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Title: Age related factors influence HIV testing within subpopulations: a cross sectional survey of MSM within the Celtic nations

Corresponding author:

Dr Jenny Dalrymple

403A, George Moore Building, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 OBA

Jenny.Dalrymple@gcu.ac.uk

0141-331-3473

Co-authors:

Dr Kareena McAloney-Kocaman

School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK

Professor Paul Flowers

MRC/CSO Social & Public Health Sciences Unit, University of Glasgow, Glasgow, UK

Professor Lisa McDaid

MRC/CSO Social & Public Health Sciences Unit, University of Glasgow, Glasgow, UK

Dr Jamie Frankis

School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, UK

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ABSTRACT

Objectives

Despite a recent fall in the incidence of HIV within the UK, men who have sex with men (MSM) continue to be disproportionately affected. As biomedical prevention technologies, including pre-exposure prophylaxis (PrEP) are increasingly taken up to reduce transmission, the role of HIV testing has become central to management of risk. Against a background of lower testing rates among older MSM, this study aimed to identify age related factors influencing recent (≤ 12 months) HIV testing.

Methods

Cross sectional sub-population data from an online survey of sexually active MSM in the Celtic nations: Scotland, Wales, Northern Ireland and the Republic of Ireland (n=2436) were analysed to compare demographic, behavioural and socio-cultural factors influencing HIV testing between MSM aged 16-25 (n=447), 26-45 (n=1092) and ≥ 46 (n=897).

Results

Multivariate logistic regression demonstrated that for men aged ≥ 46 , not identifying as gay (OR 0.62 CI 0.41-0.95), location (Wales) (OR 0.49, CI 0.32-0.76) and scoring higher on the personalised stigma scale (OR 0.97, CI 0.94-1.00) significantly reduced the odds for HIV testing in the preceding year. Men aged 26-45 who did not identify as gay (OR 0.61, CI 0.41-0.92) were also significantly less likely to have recently tested for HIV. For men aged 16-25, not having a degree (OR 0.48, CI 0.29-0.79), location (Republic of Ireland) (OR 0.55, CI 0.30-1.00) and scoring higher on emotional competence (OR 0.57, CI 0.42-0.77) were also significantly associated with not having recently tested for HIV.

Conclusion

Key differences in age related factors influencing HIV testing suggest health improvement interventions should accommodate the wide diversities among MSM populations across the life course. Future research should seek to identify barriers and enablers to HIV testing among the oldest and youngest MSM, with specific focus on education and stigma.

BACKGROUND

Since 2016, the incidence of HIV has fallen among all subpopulations within the UK and remained steady within the Republic of Ireland.[1,2] In 2017, however, 53% of all new diagnoses in both nations occurred among men who have sex with men (MSM) clearly evidencing that this group remains disproportionately affected.[3] HIV testing is recognised as a key pillar of HIV risk reduction, in order to identify people who have acquired HIV and to facilitate early access to treatment, enabling the success of biomedical interventions including treatment as prevention (TasP). For HIV negative people at high risk of infection, testing is a baseline for consideration of HIV pre-exposure prophylaxis (PrEP).[4] This is of particular concern in the UK where, in England an estimated 4200 MSM remain undiagnosed, and in Scotland, over one third of MSM with HIV are undiagnosed.[1,5] Late diagnosis of HIV, characterised as having a CD4 cell count of less than 350, is associated with unfavourable outcomes, including a significantly higher likelihood of death within one year.[6] Over

30% of the most recently reported HIV diagnoses among MSM in the UK and the Republic of Ireland were late, representing the greatest number of late diagnoses among the subpopulation groups.[2,3] In Northern Ireland, despite a substantial recent rise in first episode testing of MSM in sexual health clinics, almost 30% of HIV diagnoses among this group were categorised as late.[7] The British Association for Sexual Health and HIV (BASHH) guidelines recommend annual testing for all sexually active MSM.[8] This advice is supported by recent evidence from sexual health services in England where 77% of MSM diagnosed with HIV had not been tested within two years, compared with 8% who had had at least two tests in the preceding year.[2].

