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# A Systematic Review of Kissing as a Risk Factor for Oropharyngeal Gonorrhoea or Chlamydia

Finley Charleson, MD,\*† Julien Tran, MPH,\*‡ Adam Kolobaric, BSc (Hon),§ Richard Case, MD,\* Christopher K. Fairley, MBBS, PhD,\*‡ Jane S. Hocking, MPH, MHLthSc, PhD,† and Eric P.F. Chow, MScMed (ClinEpid), MPH, MBiostat, MAppSc, PhD\*†‡

**Background:** Tongue kissing is a poorly studied risk factor for sexually transmitted infections (STIs). We undertook the first systematic review to assess whether kissing is a risk factor for gonorrhoea or chlamydia of the oropharynx.

**Methods:** Online databases (MEDLINE, EMBASE, CINAHL, Web of Science, Cochrane) and reference lists were searched until September 30, 2022. The eligibility criteria for studies included: any peer-reviewed study design in the English language; gonorrhoea or chlamydia diagnosed by nucleic acid amplification test, or an infection self-reported by a patient; tongue kissing or its equivalent measured as an exposure. Studies were appraised using a quality scoring tool and qualitatively synthesized.

**Results:** Of 8248 studies screened, 6 were eligible for review. All were conducted among men who have sex with men in Australia, including 3 prospective cohort studies, 2 cross-sectional studies, and 1 age-matched case-control study. In summary, all 5 studies examining gonorrhoea found an unadjusted association between kissing and oropharyngeal gonorrhoea. Two cross-sectional studies found that tongue kissing was an independent risk factor for oropharyngeal gonorrhoea after adjusting for other confounders, such as participant demographic characteristics and other sexual practices. In contrast, a single eligible prospective cohort study found no association between kissing and oropharyngeal chlamydia.

**Conclusions:** This systematic review summarized the existing evidence that suggests that tongue kissing may be a risk factor for oropharyngeal gonorrhoea but not chlamydia. Reinforcing the message that oropharyngeal gonorrhoea could be transmitted through kissing may inform the development of novel approaches to prevent and treat gonorrhoea.

The World Health Organization estimates that at least 374 million curable sexually transmitted infections (STIs) were occurred globally in 2020.<sup>1</sup> Of these, gonorrhoea and chlamydia are of significant interest: chlamydia is the most commonly notifiable STI and gonorrhoea is an urgent public health threat due to rising antimicrobial resistance.<sup>2</sup> Since the 2010s, there has been a substantial increase in gonorrhoea among gay, bisexual and other men who have sex with men (MSM).<sup>3</sup> To better understand this concerning trend, investigators have started to reexamine its mode of transmission.<sup>4</sup>

Recent studies have demonstrated that *Neisseria gonorrhoeae* and *Chlamydia trachomatis* can be detected in the saliva of people diagnosed with oropharyngeal gonorrhoea and chlamydia, respectively.<sup>5,6</sup> These findings raise the possibility that tongue kissing (also referred to as simply kissing in this review), during which saliva is exchanged, may contribute to oropharyngeal transmission. The US Centers for Disease Control and Prevention has acknowledged that the role of kissing in STI transmission has not been well studied in their 2021 STI treatment guidelines.<sup>7</sup> Although the morbidity of oropharyngeal gonorrhoea and chlamydia is not considered to be high, there are implications for disease burden if transmission occurs from oropharyngeal infection to other body sites including pelvic inflammatory disease and epididymitis,<sup>8,9</sup> and also the development of gonococcal antimicrobial resistance. These oropharyngeal infections are often asymptomatic, which means that individuals may not be aware of the infection, and this could result in onward transmission prior to detection. Hence, we conducted a systematic review to assess whether tongue kissing is a risk factor for oropharyngeal gonorrhoea or chlamydia.

## METHODS

This systematic review was undertaken following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews.<sup>10</sup> The protocol for this review was registered (CRD42018092368) with the International Prospective Register of Systematic Reviews (PROSPERO).

