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USE OF GEO-SOCIAL NETWORKING APPLICATIONS IS INDEPENDENTLY ASSOCIATED WITH DIAGNOSIS OF SEXUALLY TRANSMITTED INFECTION (STI) AMONG MEN WHO HAVE SEX WITH MEN TESTING FOR STIS: FINDINGS FROM THE CROSS-SECTIONAL MSM INTERNET SURVEY IRELAND (MISI) 2015

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KEY MESSAGES

- Use of geo-social networking applications to meet sexual partners is associated with STI diagnosis in MSM who test for STIs
- Condomless anal intercourse with multiple partners and increasing number of all sexual partners are associated with STI diagnosis in MSM who test for STIs
- Geo-social networking applications are key settings to provide MSM with information on STI risk reducing strategies and prevention

ABSTRACT

Objectives

MISI 2015 was an anonymous, self-completed, cross-sectional internet survey assessing sexual behaviours and health needs among men who have sex with men (MSM) in Ireland. We explored factors associated with self-reported STI diagnosis among MSM who were sexually active and had an STI test in the previous year.

Methods

We compared the study population (n=1,158; 37% of total population), with the sexually active MISI population not testing for STIs (n=1,620; 52% of total population). Within the study population, we identified socio-demographics and sexual behaviours associated with self-reporting an STI diagnosis. We used multivariable logistic regression to estimate adjusted odds ratios (aORs).

Results

The socio-demographics, lifestyle and sexual behaviours of the study population differed significantly from the sexually active MISI population who didn't test for STIs. Within the study population, 65% met a sexual partner via GSNa and 21% self-reported an STI diagnosis in the previous year. On univariable analysis, factors associated with STI diagnosis included; older age, identifying as gay, HIV positive status, increasing number of sexual partners in the previous year, condomless anal intercourse (CAI) with ≥ 2 non-steady partners and using GSNa to meet a new sexual partner in the previous year or most recent sexual partner. On multivariable analysis, STI diagnosis was associated with: being aged 25-39 years (aOR 1.8, 95%CI 1.04-3.15), CAI with ≥ 2 non-steady partners (aOR 2.8, 95%CI 1.84-4.34), total number of sexual partners (aOR 1.02, 95%CI 1.00-1.03), and using GSNa to meet a new sexual partner (aOR 1.95, 95%CI 1.12-3.39).

Conclusions

STI diagnosis among MSM testing for STIs is associated with GSNa use, as well as sexual behaviours.

GSNa are key settings for STI prevention interventions, which should prioritise men with high numbers of sexual partners and those with multiple CAI partners.

INTRODUCTION

Globally, men who have sex with men (MSM) are disproportionately affected by sexually transmitted infections (STIs).[1] In Ireland the pattern is similar. In 2015, 82% (n=220) of early syphilis cases and the majority of gonorrhoea cases (55%, n=401) occurred in the MSM population.[2, 3] The incidence of STIs in MSM in Ireland is increasing. From 2005 to 2015, there was a four-fold increase in new HIV diagnoses among MSM in Ireland. Between 2013 and 2016, there were several outbreaks in the MSM population, including two lymphogranuloma venereum (LGV) outbreaks, a gonorrhoea outbreak and a shigella outbreak.[4] Co-infection with different STIs is common. In 2015, 30% of MSM diagnosed with syphilis were co-infected with HIV and 26% were co-infected with an STI, other than HIV.(2) International guidance recommends that MSM should regularly test for STIs.[5-7]

Several factors have been identified as influencers of STI testing patterns among MSM including; demographics, sexual behaviour such as higher number of sexual partners and history of previous STI diagnosis [8,9]. In addition, demographic, lifestyle and sexual behaviour factors have been identified as increasing the risk of STI acquisition in MSM, including alcohol consumption, recreational drug use[10-12]and use of geo-social networking smart-phone applications (GSNa) to meet sexual partners.[13,14] Previous observational studies have reported increased odds of STI diagnosis with higher numbers of sexual partners [10,13,15-17] and condomless anal intercourse (CAI).[15,16]In addition, being HIV positive is well established as a risk factor for being diagnosed with other STIs.[11, 17-19]However, there is little existing data on factors associated with STIs in MSM in Ireland.