Testing among older MSM in the UK, however, remains problematic, with the over 40s among those least likely to have recently tested for HIV.[9-11] While MSM aged between 25 and 45 are most likely to acquire HIV in the UK, recent evidence demonstrates that MSM in middle age and beyond remain sexually active and at risk of HIV acquisition.[2,12] In England, the same percentage of MSM aged 50-64 were diagnosed with HIV in 2017 as those aged 36-49.[2] In addition, European trends point to a steeper rise of HIV diagnoses among MSM aged over 50 than younger men, further reinforcing that this age group warrants attention.[13] Existing evidence associates socio-demographic, as well as complex socio-cultural and behavioural factors with HIV testing frequency among MSM, including environment, education, risk related activity, gay identity, cultural norms and stigma.[9,11,13-16,] It remains unclear, however, whether factors influencing HIV testing vary across the life course. Such an understanding would facilitate targeted health improvement interventions, avoiding homogenising several generations of MSM. This is of particular concern to the current cohort of ageing MSM, whose older men have lived through dramatic sociocultural changes, including the introduction of sexual rights legislation and the devastating impact of HIV.[17] It is unclear to what extent living through these earlier experiences when young governs current testing behaviour. This study therefore aims to identify age related factors influencing recent HIV testing within a sample of MSM, incorporating men from Scotland, Wales, Northern Ireland and the Republic of Ireland. These countries are known collectively as Celtic nations for political, ethno-cultural and language related reasons, and are referred to as such within this paper for ease of identification.[18]

METHODS

The social media, men who have sex with men, sexual and holistic health (SMMASH2) study is a cross sectional online survey updating a previous Celtic survey undertaken in 2012/3.[19] The questionnaire development was overseen by an interdisciplinary steering group including community members and run via an online survey application, RedCap, which collected data on sexual health related behaviour, including HIV and other sexually transmitted infection testing activity, as well as a wide range of

psychosocial issues. Men accessing gay orientated social media websites and apps (Gaydar, Recon, Grindr, Growlr, Squirt and Hornet) were targeted with message blasts and banner adverts promoting the survey. Inclusion criteria were: men wishing to or having sex with men, aged ≥ 16 living in Scotland, Wales and Northern Ireland, or aged ≥ 17 living in the Republic of Ireland. Participants who clicked on the adverts were taken to an information sheet outlining the voluntary nature of the survey and the confidentiality and anonymity of their data. Recruitment took place between April and June 2016. SMMASH2 received ethical approval by the Nursing and Community Health Sciences ethics committee, Glasgow Caledonian University: HLS/NCH/15/26. Within the current study, subpopulation analysis of data from the SMMASH2 survey was undertaken to identify factors associated with recent (< 1 year) HIV testing versus testing ≥ 1 year or never among MSM who had never tested HIV+ and were sexually active in the preceding year. The survey dataset was reduced to include participants with profile locations, PC IP address or GPS coordinates in Scotland, Wales, Northern Ireland and the Republic of Ireland (see figure 1). Independent variables were selected based on participant demographics, including country of origin, highest qualification gained, sexual orientation and relationship status. Sexual orientation was divided into "gay" and "non-gay identified". The latter incorporated bisexual and other orientations, the total number of participants identifying as "other" being too small to analyse separately ($n=22$). Behavioural variables included hazardous drinking, based on the FAST measure, drawn from previous review evidence associating high risk sexual activity with drinking among older MSM.[20-22] In addition, psychosocial factors including emotional competence and gay related stigma were included. It was considered that these factors may have influenced older MSM who had been young at a time of greater social prejudice and stigma, as well as growing up when HIV testing was less normalised and that they may have taken these influences forward into middle age and beyond.[17, 23] The prevalidated Trait Emotional Intelligence Questionnaire was utilised by Frankis et al (2018) to measure participants' capacity to manage their emotions.[20, 24] The personalised Stigma Scale comprising 24 questions measured men's 'awareness of social attitudes about gay people' and their perceptions of 'the potential social consequences related to being gay'. [20, 25] The dataset excluded the 225 men who believed themselves to have HIV, due to the research question focus on HIV testing. The final dataset totalled 447 men aged 16-25, 1092 men aged 26-45 and 897 men aged 46 and older. Responses from men aged under and over 46 were divided at this point as those aged 46, born in 1971 would have been aged 16 when the first UK national AIDS public information campaign was released in 1987.[20] Younger MSM would have reached sexual maturity with HIV already on the cultural landscape. Further subdivision separated those aged 26-45, identified as the age group most at risk for HIV in the UK and Ireland from the youngest MSM.[1,3] Men identifying as transgendered were included in the overall analysis ($n=151$,