## Search Strategy

We searched literature published in MEDLINE and EMBASE, through Ovid, CINAHL, Web of Science and the Cochrane Central Register of Controlled Trials until September 30, 2022. Date restrictions were not applied to our searches; however, studies were limited to human studies and those written in English.

From the \*Melbourne Sexual Health Centre, Alfred Health; †Melbourne School of Population and Global Health, The University of Melbourne; ‡Central Clinical School, Faculty of Medicine, Nursing and Health Sciences, Monash University; and §School of Science, RMIT University, Melbourne, Victoria, Australia

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Correspondence: Finley Charleson, MD, Melbourne Sexual Health Centre, 580 Swanston St, Carlton 3053, Victoria, Australia. E-mail: FinleyCharleson@gmail.com; Eric P.F. Chow, MScMed (ClinEpid), MPH, MBiostat, MAppSc, PhD, Melbourne Sexual Health Centre, 580 Swanston St, Carlton 3053, Victoria, Australia. E-mail: Eric.Chow@monash.edu.

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The following search terms (with wild cards “\*”) were included: (gonorrhoea OR gonorrhea OR N. gonorrhoeae OR chlamydia\*) AND (kiss\* OR oropharyn\* OR pharyn\* OR oral OR throat).

The initial title and abstract screenings were performed by 3 independent reviewers (F.C., A.K., J.T.). The full texts of screened articles were subsequently assessed against eligibility criteria (F.C., A.K.). All discrepancies were resolved in consultation with a fourth reviewer (E.P.F.C.).

### Inclusion and Exclusion Criteria

We included all study designs (eg, cohort, case-control, cross-sectional) that provided primary data and were published in a peer-reviewed journal in the English language. We included studies if they provided data about kissing and its association with oropharyngeal gonorrhea or chlamydia diagnoses (either self-reported or a laboratory-confirmed test).

We excluded any studies that were case reports, editorials, reviews, mathematical modeling studies, or other articles, without primary data. Studies on mouth-to-mouth resuscitation were ineligible.

### Data Extraction and Synthesis

Data were extracted by 2 independent reviewers (F.C. and A.K.). For each study, we extracted the following: first author, study period, study location, study design, sample size, age, gender, sexuality, the definition of kissing, the number of cases of incident or prevalent oropharyngeal gonorrhea or chlamydia diagnosed or reported and the diagnostic method used.

### Outcome and Exposure Definition

The outcome of interest was prevalent or incident oropharyngeal gonorrhea or chlamydia of the oropharynx. The exposure of interest was tongue kissing (including open mouth kissing, deep kissing, and dry or wet kissing).

### Analysis

Pooling of results using meta-analysis was not possible due to the differences in study design, measurements of kissing, and participant characteristics. Therefore, a narrative review was undertaken to describe the key findings for each study and these were stratified by STI and study design.

### Quality Assessment

All studies were independently reviewed for quality by 2 reviewers (F.C. and R.C.) using a modified form of the Quality Index (QI),<sup>11</sup> and any discrepancies were resolved through a consensus discussion. A higher QI score suggests greater methodological quality. Individual questions are either given a score of 0 (no/indeterminate) or 1 (yes). The QI scale includes 4 subcategories that are tallied for a final score: reporting (0–7), external validity (0–3), internal validity (0–5), and power (0–1). The assessment items are outlined in Supplementary Table 1 (<http://links.lww.com/OLQ/A907>).

## RESULTS

We identified 12,239 records based on our search strategy. After removing duplicates, 8248 articles were identified from the databases, and a further article was identified through searching