In 2015, an internet-based survey of MSM living in Ireland (MISI 2015) was undertaken to further understand the knowledge, attitudes, needs and behaviours of the MSM population in Ireland.[20] In response to the observed increase in STI diagnoses in MSM and the dearth of risk factor data, we report on a subset analysis of the MISI study, focusing on the identification of risk factors associated

with the self-reported diagnosis of STIs among sexually active MSM who had an STI test in the previous 12 months. This population was chosen as they are already aware of, and engaged with, health services. Therefore, there are opportunities to provide targeted interventions to reduce the incidence of STIs in this population.

METHODS

Study design

We used data from MISI 2015.[20] MISI was an online cross-sectional survey designed to measure sexual health morbidities, knowledge, behaviours, attitudes and service use among MSM in Ireland. It was anonymous and self-administered. The survey was available in English only and took approximately 14 minutes to complete. Questions were taken from the UK Gay Men's Sex Survey 2014 [21] and the European MSM Internet Survey 2010,[17] adapted and supplemented for the Irish context, including additional questions on alcohol and tobacco use from the Healthy Ireland Survey 2015.[22]

The survey was accessible online from March 1st 2015 to May 31st 2015 and was advertised on 10 national LGBT community, sexual health, HIV and health promotion websites and through social media including a popular GSNa. [20]Seven thousand promotional cards were distributed at gay social and community venues, the Gay Men's Health Service, sexual health services, LGBT student services and through the national network of youth centres.[20] A survey launch party was organised which received media coverage. Adverts, social media messages and tweets continued while the survey remained open. Inclusion criteria were: identifying as a man or trans-man and aged 18-80 years and currently living in Ireland, and one of the following; attracted to men, had sex with men and/or expecting to in the future. An information paragraph, which included details on confidentiality, and a consent form to participate was included at the start of the survey.[20] Ethics approval for MISI 2015 was given by the Royal College of Physicians in Ireland in December 2014.

Sample size calculation for MISI 2015

Published studies estimate that the prevalence of MSM in the Irish male population is 3%. [23, 24] The male population aged 15 to 65 years of age in the 2011 Irish Census was 1,528, 196. The 15 to 64 years age group was used so as not to overestimate the MSM population in the over 65 year olds. Finally, in 2013 82% of the population of Ireland had access to a computer connected to the internet. (Source: CSO, Ireland, www.cso.ie). Therefore a sample size of 1,038 was required for a desired precision of +/-4% with a 95% confidence level. However, considering that MISI was a self-selected, convenience sample, this 1,038 sample size was just an approximation.

Study population

We restricted our analysis to men who reported that they had sex with a man and had an STI test in the previous 12 months, resulting in a study population of 1,158. This population was chosen as they are already accessing sexual health services and opportunities exist to provide targeted interventions.

STI testing in the previous 12 months was determined from the question “When did you last have a test for STIs other than HIV?”. This question offered seven answers (only one answer possible). We combined the number of respondents with answers from “within the last 24 hours” to “within the last 12 months” to determine the total number of respondents who reported having an STI test in the previous 12 months.

Statistical analysis

We undertook descriptive analysis of the study population and compared it to the sexually active MISI population who had not tested for STIs in the previous year, to identify if the two populations were comparable. We included the following socio-demographic variables: age (three age groups: <25 years, 25 to 39 years and ≥40 years), area of residence (Dublin versus other), born in Ireland,

education (lower than degree level versus degree level or higher), employment status (four categories: employed, unemployed, student and other), sexual identity (gay versus bisexual/other), and outness (out to all/ more than half of family and friends, versus out to less than half/few/no family and friends). As lifestyle variables we included: current smoking, binge drinking (defined as ≥ 6 standard drinks per usual drinking session), use of poppers in the previous 12 months, use of any other/recreational drugs in the previous 12 months, use of a GSNa to meet a new sexual partner in the previous 12 months, and use of a GSNa to meet most recent sexual partner. As sexual behaviour variables we included: total number of sexual partners in the previous 12 months, and having had CAI with two or more non-steady partners in the previous 12 months. HIV status was also included in the analysis as a binary variable (positive versus negative/unknown status). All variables were analysed as binary variables except: age (categorical age-groups), employment status (categorical) and total number of sexual partners in the previous 12 months (continuous). Reference categories within variables were the same as in the overall MISI report. [20]

Self-reported STI diagnosis was assumed if a 'yes' answer was given to the following survey question "Have you been diagnosed with an STI (e.g. syphilis, chlamydia, gonorrhoea) in the last 12 months? Information on disease-specific STIs was not requested.