6.2%). Across the age groups, 13.2% of 16-25s, 5.5% of 26-45s and 3.6% of ≥ 46 s identified as transgendered. Inferential statistics, using Pearson's chi-square and independent t-test analyses were calculated on a valid by case basis. Variables significant at the univariate level ($p < 0.05$) were entered into three logistic regression models to predict odds ratios and 95% confidence intervals against the dependent variables of recent HIV testing for each age group. Analysis was undertaken using SPSS statistical analysis package version 23.

Table 1: MSM demographic characteristics

	Men aged 16-25 n=447		Men aged 26-45 n=1092		Men aged ≥46 n=897		Total n=2436	
Tested for HIV in previous year *	n	%	n	%	n	%	n	%
yes	226	50.6	618	56.6	398	44.4	1242	51.0
no	211	47.2	455	41.7	469	52.3	1135	46.6
Total	437	97.8	1073	98.3	867	96.7	2377	97.6
<u>Country</u>								
Scotland	236	52.8	532	48.7	437	48.7	1205	49.5
Wales	61	13.6	158	14.5	168	18.7	387	15.9
N Ireland	32	7.2	85	7.8	66	7.4	183	7.5
R of Ireland	118	26.4	317	29.0	226	25.2	661	27.1
Total	447	100	1092	100	897	100	2436	100
<u>Ethnicity</u>								
white (Celtic, British, other white background)	431	96.4	1048	96	884	98.6	2363	97.0
non-white ethnicity	16	3.6	39	3.6	11	1.2	66	2.7
Total	447	100	1087	99.5	895	99.8	2429	99.7
<u>Qualifications</u>								
below degree	208	46.5	341	31.2	339	37.8	888	36.5
degree and above	237	53	725	66.4	539	60.1	1501	61.6
Total	445	99.6	1066	97.6	878	97.9	2389	98.1
<u>Sexual orientation</u>								
gay	355	79.4	913	83.6	673	75	1941	79.7
non-gay identified	89	19.9	169	15.5	218	24.3	476	19.5
Total	444	99.3	1082	99.1	891	99.3	2417	99.2
<u>Relationship status</u>								
single	348	77.9	660	60.4	429	47.8	1437	59.0
reg male partner	85	19.0	366	33.5	303	33.8	754	31.0
regular female partner	14	3.1	62	5.7	160	17.8	236	9.7
Total	447	100	1088	99.6	892	99.4	2427	99.6
<u>Drinking</u>								
safe	215	48.1	544	49.8	494	55.1	1253	51.4
hazardous	134	30	315	28.8	217	24.2	666	27.3
Total	349	78.1	859	78.7	711	79.3	1919	78.8