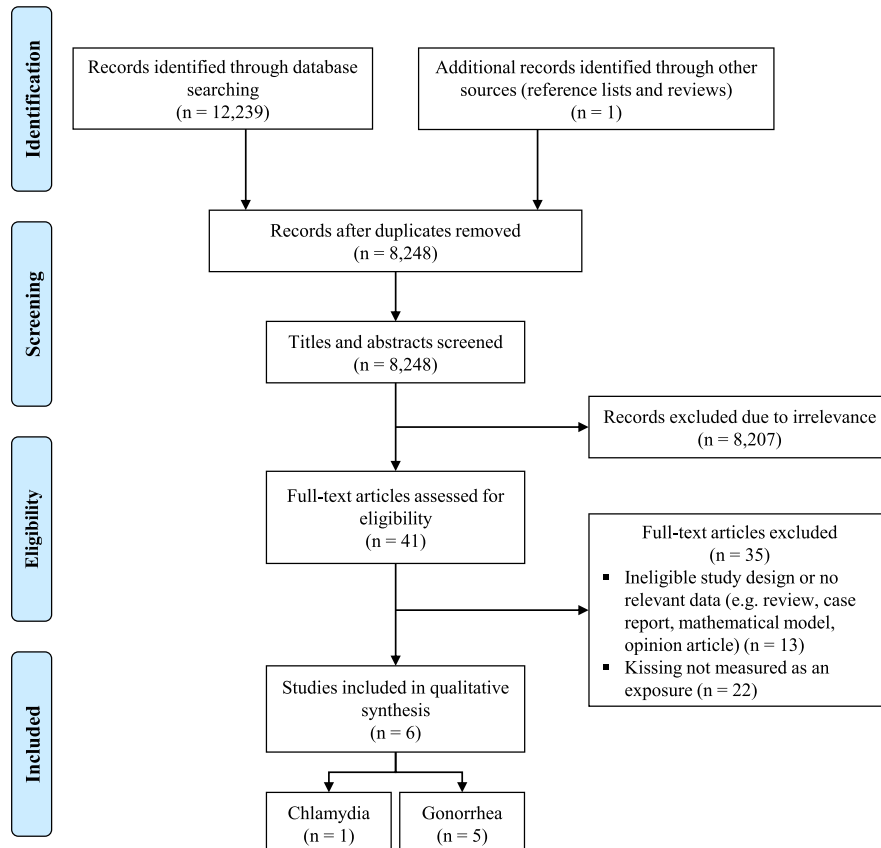


Figure 1. Study selection flowchart.

TABLE 1. Summary of Included Study Findings

Study (Year), Location, Type	Study Type	Study Population	n	Kissing Exposure	Measure of Association	Crude Result (95% CI)	Adjusted Result (95% CI)	Comments
<b>Chlamydia</b> Templeton (2008), <sup>13</sup> Australia	Prospective cohort	HIV- MSM (non-random convenience sample)	1427	Dry kissing and wet kissing casual partners in last 6 mo (never, occasionally, or often)	HR	Dry kissing: Never: 1.0 (ref); Occasionally: 1.81 (0.52 to 6.29); Often: 0.92 (0.24 to 3.47) Wet kissing: Never: 1.0 (ref); Occasionally: 1.51 (0.34 to 6.77); Often: 0.85 (0.19 to 3.82)	NR	Multivariate analysis/adjustment was not performed for kissing
<b>Gonorrhoea</b> Chow (2021), <sup>12</sup> Australia	Prospective cohort	HIV +/- MSM (full study population details Supplementary Table 2, <a href="http://links.lww.com/OLQ/A908">http://links.lww.com/OLQ/A908</a> )	100	No. tongue kissing partners over a 12-week study period	IRR	No. tongue kissing partners: 1.08 (1.03 to 1.12)*	NR	Of the incident oropharyngeal gonorrhoea cases, 2 men reported kissing only without penile-oral sex or insertive rimming
Chow (2019), <sup>16</sup> Australia	Cross-sectional	HIV +/- MSM from a sexual health clinic	3677	Kissing-only or kissing-with-sex partners in the last 3 mo (kissing-only is kissing without other sexual contact in last 3 mo)	OR	No. kissing only partners in last 3 mo: 0-1 partners: 1 (ref), 2-3 partners: 1.34 (0.91 to 1.97), ≥4 partners: 2.02 (1.49 to 2.74)*	No. kissing only partners in last 3 mo: 0-1 partners: 1 (ref), 2-3 partners: 1.30 (0.87 to 1.95), ≥4 partners: 1.46 (1.04 to 2.06)* $P_{\text{trend}} = 0.029^*$	Also measured number of sex-only and kissing-with-sex partners to separate kissing from sex as an exposure Multivariable regression adjusting for kissing-only, sex-only and kissing-with-sex partners
Cornelisse (2018), <sup>15</sup> Australia	Case-control	Age-matched MSM from a sexual health clinic	Cases (n = 177) Controls (n = 354)	No. tongue kissing partners in last 3 mo	OR	Median number of casual sexual partners kissed (CSP): Cases: 4 vs controls: 2.5* CSP tongue kissed: No: (ref); Yes: OR, 2.17 (1.31 to 3.59)* Median duration of kiss (min): Cases: 10 vs controls: 10 Days since last kiss: Cases: 10 vs controls: 7 Proportion kissing > 75% of CSP: ≤75%: (ref); >75%: 1.38 (0.94 to 2.03)	Proportion kissing >75% of CSP: ≤75%: (ref); >75%: 1.55 (0.96 to 2.49)	Multivariable regression adjusted for receptive fellatio with/without ejaculation and insertive rimming

