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# BMJ Open Associations between oral sex practices and frequent mouthwash use in heterosexuals: a cross-sectional survey in Melbourne, Australia

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## ABSTRACT

**Objective** This study aimed to determine the frequency of mouthwash use and its association to oral sex practice in heterosexuals.

**Design** A cross-sectional study.

**Setting** Data obtained from a sexual health clinic in Victoria, Australia, between March 2019 and April 2019.

**Participants** Heterosexual men and women attending the sexual health clinic answered a survey using computer-assisted self-interview.

**Primary and secondary outcome measures** Univariable and multivariable logistic regression were performed to examine the association between frequent mouthwash use (ie, daily or weekly mouthwash use) and oral sex practices (including tongue kissing, fellatio, cunnilingus and insertive rimming).

**Results** There were 681 heterosexuals included in the analysis: 315 (46.3%) men and 366 (53.7%) women. Of participants, 302 (44.3%) used mouthwash frequently, 173 (25.4%) used mouthwash infrequently and 206 (30.2%) never used mouthwash. There was no significant difference in the proportion of frequent mouthwash users between men and women (46.4% of men vs 42.6% of women;  $p_{\text{trend}}=0.329$ ). The proportion of frequent mouthwash users increased with increasing age groups (39.3% in  $\leq 24$  years, 45.2% in 25–34 years and 52.8% in  $\geq 35$  years or older;  $p_{\text{trend}}=0.039$ ) with those aged  $\geq 35$  years having a 1.80 times (95% CI: 1.12 to 2.89) higher odds of being a frequent mouthwash user than those aged  $\leq 24$  years. There were no significant associations between frequent mouthwash users had sexually transmitted infection (STI) risk after adjusting for age and country of birth.

**Conclusion** Older heterosexuals are more likely to use mouthwash. Given the high proportion and associations of mouthwash use in heterosexuals, future investigations related to oral STIs in this group should include mouthwash use.

## INTRODUCTION

Sexually transmitted infections (STIs) have been rising rapidly in many developed countries in both heterosexuals<sup>1–4</sup> and among men who have sex with men (MSM).<sup>5–9</sup> Most STIs not only infect the genitals but also extragenital sites, including the oropharynx. Estimates of

## Strengths and limitations of this study

- This is the first survey, to the best of our knowledge, that asks about mouthwash use and oral sex practice in heterosexuals.
- Participants were recruited from a sexual health clinic and thus includes data from sexually active individuals.
- Data were collected on the frequency of mouthwash use.
- As this data only include sexually active individuals, findings may not be generalisable to a wider heterosexual population.

the incidence of oropharyngeal gonorrhoea, the most common STI in the oropharynx, are as high as 10% in MSM attending sexual health clinics<sup>10–13</sup>; however, there is sparse data on the prevalence of oropharyngeal gonorrhoea in heterosexuals as only women who report engaging in oral sex<sup>14</sup> and female sex workers (FSW)<sup>15</sup> are routinely tested at this site. In one study of 102 men and 82 women who self-reported being contacts of gonorrhoea, 18% and 46%, respectively, were positive for gonorrhoea at the oropharynx,<sup>16</sup> while estimates of oropharyngeal gonorrhoea and chlamydia among FSW attending a sexual health clinic in Melbourne, Australia, in 2017 was 2% (59/2883 for gonorrhoea and 61/2878 for chlamydia). No other STIs are routinely tested for in the oropharynx among asymptomatic heterosexuals. Nevertheless, research has implicated the oropharynx in the transmission of STIs<sup>10 17–19</sup> and the asymptomatic nature of STIs at the oropharynx means that they are likely to lead to ongoing transmission.<sup>20–22</sup>

Mathematical models and empirical epidemiological studies have indicated that condoms cannot prevent all oropharyngeal STI cases.<sup>23 24</sup> The use of antiseptic

mouthwash has been proposed as a potential intervention for oropharyngeal STIs,<sup>25–29</sup> although given it can alter the microbiome,<sup>30</sup> it is also possible that it may increase the risk of STI acquisition.<sup>31</sup> Although the effectiveness of mouthwash against oropharyngeal STI is still currently investigated in a number of clinical trials,<sup>32–33</sup> sex workers have long been recommended to use mouthwash after oral sex with clients.<sup>34</sup>