Chi² tests were used to compare the socio-demographic features and sexual and lifestyle behaviours of the study population and the sexually active MISI population who did not test for STIs.

Univariable analysis, using logistic regression, was used to identify associations between socio-demographic features, sexual and lifestyle behaviours and self-reported STI diagnosis. Odds ratios (OR) were calculated with 95% confidence intervals (CI) and significance set at $p < 0.05$. We undertook multivariable analysis using the 'enter' method to control for confounding. Factors with a p-value of ≤ 0.05 on univariable analysis were included in the multivariable model. Adjusted odds ratios with 95% CI were calculated using logistic regression to identify independent variables that remained associated with STI diagnosis in the multivariable model. Before performing multivariable

analysis we checked for correlation between variables using Spearman’s correlation co-efficient. The correlation co-efficient for “use of a GSNa to meet a new sexual partner in the previous 12 months” and “use of a GSNa to meet most recent sexual partner” was >0.4, suggesting collinearity. Thus we decided that we would exclude “use of a GSNa to meet most recent sexual partner” in multivariable analysis. We included “use of a GSNa to meet a new sexual partner in the previous 12 months” as this variable is more comprehensive and would capture more of the GSNa-using population. Data analysis was undertaken in Stata[®] v.14.1 (StataCorp., USA).

RESULTS

Almost 10,000 people clicked on the welcome page during the 13 weeks the survey was live, while almost a third of these completed the survey. Out of a total of 3,090 valid responses to the MISI survey, we selected the 1,158 (37.5%) respondents who were sexually active in the previous 12 months and had an STI test in the previous 12 months. The median age of the study population was 31 years (range 18-78). Compared with the sexually active MISI population not testing for STIs, the study population (those who had both sex and an STI test in the previous 12 months) was; older, more likely to reside in Dublin, more educated and a higher proportion was employed. They were also more likely to: identify as gay, be out to family and friends, have used a GSNa to meet a sexual partner in the previous year, and use poppers and other drugs. They were also more likely to be HIV positive, have more sexual partners and have condomless anal intercourse with ≥ 2 non-steady partners in the previous 12 months. (Table 1)

Table 1 Demographic and behavioural factors among sexually active MISI population, by STI testing in the previous year

Characteristics		Sexually active and STI test		Sexually active, no STI test	
		N [^]	%	N [^]	%
		1,158	100.0	1,620	100.0
Tested for STI in previous 12 months		1,158	100.0	0	0.0
Age (years)*	<25	298	25.7	537	33.2
	25-39	555	47.9	632	39.0
	≥ 40	305	26.3	451	27.8

Area of residence*	Dublin	612	56.5	675	45.0
	Outside of Dublin	472	43.5	824	55.0
Country of birth*	Ireland	973	84.7	1,411	87.5
	Elsewhere	176	15.3	201	12.5
Education*	Lower than degree level	424	37.7	774	49.0
	Degree level or higher	701	62.3	805	51.0
Employment status*	Employed	815	71.9	1,031	64.8
	Unemployed	67	5.9	111	7.0
	Student	201	17.7	385	24.2
	Other^^	50	4.4	65	4.1
Sexual Identity*	Gay	997	86.8	1,261	79.1
	Bisexual/other^^^	151	13.2	333	20.9
Outness^^^^*	To more than half/all family & friends	867	76.2	1,011	64.2
	To less than half/none family & friends	271	23.8	565	35.8
HIV status*	Negative/not tested	1037	90.4	1,578	98.2
	Positive	110	9.6	29	1.8
Use of GSNa to meet a new sexual partner in previous 12 months*	Yes	750	64.8	682	42.1
	No	408	35.2	938	57.9
Use of GSNa to meet most recent sexual partner*	Yes	446	48.0	392	37.4
	No	483	52.0	655	62.6
Binge drinking on a typical occasion	Yes	592	57.9	846	59.1
	No	430	42.1	586	40.9
Current cigarette smoker	Yes	414	36.0	563	35.1
	No	737	64.0	1,041	64.9
Poppers in the previous 12months*	Yes	534	47.2	430	27.2
	No	597	52.8	1,153	72.8
Other/recreational drugs in the previous 12 months*	Yes	479	41.4	552	34.1
	No	679	58.6	1,068	65.9
CAI≥2 non-steady partners in the previous 12 months*	Yes	251	33.7	192	27.3
	No	494	66.3	512	72.7
Total number of sexual partners in the previous 12 months, median (IQR**)	Total	1,098		1,497	
	Median (range)	5(2-15)		2(1-6)	