Continued next page

TABLE 1. (Continued)

Study (Year), Location, Type	Study Type	Study Population	n	Kissing Exposure	Measure of Association	Crude Result (95% CI)	Adjusted Result (95% CI)	Comments
Templeton (2010), Australia <sup>14</sup>	Prospective cohort	HIV- MSM (non-random convenience sample)	1427	Dry kissing and wet kissing casual partners in last 6 mo (never, occasionally, or often)	HR	Dry kissing: Never: 1.0 (ref); Occasionally: 1.26 (0.74–2.14); Often: 1.61 (0.95–2.73)* Wet kissing: Never: 1.0 (ref); Occasionally: 2.55 (1.10–5.91); Often: 2.98 (1.32–6.75)*	Dry kissing: Never: 1.0 (ref); Occasionally: 1.04 (0.61 to 1.77); Often: 1.18 (0.68 to 2.05) Wet kissing: Never: 1.0 (ref); Occasionally: 1.77 (0.77 to 4.06); Often: 1.83 (0.80 to 4.17)	Adjusted for repeated measures in same individual and other sexual practices (number of male sexual partners, receptive penile-oral sex with and without ejaculation, insertive oro-anal sex)
Tran (2022), Australia <sup>17</sup>	Cross-sectional	HIV +/- MSM from a sexual health clinic	2322	No. tongue kissing partners in last 3 mo	OR	No. kissing only partners in last 3 mo: 0 partners: 1 (ref), 1–2 partners: 1.87 (0.55 to 6.41), 3–4 partners: 3.27 (0.97 to 10.97), ≥4 partners: 6.28 (1.96 to 20.11)* $P_{\text{trend}} < 0.0001^*$	No. kissing only partners in last 3 mo: 0 partners: 1 (ref), 1–2 partners: 1.81 (0.48 to 6.88), 3–4 partners: 2.58 (0.68 to 9.81), ≥4 partners: 3.59 (0.95 to 13.55)* $P_{\text{trend}} = 0.014^*$	Adjusted for number of fellatio and rimming partners

\* $P < 0.05$ .

QIS, Quality Index Scale; NR, not reported; OR, odds ratio; HR, hazards ratio; IRR, incidence rate ratio; +, positive; –, negative.

reference lists. After title and abstract screening, 41 articles underwent full-text review, and of these, 6 were eligible for inclusion (Fig. 1). The eligible studies included 3 prospective cohort studies,<sup>12–14</sup> 1 age-matched case-control study<sup>15</sup> and 2 cross-sectional studies.<sup>16,17</sup> All studies were conducted among gay, bisexual and other MSM in Australia. Participants were recruited from sexual health clinics ( $n = 4$ ) and convenience samples ( $n = 2$ ). The sample sizes ranged from 100 to 3677. Five studies reported on gonorrhoea<sup>12,14–17</sup> and 1 study reported on chlamydia.<sup>13</sup> The characteristics and findings of all included studies are summarized in Table 1, and further detail is provided in Supplementary Table 2 (<http://links.lww.com/OLQ/A908>).