An Australian study showed that two-thirds of FSW reported using mouthwash after each client.<sup>35</sup> However, the reasons why FSW or other individuals use mouthwash have not been investigated in relation to sexual risk and exposure. It may be that mouthwash is used to provide fresh breath between clients but it could also be used to maintain a good oral hygiene after exposure to client's genitals or anus. Mouthwash use related to sexual exposure can lead to confounding (by indication), which can bias the association between mouthwash use and STI acquisition. This in turn will make it difficult to discern the role of mouthwash in STI risk. While STI risk and mouthwash use have been investigated in MSM and no association was found,<sup>36</sup> no similar study has been undertaken in heterosexuals. The aim of this study was to investigate whether frequent mouthwash use was associated with a particular oral sex practice (eg, tongue kissing, fellatio, cunnilingus and rimming) among sexually active heterosexuals.

## METHODS

This was a cross-sectional survey conducted at the Melbourne Sexual Health Centre (MSHC) between March 2019 and April 2019. MSHC is the largest sexual health service in the state of Victoria, Australia, providing over 50 000 consultations a year. Clients attending MSHC for the first time or who have not been seen in over 3 months are invited to complete a computer-assisted self-interview (CASI), which asks about demographic information and questions relating to their sexual health.<sup>37</sup> The overall response rate on CASI is difficult to calculate due to the complex algorithm and number of questions asked to each participant, but a previous study showed the response rate to one question, which asks about number of sexual partners, was completed by 90% of heterosexuals.<sup>38</sup>

During the study period, clients filling in CASI were shown an invitation (electronically) at the end of the routine CASI questions to participate in an additional voluntary survey named 'Annual Sexual Practices and Activities (ASAP)'. The electronic ASAP survey asked additional questions on sexual health that CASI does not ask, including a question on mouthwash use ('How often do you use mouthwash?' with seven multiple choice selections ranging from 'never' to 'at least twice a day') and questions on oral sex practices. All clients aged 16 years or older were eligible to participate in ASAP. In this analysis, we only included data from sexually active heterosexual men and women (engaged in sex in previous 3

months) who reported no current or previous sex work, as past studies have already examined the relationship between mouthwash use and oral sex practices in other populations such as MSM and FSW.<sup>35–36</sup> Heterosexual men and women are defined here as those having sex in the previous 12 months with a person of the opposite sex and no reported same-sex activity. Participants first had to select 'Yes' on CASI to consent to the study before the ASAP survey was shown. Ethics approval was obtained from the Alfred Hospital Ethics Committee, Melbourne, Australia (project number 571/17).

Descriptive statistics were calculated to describe the demographic profile of the participants. Participants were categorised into 'frequent mouthwash users' or 'infrequent mouthwash users'. We defined frequent mouthwash users as those using mouthwash daily or weekly, while infrequent mouthwash users were individuals who used mouthwash monthly or yearly or had never used mouthwash, as per previous studies.<sup>36–39</sup> Participants were categorised into three age groups ( $\leq 24$  years, 25–34 years and  $\geq 35$  years or older) for analysis, as per previous studies.<sup>36–40</sup> Mann-Whitney U test was used to compare the mean age and number of opposite-sex partners in the previous 3 months between participants who consented and completed the ASAP survey and those who declined to participate.

Univariable and multivariable logistic regression was performed to examine the association between frequent mouthwash use and demographic characteristics and oral sex practices. Any factors associated with frequent mouthwash use in the univariable analysis ( $p < 0.1$ ) were included in the multivariable logistic regression. Crude and adjusted ORs and the corresponding 95% CIs were reported.

All statistical analyses were performed using STATA (V.14; College Station, Texas, USA).

## Patient and public involvement

Patients were not involved in the design, conduct, reporting or dissemination of our research study.