^number of participants who provided an answer to this question, ^^Includes long-term sick, medically retired, retired and other, ^^ Heterosexual, but had sex with a man in the previous 12 months/don't assign themselves a sexual identity
 ^^^degree to which people were open about their sexual attraction with others

*statistically significant difference between the proportions in the study population and the MISI population who were sexually active but did not test for STIs in the previous 12 months using χ^2 , single p-value<0.05

**IQR – interquartile range

In the previous 12 months, 65% (n=750) of the study population had met a new sexual partner on a GSNa, while almost half (48%, n=446) of respondents had met their most recent male sexual partner on a GSNa.

Twenty-one percent (n=244) of the study population self-reported a diagnosis of an STI in the previous year.

On univariable analysis the following were associated with an STI diagnosis: being older, identifying as gay, being out to more than half of family and friends, HIV positive status, use of recreational/other drugs or poppers in the previous 12 months, having two or more non-steady CAI partners, and increasing number of sexual partners in the previous 12 months (Table 2). Use of a GSNa to meet a sexual partner in the previous 12 months and use of GSNa to meet most recent sexual partner were associated with higher odds of STI diagnosis (Table 2).

Table 2 Factors associated with an STI diagnosis in MSM tested for STIs in the previous 12 months

Characteristic	N [^]	STI +ve (%)	Univariable analysis		Multivariable analysis		
			OR (95%CI)	p-value	aOR (95%CI)	p-value	
Age (years)	<25	294	47 (16.0)	Ref	-	Ref	-
	25-39	554	123 (22.2)	1.50 (1.03-2.17)	0.032	1.81 (1.04-3.15)	0.035
	≥40	300	74 (24.7)	1.72 (1.14-2.60)	0.009	1.74 (0.92-3.32)	0.089
Area of residence	Outside of Dublin	467	90 (19.3)	Ref	-		
	Dublin	609	137 (22.5)	1.22 (0.89-1.66)	0.199		
Country of birth	Other	174	43 (24.7)	Ref	-		
	Ireland	965	198 (20.5)	0.79 (0.53-1.18)	0.212		
Education	Less than degree	422	97 (23.0)	Ref	-		
	Degree or higher	695	143 (20.6)	0.87 (0.64-1.18)	0.342		
Employment status	Student	201	31 (15.4)	Ref	-	Ref	-
	Employed	805	174 (21.6)	1.51 (1.00-2.30)	0.052	1.38 (0.75-2.54)	0.304
	Unemployed	67	19 (28.4)	2.17 (1.13-4.18)	0.020	1.20 (0.51-2.78)	0.680
	Other ^{^^}	50	14 (28.0)	2.13 (1.03-4.41)	0.041	1.48 (0.51-4.33)	0.475
Sexual identity	Bisexual/other ^{^^^}	149	20 (13.4)	Ref	-	Ref	-
	Gay	990	222 (22.4)	1.86 (1.14-3.06)	0.012	1.25 (0.65-2.43)	0.506
Outness ^{^^^^}	Out to less than half/none	267	45 (16.9)	Ref	-	Ref	-
	Out to more than half/all	861	193 (22.4)	1.43 (1.00-2.05)	0.052	1.53 (0.92-2.55)	0.104
HIV status	Negative/not tested	1,027	208 (20.3)	Ref	-	Ref	-
	Positive	110	34 (30.9)	1.76 (1.14-2.72)	0.013	1.00 (0.54-1.81)	0.981
Binge drink on a typical drinking occasion	No	426	86 (20.2)	Ref	-		
	Yes	589	127 (21.6)	1.09 (0.80-1.48)	0.596		
Current cigarette smoking	No	729	157 (21.5)	Ref	-		
	Yes	412	86 (20.9)	0.96 (0.71-1.30)	0.793		
Poppers in the previous 12 months	No	591	92 (15.6)	Ref	-	Ref	-
	Yes	530	143 (27.0)	2.00 (1.49-2.70)	<0.001	1.00 (0.63-1.43)	0.814
Other/recreational drugs in the previous 12 months	No	671	122 (18.2)	Ref	-	Ref	-
	Yes	477	122 (25.6)	1.55 (1.16-2.06)	0.003	1.17 (0.79-1.74)	0.429
Use of GSNa to meet new sexual partner in previous 12 months	No	402	51 (12.7)	Ref	-	Ref	-
	Yes	746	193 (25.9)	2.40 (1.71-3.38)	<0.001	1.95 (1.12-3.39)	0.020
Use of GSNa to meet most recent sexual partner*	No	476	90 (18.9)	Ref	-		
	Yes	444	117 (26.4)	1.53(1.12-2.10)	0.007		
CAI≥2 non-steady partners	No	489	82 (16.8)	Ref	-	Ref	-
	Yes	250	102 (40.8)	3.42 (2.39-4.90)	<0.001	2.83 (1.84-4.34)	<0.001
Total number of sexual partners in previous 12 months – median IQR**		1,098	233 (21.4)	1.04 (1.03-1.05)	<0.001	1.02(1.00-1.03)	0.034
		5 (2-15)	11 (4-20)				