### Kissing and Oropharyngeal Gonorrhoea ( $n = 5$ )

All 5 studies that assessed gonorrhoea found that kissing was associated with oropharyngeal gonorrhoea in the univariable analyses.<sup>12,14–17</sup> The 2 cross-sectional studies also found that kissing was associated with oropharyngeal gonorrhoea in the multivariable analyses after adjusting for other confounding factors, such as participant demographic characteristics and other sexual practices.<sup>16,17</sup>

### Case-Control Studies

Cornelisse et al<sup>15</sup> conducted a 1:2 age-matched case-control study of 531 MSM attending a sexual health clinic in Melbourne in 2015, which included 177 cases of oropharyngeal gonorrhoea and 354 controls. The univariable regression analyses demonstrated that men with oropharyngeal gonorrhoea were 2.17 (95% confidence interval [CI], 1.31 to 3.59) times more likely to have tongue kissed their casual partners in the last 3 months compared with men who did not have oropharyngeal gonorrhoea. However, kissing was highly correlated with receptive oral-penile sex and the total number of casual sexual partners ( $r = 0.91$ ,  $P < 0.001$ ) and in the multivariable analysis it was not significantly associated with oropharyngeal gonorrhoea.

### Prospective Cohort Studies

Templeton et al<sup>14</sup> conducted a prospective cohort study of 1427 MSM between 2001 and 2007 in Sydney, Australia that investigated the association between “wet” and “dry” kissing and oropharyngeal gonorrhoea. This analysis was part of the Australian Health in Men (HIM) study and included a total of 193 oropharyngeal gonorrhoea cases with an incidence rate of 4.45 (95% CI, 3.86 to 5.12) per 100 person-year. In the univariate analysis, the authors found that the odds of acquiring oropharyngeal gonorrhoea increased with an increasing frequency of dry kissing ( $P_{\text{trend}} = 0.044$  and wet kissing ( $P_{\text{trend}} = 0.008$ ) with their casual partners in the last 6 months. However, this association was not significant after

adjusting for insertive oro-anal sex (i.e. rimming) and receptive penile-oral sex in the multivariable analysis.

Chow et al<sup>12</sup> conducted a 12-week prospective cohort study between August and October 2019 of 100 MSM taking HIV preexposure prophylaxis attending a sexual health clinic in Melbourne in Australia, which included 14 incident oropharyngeal gonorrhoea cases with an incidence of 62.43 (95% CI, 36.97 to 105.41) per 100 person-years. Weekly saliva specimens were self-collected and sent to the clinic by postal service and clinician-collected oropharyngeal swabs were obtained during clinic visits at weeks 0 and 12. Both saliva specimens and oropharyngeal swabs were tested for *N. gonorrhoeae* by nucleic acid amplification test. Incident oropharyngeal gonorrhoea was found to be associated with the number of kissing partners in the past week (incidence rate ratio (IRR): 1.08; 95% CI, 1.03 to 1.12). However, the high collinearity of sexual practices made it difficult to establish the individual contribution of exposures to either mouth or urethra independently.

### Cross-Sectional Studies

Chow et al<sup>16</sup> recruited 3677 MSM in a cross-sectional study from a sexual health clinic in Melbourne between 2016 and 2017. The prevalence of oropharyngeal gonorrhoea was 6.2% (229/3677). The study collected data on the number of kissing-only partners (where kissing occurred without sex), sex-only partners (where sex occurred without kissing) and kissing-with-sex partners (where both sex and kissing occurred) in the last 3 months. The authors defined “sex” as having oral or anal sexual encounters. The study found that, after adjusting for potential confounding factors, MSM who had  $\geq 4$  kissing-only partners had 1.46-fold (95% CI, 1.04 to 2.06) higher odds of having oropharyngeal gonorrhoea compared with those who had 0–1 kissing-only partners in the last 3 months. There was also a significant trend seen with increasing numbers of kissing partners in the last 3 months ( $P_{\text{trend}} = 0.029$ ). However, one of the limitations of this study was that the study did not include direct measures of other sexual activities with potential exposure to the oropharynx, such as fellatio or rimming.