## RESULTS

There were 3008 women and heterosexual men who were invited to participate in ASAP on CASI, of whom 775 (25.8%) completed the survey. We excluded 38 women (5.0% of total surveys; 9.0% of women) who reported sex with both women and men and 9 women who reported sex with women only, as well as 30 men and 17 women who had no sex in the previous 3 months from this analysis, leaving 681 participants for analysis. Participants included in the analysis had a slightly younger mean age than those who declined (28.5 years vs 29.1 years;  $p = 0.028$ ). There was no significant difference in the number of opposite-sex partners in the previous 3 months between those who participated and those who did not ( $p = 0.104$ ). Among consenting participants, there was a higher proportion who were born in Australia and a lower proportion who

were born overseas or did not disclose their country of birth compared with those who did not consent to the study (35.6% Australian born vs 32.1%; 62.4% born overseas vs 64.3%; 2.1% unknown country of birth vs 3.5%;  $p=0.049$ ).

Among the 681 participants who completed the survey, 315 (46.3%) were heterosexual men and 366 (53.7.6%) were heterosexual women. The median age of men in the study was 28 years (SD: 9.3 years; IQR: 25–34 years) and the median age of women was 25 years (SD: 6.6 years; IQR: 23–29 years). The median number of opposite-sex partners for men and women was 2 (SD: 2.3; IQR: 1–3). Among the participants, one man (0.3%) and one woman (0.3%) were living with HIV.

Overall, there were 302 participants (44.3%; 95% CI: 40.6% to 48.2%) who used mouthwash frequently (ie, 164 (24.1%; 95% CI: 20.9% to 27.5%) reported daily use and 138 (20.3%; 95% CI: 17.3% to 23.5%) used weekly); 173 (25.4%; 95% CI: 22.2% to 28.8%) used mouthwash infrequently (monthly or yearly) and 206 (30.2%; 95% CI: 26.8% to 33.9%) never used mouthwash. There was no significant difference in the proportion of frequent (ie, daily or weekly) mouthwash users between men ( $n=146$  men; 46.4%; 95% CI: 40.7% to 52.0%) and women ( $n=156$ ; 42.6%; 95% CI: 37.5% to 47.9%) ( $p=0.329$ ). Likewise, there was no significant difference in number of sexual partners in the previous 3 months between those who used mouthwash frequently and those who did not ( $p=0.481$ ).

The proportion of frequent mouthwash users increased with increasing age groups (39.3% in  $\leq 24$  years, 45.2% in 25–34 years and 52.8% in  $\geq 35$  years or older;  $p_{\text{trend}}=0.039$ ). Multivariable analysis showed that being aged  $\geq 35$  years had 1.80 times (95% CI: 1.12 to 2.89;  $p=0.015$ ) higher odds of being frequent mouthwash users compared with those aged  $\leq 24$  years (table 1). Furthermore, participants born overseas had a 1.48 times (95% CI: 1.06 to 2.07;  $p=0.020$ ) higher odds of being a frequent mouthwash user than those born in Australia in the multivariable analyses. However, there was no association between sex and frequent mouthwash use (table 1).

The sexual risks between frequent and infrequent mouthwash users were similar with the exception of a near significant difference in rimming. Frequent mouthwash users had a 1.45 times (95% CI: 0.96 to 2.19;  $p=0.074$ ) higher odds of having performed rimming (oro-anal sex) in the previous 3 months compared with those who infrequently used mouthwash after adjusting for age and country of birth. There were no significant associations between the other sex practices analysed (including kissing, performing oral sex and group sex) and being a frequent mouthwash user, nor was there an association between having a regular or casual partner or injecting drugs in the previous 3 months and frequent mouthwash use.

## DISCUSSION

Almost half (44.3%) of sexually active heterosexual men and women were frequent mouthwash users. There was no difference in the proportion of frequent mouthwash users between the sexes but frequent mouthwash use was more common with increasing age. No association was found between STI risk and mouthwash use. There are no other studies of STI risk and mouthwash use in heterosexuals, although a similar study in MSM also reported a trend with increasing age and no association between mouthwash use and STI risk.<sup>36</sup> If mouthwash use is shown to protect or potentially increase STI risk at the oropharynx, understanding how it is used will be an important factor when investigating the reason for STI rises currently being seen in heterosexuals.