^number of participants who provided an answer to this question, ^^Includes long-term sick, medically retired, retired and other, ^^^ Heterosexual, but had sex with a man in the previous 12 months/don't assign themselves a sexual identity ^^^^degree to which people were open about their sexual attraction with others

* We did not include the variable 'use of GSNa to meet most recent sexual partner' in the multivariable model because of correlation with the variable 'use of GSNa to meet a sexual partner in the previous 12 months'. **IQR – interquartile range

1 On multivariable analysis; being aged 25-39 years, use of a GSNa to meet a new sexual partner in the previous 12
2 months and having two or more non-steady CAI partners were independently associated with an STI diagnosis. We
3 observed an increase in the odds of an STI diagnosis with increasing number of sexual partners in the previous 12
4 months. (Table 2)

5 **DISCUSSION**

6 Our study population were MSM who were sexually active and had tested for STIs in the previous 12 months. They
7 were predominantly born in Ireland and resident in Dublin. The demographics of the study population were different
8 to the sexually active MISI population not testing for STIs as was their use of drugs and GSNa and sexual behaviour.

9 Our study population had some similarities with previous research on populations consistently testing for STIs. [8,9]
10 They were more likely to self-identify as gay, be HIV positive and have more sexual partners. However, they differed
11 regarding education level and some “higher risk” sexual behaviours. [8,9] Our study population was significantly
12 more likely to engage in higher risk sexual behaviours, including higher numbers of sexual partners and CAI with two
13 or more non-steady partners, when compared with the non-testing sexually active MISI population suggesting that
14 MSM at increased risk of STI diagnosis are appropriately accessing testing. In the study population, we found that
15 STI diagnosis was significantly associated with: use of GSNa to meet a new sexual partner in the previous 12 months,
16 increasing number of sexual partners, and CAI with two or more non-steady partners. Being aged 25-39 years was
17 also associated with an STI diagnosis in the study population.

18 Online dating and sexual partner seeking has become popular in all populations including among MSM.[25] GSNa use
19 global positional systems to identify others using the same app in nearby geographical locations, thus facilitating the
20 identification of possible local sexual partners.[26] The majority of our study population had met a new male sexual
21 partner via GSNa in the previous 12 months. We identified that using GSNa to meet a new sexual partner in the
22 previous 12 months was associated with STI diagnosis. This finding is consistent with previous research in a similar
23 population in the United States that found that MSM STI clinic attendees who used GSNa to meet sexual partners
24 had higher odds of testing positive for chlamydia and gonorrhoea than clinic attendees who did not use GSNa.[14]
25 However, a considerable proportion of the sexually active MISI population not testing for STIs also used GSNa to
26 meet sexual partners in the previous year. This suggests that there may be a substantial burden of undiagnosed STI

1 in untested, sexually active MSM using GSNa. Further research focusing on MSM using GSNa would be useful. This
2 observation supports the development of combination sexual networking and sexual health information
3 applications. At present, the Gay Health Network in Ireland use health messages on GSNa to signpost users to the
4 www.man2man.ie website, which provides sexual health information for MSM.[27,28] We recommend additional
5 health content, including information on access to free STI testing and condoms should be added to GSNa.