Tran et al<sup>17</sup> recruited 2322 MSM in a cross-sectional study from a sexual health clinic in Melbourne between 2018 and 2020. The prevalence of oropharyngeal gonorrhoea was 5.2% (120/2322). This study examined the association between kissing and oropharyngeal gonorrhoea, and also adjusted for other oral sexual practices that exposed the oropharynx, including performing fellatio and performing rimming. In the multivariable regression analysis, oropharyngeal gonorrhoea was significantly associated with increasing numbers of kissing partners ( $P_{\text{trend}} = 0.014$ ). It is worth noting that this study was conducted between November 2018 and December 2020, which included a period during the COVID-19 pandemic lockdown restriction, which might have

TABLE 2. Quality Index Scale Scores With Means and Standard Deviations

Study	Reporting	External Validity	Internal Validity	Power	Total
Chow (2019) <sup>16</sup>	7	1	3	0	11
Chow (2021) <sup>12</sup>	7	1	3	0	11
Cornelisse (2018) <sup>15</sup>	6	1	4	1	12
Templeton (2008) <sup>13</sup>	5	1	3	0	9
Templeton (2010) <sup>14</sup>	7	1	3	0	11
Tran (2022) <sup>17</sup>	7	1	5	1	14
Max score possible	7	3	5	1	16
Mean	6.5	1.0	3.5	0.3	11.3
SD	0.8	0.0	0.8	0.5	1.6

SD, standard deviation.



influenced some changes in sexual practices during this period as suggested elsewhere.<sup>18</sup>

### Kissing and Oropharyngeal Chlamydia (n = 1)

We only identified 1 prospective cohort study examining the association between kissing and oropharyngeal chlamydia. In the study by Templeton et al.,<sup>13</sup> also collected from the HIM cohort among 1427 MSM, which included 25 oropharyngeal chlamydia infections with an incidence of 0.58 (95% CI, 0.39–0.85) per 100 person-years. However, there was no association between kissing (either wet or dry kissing) and oropharyngeal chlamydia in the univariate analysis.

### Assessment of Quality

Overall, the mean QIS for the eligible studies was 11.3 (standard deviation, 1.6; range, 9–14) (Table 2), which indicates imperfect methodological quality on average. Several items were reported clearly in all studies, such as how the outcomes were measured. However, the external validity of studies was low due to selection bias and the internal validity was compromised by potential confounding and recall bias in the analyses. Sample size and power calculations were rarely provided.

## DISCUSSION

To the best of our knowledge, this is the first systematic review assessing the association between kissing and gonorrhea or chlamydia of the oropharynx. We identified 6 eligible studies of which 5 examined gonorrhea and 1 examined chlamydia. Of the 5 studies examining oropharyngeal gonorrhea, all found that kissing was associated with oropharyngeal gonorrhea among MSM in their unadjusted analyses, whereas 2 studies found kissing was an independent risk factor for oropharyngeal gonorrhea after adjusting for other confounders such as participant demographic characteristics and other sexual practices.<sup>16,17</sup> In particular, Tran et al<sup>17</sup> found an association after specifically adjusting for other oral exposures (ie, performing fellatio and performing rimming). A single study examined chlamydia and did not find an association between kissing and oropharyngeal chlamydia.<sup>13</sup> The consistency of the finding of an association between kissing and oropharyngeal gonorrhea suggests that it is likely to be a real finding although the studies were exclusively from Australia and should be repeated elsewhere.

The uncertainty created by multiple sexual activities with high collinearity occurring during a single sexual encounter is a key issue that impedes confirming the role of kissing as an independent risk factor.<sup>19,20</sup> Chow et al<sup>16</sup> showed that tongue kissing in the absence of sex was an independent factor for oropharyngeal gonorrhea after adjusting for multiple confounding factors, such as the number of sex-only partners (sex without kissing) and kissing-with-sex partners. However, sex-only partners could participate in a range of sexual activities, including fellatio and rimming, which are also known risk factors for oropharyngeal gonorrhea.<sup>14,15,17</sup> The additional data collected by Tran et al attempted to address this limitation by specifically asking about the number of fellatio and insertive rimming partners, and reached the same conclusion with its findings suggesting tongue kissing is an independent risk factor for oropharyngeal gonorrhea after adjusting for performing fellation and performing rimming. Interestingly, Tran et al found that performing fellatio is not a significant risk factor for oropharyngeal gonorrhea. Supporting this conclusion, a prospective cohort study in the United States by Barbee et al,<sup>9</sup> which did not fulfill the inclusion criteria for this review, found that oropharyngeal gonorrhea is likely to occur in the absence of fellatio—15% of the incident gonorrhea infections were identified in men

