–6 months [20]. Individuals' high levels of HIV knowledge suggest that they are aware of the risks associated with their sexual behaviour and, therefore, of the need to test for HIV on a regular basis. Frequency of HIV testing directly predicted PrEP acceptability in MSM. Indeed, previous research has

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found that those MSM who endorse PrEP are generally engaged with sexual health services [7]. This empirical relationship suggests that, in the era of biomedical HIV prevention, MSM who are engaging with sexual health services and discussing their sexual risk behaviour with clinicians are more likely to become aware of, and to understand, PrEP. This in turn increases acceptability. HIV testing is an important context in which accurate HIV and PrEP knowledge can be acquired and in which reassurance concerning the effectiveness and tolerability of PrEP can be provided to potential patients. Indeed, previous research confirms that these are significant barriers to PrEP acceptability and uptake [9–11].

Limitations

This study has several limitations which should be addressed in future research in this area. First, this study was a cross-sectional correlational study, which did not allow assertions regarding the causal factors underlying PrEP acceptability. An experimental design that, for instance, exposes MSM to distinct vignettes/scenarios may enable researchers to infer causality. Secondly, the study used the popular geospatial gay social networking application Grindr to recruit an opportunity sample, rather than a sample representative of MSM in Leicester. Opportunity sampling is common in research into minority groups. While the demographic data suggested a diverse sample in terms of age, income and educational attainment, the ethnic diversity of Leicester was not fully captured in the survey. Future research should attempt to recruit a larger sample of MSM of BME backgrounds, especially given the significant sexual health inequalities experienced by members of this community [19]. Also, future studies could use applications other than Grindr, for example Scruff and Tinder, to recruit a more diversified MSM sample. Thirdly, we decided to limit the focus of our study to the City of Leicester, given the relatively high HIV prevalence and incidence in this city. However, it would be useful to conduct this survey in other major UK cities with large MSM communities, such as Manchester, Leeds and Birmingham, in order to obtain a more complete picture of PrEP acceptability and its correlates outside of London.

Conclusions

The results reveal socio-economic inequalities in HIV knowledge and HIV testing, and suggest that MSM with high levels of HIV knowledge and perceived HIV risk and who regularly test for HIV are most likely to endorse PrEP as a personally beneficial HIV prevention method. It is necessary to increase HIV knowledge and to facilitate accurate risk appraisal in MSM in order to promote PrEP acceptability in MSM at risk of HIV infection. Campaigns to increase HIV testing and to raise awareness of PrEP ought to be integrated. The HIV testing context constitutes an ideal context for the promotion of PrEP to MSM who may benefit from it. This study adds to the overall body of research into PrEP with important local data which should inform the commissioning of PrEP in this area.

References

1 McCormack S, Dunn DT, Desai M *et al*. Pre-exposure prophylaxis to prevent the acquisition of HIV-1 infection (PROUD): effectiveness results from the pilot phase of a pragmatic open-label randomised trial. *Lancet* 2016; **387**: 53–60.

2 Molina J-M, Capitant C, Spire B *et al*. On-demand preexposure prophylaxis in men at high risk for HIV-1 infection. *N Engl J Med* 2015; **373**: 2237–2246.

3 Aghaizu A, Mercey D, Copas A, Johnson AM, Hart G, Nardone A. Who would use PrEP? Factors associated with intention to use among MSM in London: a community survey. *Sex Transm Infect* 2013; **89**: 207–211.

4 Public Health England 2017 [Internet]. Available at: https://fingertips.phe.org.uk/search/HIV

5 Liu AY, Kittredge PV, Vittinghoff E *et al*. Limited knowledge and use of Hiv post- and pre-exposure prophylaxis among gay and bisexual men. *Jaids J Acquir Immune Defic Syndr* 2008; **47**: 241–247.

6 Bull L, Dimitrijevic P, Beverley S *et al*. Perceived need of, and interest in, HIV pre-exposure prophylaxis amongst men who have sex with men attending three sexual health clinics in London, UK. Int J STD AIDS [Internet]. 2017 [cited 2018 Feb 13]; Available at: http://journals.sagepub.com/doi/abs/10.1177/0956462417730259?url_ver=Z39.88-2003&trfr_id=ori:rid:crossref.org&trfr_dat=cr_pub%3dpubmed

7 Young I, McDaid L. How acceptable are antiretrovirals for the prevention of sexually transmitted HIV?: a review of research on the acceptability of oral pre-exposure prophylaxis and treatment as prevention. *AIDS Behav* 2014; **18**: 195–216.

8 Wagenaar BH, Sullivan PS, Stephenson R. HIV knowledge and associated factors among internet-using men who have sex with men (MSM) in South Africa and the United States. Lama JR, editor. *PLoS ONE* 2012;**3**:e32915.

9 Peng P, Su S, Fairley CK *et al*. A global estimate of the acceptability of pre-exposure prophylaxis for HIV among men who have sex with men: a systematic review and meta-analysis. *AIDS Behav* 2018; **22**: 1063–1074.

10 Jaspal R, Daramilas C. Perceptions of pre-exposure prophylaxis (PrEP) among HIV-negative and HIV-positive men who have sex with men (MSM). Lee A, editor. *Cogent Med* 2016; **3**: 1256850.

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11 Golub SA, Kowalczyk W, Weinberger CL, Parsons JT. Preexposure prophylaxis and predicted condom use among high-risk men who have sex with men. *Jaids J Acquir Immune Defic Syndr* 2010; **54**: 548–555.
12 Zhou F, Gao L, Li S *et al.* Willingness to accept HIV pre-exposure prophylaxis among chinese men who have sex with men. *PLoS ONE* 2012; **7**: e32329.
13 Cohen SE, Vittinghoff E, Bacon O *et al.* High interest in pre-exposure prophylaxis among men who have sex with men at risk for HIV-infection: baseline data from the US PrEP demonstration project. *J Acquir Immune Defic Syndr* 2015;**68**:439–448.
14 Frankis J, Young I, Flowers P, McDaid L. Who Will Use Pre-Exposure Prophylaxis (PrEP) and Why?: understanding PrEP Awareness and Acceptability amongst Men Who Have Sex with Men in the UK – A Mixed Methods Study. *PLoS ONE* 2016; **11**: e0151385. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4836740/
15 Saberi P, Gamarel KE, Neilands TB *et al.* Ambiguity, Ambivalence, and Apprehensions of Taking HIV-1 Pre-Exposure Prophylaxis among Male Couples in San Francisco: a Mixed Methods Study. *PLoS ONE* 2012; **7**: e50061.
16 Brown AE, Mohammed H, Ogaz D *et al.* Fall in new HIV diagnoses among men who have sex with men (MSM) at selected London sexual health clinics since early 2015: testing or treatment or pre-exposure prophylaxis (PrEP)? *Euro Surveill* 2017; **22**: 30553. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5490453/
17 Carey MP, Schroder KEE. Development and psychometric evaluation of the brief HIV knowledge questionnaire. *AIDS Educ Prev* 2002; **14**: 172–182.
18 Napper LE, Fisher DG, Reynolds GL. Development of the perceived risk of HIV scale. *AIDS Behav* 2012; **16**: 1075–1083.
19 Jaspal R. Black and minority ethnic men who have sex with men. 2016. [Internet]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/525843/BlackandminorityethnicmenwhohavesexwithmenProjectevaluationandsystematicreview.pdf
20 British Association for Sexual Health and HIV; Recommendations for testing for men who have sex with men, 2014 [Internet]. Available at: https://www.bashhguidelines.org/media/1083/bashh-recommendations-for-testing-for-stis-in-msm-final.pdf

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