There are limited studies of mouthwash use in the general population, though none look specifically at heterosexuals, to the best of our knowledge.<sup>28</sup> Surveys of mouthwash use in the general population in Sweden (2012) and Scotland<sup>41</sup> have reported more women using mouthwash compared with men.<sup>41 42</sup> Although there is no comparable study in Australia in heterosexuals, to the best of our knowledge, our finding that almost half of the heterosexuals are frequent mouthwash users is slightly higher than an Australian survey in 2011 that found 39% of respondents had used mouthwash in the previous week.<sup>43</sup> Our results indicate the proportion of frequent (ie, daily or weekly) mouthwash users in heterosexuals is similar to that in MSM (53.4%)<sup>36</sup> and lower than that in FSW (84.4%) in Australia.<sup>35</sup>

Our finding that heterosexuals aged 35 years or older are 1.80 times more likely than those 24 years or younger to be a frequent mouthwash user are consistent with our previous study of MSM which found a significant age pattern with mouthwash use (37.6% in those aged  $\leq 24$  years; 56.1% in those aged 25–34 years and 61.4% in those aged  $\geq 35$  years;  $p_{\text{trend}} < 0.001$ ),<sup>36</sup> a trend that is possibly explained by the increase in periodontal disease with older age; however, an increase in frequency with age has not been reported in other studies among the general population.<sup>41 42</sup> It is possible the increase with age is only seen in sexually active individuals, but there is a lack of data in the literature to substantiate this. There was a not significant association between frequent mouthwash use and performing rimming, with those frequent mouthwash users in the adjusted analysis having 1.45 times greater odds of performing rimming compared with infrequent users. Although the association was not statistically significant in the adjusted analysis, the lower bound of the 95% CI is 0.96, which is close to 1, suggesting the sample size may have limited power to detect the association. An association between rimming and mouthwash use may be attributed in part to women's attitudes toward rimming as an unhygienic practice,<sup>44</sup> though future qualitative studies would be needed to understand heterosexual men's attitudes to rimming.

There is a possibility that mouthwash use may increase the risk of STIs, with one study of 96 MSM in Indonesia