who denied any recent oral-penile contact. A possible explanation is that urethral gonorrhea is usually symptomatic, which would make it less likely to be transmitted through performing fellatio.<sup>21,22</sup> Taken together, accumulating evidence supports oropharyngeal gonorrhea being transmitted through kissing. The 2021 Centers for Disease Control and Prevention STI Treatment Guidelines stated kissing has not been well studied in gonorrhea and chlamydia transmission<sup>7</sup>; however, 3 important studies are published after this guideline<sup>9,12,17</sup> and therefore these studies should be considered in the next update.

In this review, all included studies were conducted among MSM. We did not limit the study populations for this review, but we were unable to identify studies on non-MSM populations. Past studies have shown that oropharyngeal STIs are also found in other at-risk populations such as female sex workers and heterosexual men and women,<sup>23–25</sup> and these populations also frequently report kissing.<sup>26,27</sup> The lack of studies in non-MSM populations may also be due to the lack of universal screening of extragenital STIs in these populations. A Melbourne-based study of a sexual network, which included 4 females, 2 men and 1 nonbinary, non-gender-conforming participant who attended a music festival, found that 6 of 7 individuals within the sexual network had oropharyngeal gonorrhea but none had urogenital gonorrhea.<sup>28</sup>

There are several limitations in our systematic review. First, the specific measurements of kissing used and the study designs employed were not consistent, which prevented using a meta-analysis approach to calculate pooled summary estimates of association. Second, several studies did not conduct multivariable analyses, and as a result, confounding cannot be excluded from the results. Third, the 2 studies that identified kissing as an independent risk factor for oropharyngeal gonorrhea in the multivariable analyses were both cross-sectional studies; hence, a causal relationship between kissing and oropharyngeal gonorrhea cannot be established. Fourth, recall bias on sexual practices, particularly on the number of kissing partners might have occurred in the included studies. Fifth, all included studies were conducted in Australia. Sexual practices, including kissing practices, may vary across ethnicities and cultures<sup>29</sup>; therefore, further studies conducted outside Australia are required to support this evidence. Finally, some of the coauthors in this review have also served as coinvestigators in 4 of 6 of the studies included in this review. However, the full texts screening, data extraction, and quality assessments were performed by independent investigators who are not coauthors of the included studies.

Considerably more research is required to clarify the role of kissing as a route of transmission across populations other than MSM. This is important because recent work has also suggested that gonorrhea at the oropharynx appears to be an important source of gonorrhea transmission and hence future interventions may well focus on this site. If they do, it is important to establish transmission routes in heterosexuals as well. It is important to clarify the role of kissing in STI transmission in future research, as novel interventions may be required to target this mode of transmission. Concentrating on behavioral change alone might prove difficult. A previous study that surveyed 926 Australian MSM found that most (77.6%) MSM would be unlikely to stop tongue kissing to prevent oropharyngeal gonorrhea.<sup>30</sup>

## CONCLUSION

This systematic review provided some evidence to suggest a possible association between kissing and oropharyngeal gonorrhea. In contrast, we found no evidence for an association between kissing and oropharyngeal chlamydia, but only a single relevant study on chlamydia was identified. Kissing has been considered a neglected risk factor for oropharyngeal STIs. Public health and

safe sex messages around kissing and oropharyngeal STIs should be considered. Future studies will also be required to examine the role of kissing in oropharyngeal STI transmission in other settings and other at-risk populations. Furthermore, with the increase in condomless sex in the era of preexposure prophylaxis and the concern of antibiotic resistance, non-condom-based and non-antibiotic-based novel interventions are urgently required for gonorrhea prevention and control.

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