6 We found the risk of STI diagnosis was higher in men aged 25-39 years compared with other age groups, although
7 this age-group were also most likely to test for STIs (48% of the tested population versus 26% of the tested
8 population for each those aged 18-24 years and ≥ 40 years). The odds of being diagnosed with an STI increased with
9 increasing number of sexual partners. This is not surprising as higher number of sexual partners has been reported to
10 be associated with STI diagnosis in previous studies in similar populations.[15] CAI with multiple non-steady partners
11 was associated with STI diagnosis in our population. CAI has previously been reported as a risk factor for STI
12 diagnosis in MSM populations testing for STIs in Germany 15] STI prevention interventions should focus on safer sex
13 awareness, STI prevention techniques including reduction of number of sexual partners and consistent condom use.

14 Adjusting for confounding in the multivariable model attenuated the odds of STI diagnosis in HIV positive MSM and
15 in MSM who used drugs and poppers in our population. This is in contrast to other studies in similar populations and
16 the wider MSM population.[15, 17,19] This result may be due to relatively small numbers in the study population.

17 MISI is the largest survey of MSM to be carried out in Ireland and while our study is limited to sexually active MSM
18 who had an STI test in the previous 12 months, the findings endorse targeted health promotion activities in this
19 population in Ireland and also support ongoing health promotion activities to address our findings.

20 We found that our study population differed considerably from the sexually active MISI population not testing for
21 STIs and therefore our findings are not generalisable to the wider MSM population. However, there were similarities
22 between our findings and the results of other studies of MSM who opted to test for STIs. [8,9,19]

23 The MISI survey was anonymous and self-administered, therefore self-reporting is likely to be a limitation of the
24 overall survey. The prevalence of STIs is possibly an underestimation in our study population. The respondents were
25 limited to those who self-reported a diagnosis of STI in the previous 12 months. There are likely to be respondents
26 with asymptomatic STIs who did not attend for testing at the time of infection. However, frequency of testing is

1 unknown for the study population but all had an STI test in the previous 12 months, so the underestimation is likely
2 to be small.

3 The MISI survey was an online, English-language survey and therefore participation was limited to those who self-
4 selected to participate, were English-speaking, computer literate and had access to the internet. The study also used
5 convenience sampling which typically recruits younger and better educated MSM than those recruited through
6 probability sampling [29]. Consequently, the study population may not be representative of the MSM population
7 testing for STIs in Ireland as certain groups of the population were less likely to have been represented.
8 Notwithstanding this, MISI 2015 was the largest survey of MSM ever conducted in Ireland, and is thus likely to be
9 more representative of this community than previous national surveys.

10 **CONCLUSION**

11 We identified that increasing numbers of sexual partners, having CAI with 2 or more non-steady partners, and using
12 a GSNa to meet a new sexual partner in the previous 12 months, were important factors associated with self-
13 reported STI diagnosis in the MSM population testing for STIs. In view of our findings, we recommend that STI
14 prevention and testing information should be continued and enhanced on commonly used GSNa. We also
15 recommend that services providing STI testing for MSM should have [condoms and information highlighting STI risk](#)
16 [reduction strategies readily available](#).

17

18 **Ethics approval**

19 Ethics approval was obtained for the overall MISI 2015 study. RCPI RECSAF 30

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23 **Competing interests**

24 None

1 **Author's contributions**

2 LOC wrote the first draft of the manuscript and amended subsequent drafts based on co-author
3 contributions. FH wrote the survey on which MISI was based and was involved in its adaptation. KOD, MF,
4 DI, MQ and DM were involved in the design and conducting of the MISI survey and DI and MQ were
5 involved in promotion activities encouraging participation. PB, KOD and MF were involved in the analysis of
6 the original data from MISI. LOC, KOD, MF, PB, FH, AB and DI were involved in the design of the statistical
7 analysis for this paper. LOC performed the data analysis. LOC, KOD, MF, PB, FH, AB, DM, MQ and DI
8 contributed to the interpretation of the results for this study. All authors contributed to the writing of the
9 manuscript, provided comments and agreed the final manuscript.

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