**Table 1** Factors associated with frequent mouthwash use among heterosexual men and women (n=728)

	No. of individuals (%)	No. that use mouthwash frequently/N (%)	OR (95% CI)	P value	Adjusted OR (95% CI)	P value
<b>Sex</b>						
Male	315 (46.2)	146/315 (46.3)	1 (ref.)			
Female	366 (53.7)	156/366 (42.6)	0.86 (0.63 to 1.16)	0.329		
<b>Age (years)</b>						
16–24	234 (34.4)	92/234 (39.3)	1 (ref.)		1 (ref.)	
25–34	341 (50.1)	154/341 (45.2)	1.27 (0.91 to 1.78)	0.164	1.21 (0.86 to 1.70)	0.275
≥35	106 (15.6)	56/106 (52.8)	1.73 (1.09 to 2.75)	0.020	1.80 (1.12 to 2.89)	0.015
<b>Country of birth</b>						
Australia	240 (35.2)	95/240 (39.6)	1 (ref.)		1 (ref.)	
Overseas	429 (63.0)	203/429 (47.3)	1.37 (0.99 to 1.89)	0.054	1.48 (1.06 to 2.07)	0.020
Unknown/missing	12 (1.8)	4/12 (33.3)	0.76 (0.22 to 2.61)	0.666	0.84 (0.24 to 2.88)	0.776
<b>Had a regular sex partner*</b>						
No	367 (53.9)	170/367 (46.3)	1 (ref.)			
Yes	302 (44.3)	127/302 (42.1)	0.84 (0.62 to 1.14)	0.269		
Unknown/missing	12 (1.8)	5/12 (41.7)	0.83 (0.26 to 2.66)	0.751		
<b>Had a casual sex partner*</b>						
No	83 (12.2)	34/83 (41.0)	1 (ref.)			
Yes	539 (79.1)	242/539 (45.0)	1.17 (0.73 to 1.88)	0.502		
Unknown/missing	59 (8.7%)	26/59 (44.1)	1.14 (0.58 to 2.23)	0.712		
<b>Injecting drug use*</b>						
No	672 (98.7)	297/672 (44.2)	1 (ref.)			
Yes	4 (0.6)	2/4 (50.0)	1.26 (0.18 to 9.02)	0.816		
Unknown/missing	5 (0.7)	3/5 (60.0)	1.89 (0.31 to 11.41)	0.486		
<b>Tongue kissing*</b>						
No	9 (1.3)	4/9 (44.4)	1 (ref.)			
Yes	672 (98.7)	298/672 (44.3)	0.98 (0.42 to 2.31)	0.969		
<b>Performed oral sex*†</b>						
No	72 (10.6)	28/72 (38.9)	1 (ref.)			
Yes	609 (89.4)	274/609 (45.0)	1.30 (0.84 to 1.99)	0.236		
<b>Performed insertive rimming‡</b>						
No	567 (83.3)	242/567 (42.7)	1 (ref.)		1 (ref.)	
Yes	114 (16.7)	60/114 (52.6)	1.55 (1.05 to 2.30)	0.029	1.45 (0.96 to 2.19)	0.074
<b>Paid for sex§</b>						
No	639 (93.8)	279/639 (43.7)	1 (ref.)			
Yes	42 (6.2)	23/42 (54.8)	1.58 (0.85 to 2.94)	0.147		
<b>Group sex</b>						
No	648 (95.2)	287/648 (44.3)	1 (ref.)			
Yes	33 (4.8)	15/33 (45.5)	1.02 (0.50 to 2.05)	0.962		

\*Participants were asked to report sex partners, injecting drug use and sex practices that occurred in the previous 3 months.

†Oral sex was defined as performing fellatio for females and performing cunnilingus for males.

‡Insertive rimming means participant's tongue in and around sex partner's anus.

§Paid for sex indicates they paid someone for sex, not that they were themselves paid for sex as this analysis excluded sex workers.

finding men who used mouthwash were significantly more likely to test positive for syphilis.<sup>31</sup> A broad-spectrum antiseptic mouthwash, chlorhexidine, has been shown to alter the oral microbiome,<sup>30</sup> which may have effects on STI transmission; however, it is unclear whether other mouthwash varieties have a similar effect. A study of fluoride mouthwash use in adolescents showed minimal changes in the oral microbiome.<sup>45</sup>

There are several limitations to this study. First, our study was conducted at one urban sexual health centre among sexually active individuals and may not be generalisable to all heterosexuals throughout Australia. Second, a high number of individuals declined to participate in this survey (74.2%) and we cannot know if those who declined have differences in mouthwash frequency or associated oral sex practices. We noted a higher proportion of participants was born in Australia versus overseas than those who declined, though being born overseas was still associated with frequent mouthwash use among participants. As the ASAP survey invitation was shown after routine CASI, it was possible that survey fatigue played a role in the high number declining to participate. Third, there could be recall bias as participants were asked to report sexual practice retrospectively. In order to mitigate this, we asked participants about behaviours only in the previous 3 months. Lastly, we did not collect information from participants regarding their socioeconomic status or tobacco and alcohol use in this study, which may contribute to mouthwash use.<sup>43</sup>

This study contributes to our understanding of mouthwash frequency and the associations of oral sex practice with frequent mouthwash use in heterosexuals. Regardless of whether mouthwash was found to be effective at preventing STIs or even increased the risk of them, given the high prevalence and associations of mouthwash use in heterosexuals, future investigations related to oral STIs in this group should include mouthwash use.

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**Contributors** TRP wrote the first draft of the manuscript and assisted in data analysis. EPFC, CKF, CSB and JSH were involved in study design and conception. EPFC oversaw the study and performed data analysis. KM was involved with study management. MT and all authors were involved in data interpretation and manuscript revision.

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**Competing interests** None declared.

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