*percentages given from total dataset

RESULTS

A total of 2436 sexually active MSM responders from the Celtic nations who were HIV negative or of unknown status, were included for analysis (see table 1). The youngest age group ranged from 16-25 (median 22, SD 2.5). The middle age group were between 26 and 45 (median 35, SD 5.8) while the older group ranged from 46-78 (median 54, SD 6.9). The majority were from Scotland (n=1205, 49.5%), with 387 (15.9%) from Wales, 183 (7.5%) from Northern Ireland and 661 (27.1%) from the Republic of Ireland. The vast majority overall (n=2363, 97%) were of white ethnicity, consistent with census information in these 4 countries. Most men were educated to degree level or above (n=1501, 61.6%). While 79.7% of participants identified as gay (n=1941), 19.5% (n=476) had a non-gay identity. The majority were single (n=1437, 59%) and 27.3% (n=666) were identified as hazardous drinkers. Across the age groups, chi square analysis demonstrated that men aged 16-25 were significantly more likely to be single ($p<0.001$), and less likely to have a degree ($p<0.001$). Men aged 26-45 were significantly more likely to identify as gay ($p<0.001$), to have a degree ($p<0.001$) and to have tested for HIV within the previous year ($p<0.001$). Men aged ≥ 46 were significantly more likely to be of white ethnicity ($p<0.003$), have a regular female partner ($p<0.001$) and drink safely ($p<0.011$). Men ≥ 46 were less likely to be single ($p<0.001$), identify as gay ($p<0.001$) or to have tested for HIV within the previous year ($p<0.001$).

Univariate analysis (table 2) found among sexually active men aged 16-25, not reporting a recent (< 1 year) HIV test was significantly related to not having a degree, non-gay sexual identity, hazardous drinking, having higher emotional competence and geographical location. Among sexually active men aged 26-45, having a non-gay sexual identity and a regular female partner was significantly related to not testing for HIV in the previous year. For men ≥ 46 , significant factors included geographical location, reporting a non-gay sexual identity, a regular female partner, and higher personalised stigma. Several different factors were relevant for the three age groups; specific to the youngest men was not having a degree, hazardous drinking and higher emotional competency. For the oldest men, the only unique factor was having greater stigma. The 26-45 age group had no unique factors. Across all three age groups, having a non-gay identity was significantly related to not testing recently. For the 26-45 and oldest men, having a regular female partner was a shared factor and both the oldest and youngest age groups shared geographical location in not reporting recent testing.

	Age 16-25			Age 26-45			Age ≥46		
	Recent	Never / > 1 year	p	Recent	Never / > 1 year	p	Recent	Never / > 1 year	p
chi square tests *									
Country	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Scotland	136 (58.6)	96 (41.4)		302 (58.0)	219 (42.0)		197 (46.9)	223 (53.1)	
Wales	27 (45.0)	33 (55.0)	0.023	82 (52.9)	73 (47.1)	0.478	55 (33.1)	111 (66.9)	0.002
N Ireland	14 (45.2)	17 (54.8)		46 (54.8)	38 (45.2)		35 (53.8)	30 (46.2)	
R of Ireland	49 (43.0)	65 (57.0)		188 (60.1)	125 (39.9)		111 (51.4)	105 (48.6)	
Highest qual									
less than degree	81 (40.3)	120 (59.7)	<0.001	179 (53.4)	156 (46.6)	0.065	139 (42.5)	188 (57.5)	0.179
degree or more	144 (61.5)	90 (38.5)		424 (59.5)	289 (40.5)		247 (47.2)	276 (52.8)	
Sex orientation									
gay	189 (54.3)	159 (45.7)		538 (59.8)	362 (40.2)		322 (49)	335 (51)	
non gay identified	35 (40.7)	51 (59.3)	0.024	74 (45.4)	89 (54.6)	<0.001	73 (35.8)	131 (64.2)	0.001
R'ship status									
single	176 (51.8)	164 (48.2)		390 (60.0)	260 (40.0)		212 (50.2)	210 (49.8)	
reg male partner	46 (55.4)	37 (44.6)		201 (56.1)	157 (43.9)		131 (44.7)	162 (55.3)	
reg fem partner	4 (28.6)	10 (71.4)	0.177	24 (39.3)	37 (60.7)	0.006	52 (35.4)	95 (64.6)	0.007
Fast score									
safe	111 (51.6)	104 (48.4)		332 (61.6)	207 (38.4)		229 (46.9)	259 (53.1)	
hazardous	83 (62.4)	50 (37.6)	0.049	176 (55.9)	139 (44.1)	0.058	92 (43.0)	122 (57.0)	0.335
t-tests ‡									
emotional competence	Mean (SD)			Mean (SD)			Mean (SD)		
(1-7 high)	3.24 (0.81)	3.66 (0.82)	<0.001	3.28(0.89)	3.25(0.86)	0.660	3.02(0.91)	3.14(0.82)	0.094
Stigma (0-24-24 high)	9.67 (5.34)	10.72 (6.05)	0.089	9.94 (5.69)	10.67 (6.17)	0.082	10.54 (5.72)	11.89 (5.98)	0.003

*valid percentages given ‡ correct to 2 decimal points

Variables significant at the univariate level ($p < 0.05$) were entered into logistic regression models to calculate the unadjusted and adjusted odds ratios and 95% confidence intervals against the dependent variable of recent HIV testing for sexually active MSM aged 16-25, 26-45 and ≥ 46 years respectively (see table 3). Reference categories were chosen as the majority groups across each age range, with the exception of relationship status where men with a regular male partner were chosen as the reference category.

All variables were tested for multicollinearity; none within Pearson's pairwise coefficients exceeded 0.45, indicating low collinearity. In the final multivariate models for each of the 3 age groups, different variables remained significant predictors of not having recently tested for HIV, as follows; for men aged 16-25, not having a degree (OR 0.48, CI 0.29-0.79), higher emotional competence (OR 0.57, CI 0.42-0.77) and geographical location (Republic of Ireland) (OR 0.55, CI 0.30-1.00); for men aged 26-45, non-gay identity (OR 0.61, CI 0.41-0.92) only; for men aged ≥ 46 , non-gay identity (OR 0.62 CI 0.41-0.95) geographical location (Wales) (OR 0.49, CI 0.32-0.76) and experiencing stigma (OR 0.97, CI 0.94-1.00). Again we see that predictors of not recently testing for HIV vary by age group. No degree and higher emotional competence were unique predictors for men aged 16-25, stigma was a unique predictor for men aged ≥ 46 but no predictors were unique to men aged 26-45. Location was a

predictor of not recently testing for HIV in men aged 16-25 and ≥46, and non-gay identify was a predictor for men aged 26-45 and ≥46.

Table 3: Univariate and multivariate logistic regression predicting recent HIV testing from sociodemographic and behavioural variables for sexually active men with HIV status negative or unknown				
Predictor variable	Unadjusted odds ratio (95% CI)	p value	Adjusted odds ratio (95% CI)	p value
Age 16-25 n=447				
<u>country</u>				
Scotland (reference category)				
Wales	0.578 (0.326-1.023)	0.60	0.489 (0.228-1.050)	0.66
N Ireland	0.581 (0.273-1.236)	0.159	0.662 (0.247-1.774)	0.412
Republic of Ireland	0.532 (0.338-0.838)	0.006	0.551 (0.305-1.000)	0.049
<u>qualifications</u>				
less than degree	0.422 (0.287-0.620)	<0.001	0.479 (0.290-0.790)	0.004
degree or more (ref cat)				
<u>Sexual orientation</u>				
non-gay orientation	0.577 (0.358-0.932)	0.025	0.694 (0.352-1.370)	0.293
gay (reference category)				
<u>Fast score</u>				
hazardous	1.1555 (1.000-2.418)	0.050		
safe (reference category)				
<u>Emotional competence</u>	0.534 (0.395-0.721)	<0.001	0.567 (0.416-0.773)	<0.001
Age 26-45 n=1092				
<u>Sexual orientation</u>				
non gay orientation	0.559 (0.400-0.783)	0.001	0.612 (0.409-0.917)	0.017
gay (reference category)				
<u>Relationship status</u>				
single	1.172 (0.902-1.521)	0.235	1.222 (0.938-1.593)	0.138
reg female partner	0.507 (0.291-0.882)	0.016	0.781 (0.404-1.509)	0.462
reg male partner (ref cat)				
Age 46 and over n=897				
<u>country</u>				
Scotland (reference category)				
Wales	0.561 (0.385-0.817)	0.003	0.494 (0.319-0.765)	0.002
N Ireland	1.321 (0.782-2.230)	0.298	1.402 (0.773-2.541)	0.266
Republic of Ireland	1.197 (0.862-1.662)	0.284	1.249 (0.858-1.818)	0.246
<u>Sexual orientation</u>				
non-gay orientation	0.580 (0.419-0.802)	0.001	0.625 (0.411-0.949)	0.028
gay (reference category)				
<u>Relationship status</u>				
single	1.248 (0.926-1.684)	0.146		
reg female partner	0.677 (0.450-1.019)	0.062		
reg male partner (ref cat)				
<u>Stigma</u>	0.962 (0.937-0.987)	0.003	0.966 (0.939-0.995)	0.020

DISCUSSION

Within this study, heterogeneous factors were associated with not testing for HIV in the previous year among sexually active MSM across all three age groups. For both the 26-45 and ≥ 46 age groups, not testing was associated with a non-gay identity. For those aged 16-25 and ≥ 46 , geographical location was associated with not testing (Republic of Ireland and Wales, respectively). Among the youngest age group, not reporting a recent HIV test was also significantly related to not having a degree and demonstrating higher emotional competence, and for the oldest group, it was significantly related to reporting higher personalised stigma.

These findings demonstrate similarities between the 26-45 and ≥ 46 age groups with regard to recent HIV testing in terms of having a gay identity, in which non-gay identified men were less likely to test, concurring with previous evidence among men in the Celtic nations and elsewhere.[11, 14, 15, 26] Within the Celtic nations studies, non-gay identified men were more likely to be older, and it is noteworthy that those aged 16-25 in this study were the only group in which gay identity was not associated with not testing. This finding suggests a cohort effect, possibly linked with increased public acceptance of same sex partnerships over time, the effect of which is visible among the youngest MSM. [27].

Within this study, only the youngest men without degrees were less likely to have tested within the previous year, contrasting with Witzel et al. (2016) and Conway et al. (2015) suggesting a variation that warrants further exploration.[11, 14] Also among the youngest men, increased emotional competence was associated with not testing. This finding is counterintuitive and also merits further investigation. Specific to both the youngest and oldest men, residence in the Republic of Ireland and Wales were respectively associated with not testing for HIV in the previous year. Recent evidence has associated lower HIV testing rates among MSM living in suburban areas with few gay households and living away from the capital city.[14, 15] While these findings strengthen the link between location and testing activity, further investigation is required to understand the influence of geography within the Celtic nations. Also significant among the oldest group of MSM was a higher score on the personalised Stigma Scale among those less likely to have recently tested for HIV. Previous studies across all age groups have highlighted prejudice towards men with HIV from other gay men and elsewhere rather than gay related stigma as reasons for not testing.[16] Within this oldest age group, however, there is evidence of overlap between gay and HIV related stigma from men who have lived through the challenging cultural experience of the arrival of the HIV/AIDS epidemic in the 1980s.[17,23] In addition, wider evidence of gay related stigma is shown to affect overall general health among lesbian, gay and bisexual adults aged over 50.[28] The effect of stigma in relation to

health seeking activity such as HIV testing is therefore complex and further exploration is warranted to understand barriers and facilitators among older MSM.

STRENGTHS AND LIMITATIONS

This study has analysed a large, well-constructed dataset giving access to knowledge about age related HIV testing patterns at a critical time in the role of testing within the current framework of HIV risk-reduction. Acknowledging the significant socio-cultural changes that have taken place over the last 40 years for MSM both in the UK and elsewhere, it has sought to compare factors associated with HIV testing between an older group of men who would have already been adults at the onset of HIV in the 1980s and before the first reduction of the age of consent in 1994, with two groups of younger men who would have experienced a different cultural landscape. There are a few limitations within this study. Analysis of data retrieved from social networking sites risks excluding those who are unable to afford smartphones, as well as those with learning or language challenges. In addition, social networking is predominantly used by young adults; only 65% of 55-64 year olds in Britain used social media compared to 97% of 25-34 year olds, potentially limiting access of older MSM to the survey.[29] Internet based recruitment means that there is no facility to calculate response rate or duplicate responses. Moreover, all sexually active men from the SMMASH2 survey were included in our analysis, meaning at least some participants will have had no sexual activity constituting a risk for HIV, potentially influencing their testing decisions. Ethnicity was not included as a demographic variable, given that 97% of the sample was of white origin. While this data broadly reflect the background ethnicity of the Celtic nations, it limits transferability of the findings to other, more ethnically diverse, cultures.

IMPLICATIONS FOR INTERVENTION RESEARCH

The expansion of HIV testing beyond the historical binary diagnostic tool into the central technology underpinning an increasing range of interventions designed to reduce HIV transmission indicates that research into factors influencing testing within subpopulations of MSM is vital. The complexity of testing options available in resource rich countries offers opportunities to fine tune interventions to increase leverage among the wide range of geographical, socio-economic, ethnic and age related diversities within MSM populations.[3] For older MSM, the challenge may be recontextualising HIV testing from a history of engagement with a feared and stigmatised terminal illness to the key element

in a dynamic approach to managing their sexual health.[17] Following the findings in this paper, a programmatic approach should seek to undertake qualitative research with two separate subpopulations of MSM: younger MSM without a degree, and older MSM with a focus on understanding experiences of stigma. Evidence from this future work should identify barriers and enablers to HIV testing from which to develop targeted HIV testing interventions that, in addition, take account of life course, geographical, health and digital literacy considerations. The relatively high percentage of young MSM men identifying as transgendered within this study indicates a need for future focussed research into HIV testing activity within this subpopulation.

CONCLUSION

As testing becomes the central tool of HIV prevention, it is apparent that nuanced understandings of MSM subpopulations incorporating age, life course experience and sociocultural influences are required to facilitate interventions that have the greatest chance of success. Within this study of MSM in the Celtic nations, evidence of age-related differences in HIV testing behaviour provide an important step towards developing tailored interventions that will enable increased uptake of testing.

Key messages

- Age related factors influence recency of HIV testing among sexually active MSM within the Celtic nations.
- Education, geographical location, non-gay identity, emotional competence and stigma appear to independently influence HIV testing across age groups among MSM.
- Further focussed research among subpopulations of MSM is required to maximise the uptake of HIV testing.

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Author contributions:

JD undertook secondary data analysis of the SMMASH2 dataset, designed and drafted the paper.

KM-K undertook secondary data analysis of the SMMASH2 dataset, mentored JD in statistical analysis and contributed to redrafts of the paper.

PF designed and authored the original SMASHH2 report and contributed to redrafts of the paper.

LM designed and authored the original SMASHH2 report and contributed to redrafts of the paper.

JF is principal investigator on the SMMASH2 study. He led the development, design data collection and preliminary analysis of these data, authored the original SMMASH2 report, undertook secondary data analysis of the SMMASH2 dataset, mentored JD in statistical analysis and contributed to redrafts of the paper.

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Figure 1

