What is the global prevalence of depression among men who have sex with men? A systematic review and meta-analysis

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Abstract

Background: Depression due to stigma resulting from their sexual identity, isolation, social exclusion, and insufficient access to care and counseling services has become a health problem among men who have sex with men (MSM).

Objectives: This study aimed to determine the global prevalence of depression among MSM as a systematic review and meta-analysis.

Methods: This study was a systematic review and meta-analysis performed in five steps of search strategy, screening and selecting articles, data extraction, evaluation of the risk of bias, and meta-analysis. In this study, the determined keywords were searched in the databases of PubMed, Scopus, Embase, and Web of Science from January 1913 to July 2021 to find the initial articles, from which data were extracted according to the set checklist in the data extraction stage. Finally, the studies were included in the present meta-analysis according to the inclusion and exclusion criteria, to be evaluated using the Newcastle Ottawa scale checklist. I Square and Q Cochrane were also used to assess the degree of heterogeneity. The analyses were performed using the random-effects model in STATA 16.

Results: The results showed the quality score of the majority of cross-sectional studies included in the meta-analysis (62 studies) was equal to six or seven (moderate), and five ones had a high-quality score. After combining these studies, the pooled prevalence of depression among MSM in the world was 35% (95% CI 31%–39%, I square; 98.95%, P-value < 0.001). Population subgroup analysis showed the pooled prevalence of depression among MSM living with HIV was 47% (95% CI 39%-55%, I square; 95.76%, P-value < 0.001). Continent subgroup analysis showed the highest pooled prevalence of depression among Asian MSM at 37% (95% CI 31%-43%, I square; 99.07%, P-value < 0.001). Also, in the subgroup analysis of the sampling method, the pooled prevalence in the studies which used the respondent-driven sampling method was equal to 34% (95% CI 25%-43%, I square; 99.32%, P-value < 0.001). Sensitivity analysis revealed the pooled prevalence of depression in studies included in the meta-analysis was near or around the pooled estimate.

Conclusion: The pooled prevalence of depression among MSM was almost three times higher than the general male population. Therefore, particular and therapeutic interventions such as screening, and harm reduction programs for mental disorders, especially depression, are suggested to be considered in service packages.

Keywords: Depression, MSM, Men who have sex with men, Global prevalence, Meta-analysis

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Background

Men who have sex with men (MSM) are marginal and at-risk populations with special and unique health needs [1, 2]. These people also face sexual minority stress caused...
by constant stress and their sexual orientation, which makes them highly vulnerable to mental health problems [3, 4]. MSM are stigmatized because of their sexual orientation which causes them to avoid expressing their important problems, and become isolated and lonely. They also face discrimination, abuse, lack of social support, and frequent stressful situations. Because of such conditions, they face more problems in receiving health care and are at risk of more psychological complications [1, 5]. These conditions can lead to outcomes such as depression, substance abuse, or feelings of helplessness which limit self-help behaviors [6].

On the other hand, MSM are exposed to high-risk behaviors and its related diseases, such as HIV/AIDS. So, the stigma caused by these conditions can make them suffer from more mental disorders, especially depression [6]. Also, according to the results of previous studies, one of the most critical risk factors for depression is a homosexual orientation which means having sexual and physical tendencies and attraction to the same sex. Research showed gay men were more likely to drug abuse, depression, and suicide [1, 5].

Understanding the prevalence of depression and its associated factors in this population is very important [7]. MSM should be screened for symptoms of depression and anxiety and should seek appropriate mental health services if needed [8–12]. Due to their special conditions, the need for further systematic reviews and meta-analyses on the incidence of depression in them, and the importance of depressive disorders, this study was conducted to determine the global prevalence of depression in MSM as a systematic review and meta-analysis. This meta-analysis is the most up-to-date study in the world to estimate the prevalence of depression in the general population of MSM with appropriate tools and analysis in different subgroups with greater generalizability.

**Methods**

The article protocol was registered on the PROSPERO site with the code CRD42021239819.

**Search strategy and screening articles**

Articles published from January 1913 to July 2021 in four electronic databases (PubMed, Scopus, Web of Science, and Embase) were retrieved and reviewed. The study main keywords were “Depression” and “Men who Have Sex with Men”. The search syntax is shown in Table 1.

Also, to perform gray literature in the present meta-analysis, a manual search was performed by reviewing the references of related articles and the first ten pages of Google Scholar. After retrieving the articles and creating a library in the Endnote software (version nine) for each database, the articles were placed in another library in combination. The duplicate ones were removed based on the default of the Endnote software. Then the remaining articles were reviewed based on their titles, abstracts, and full texts, considering the inclusion criteria. Two authors independently screened the articles based on their titles, abstracts, and full texts, and in case of any disagreement, the results were reviewed by the study supervisor. After screening, the final selection of studies was made by evaluating the full text of selected articles.

**Table 1** The search terms and search syntax

| Databases | Search syntax |
|-----------|---------------|
| PubMed    | ("Depressions"[Title/Abstract] OR "Depressive Symptoms"[Title/Abstract] OR "Depressive Symptom"[Title/Abstract]) OR ("Emotional Depression"[Title/Abstract] AND "Depressive"[Title/Abstract]) OR ("Symptoms"[Title/Abstract] AND "Depressive"[Title/Abstract]) OR ("Depression"[Title/Abstract] AND "Emotional"[Title/Abstract]) OR ("Depressions"[Title/Abstract] AND "Emotional"[Title/Abstract]) OR ("Symptoms"[Title/Abstract] AND "Depressive"[Title/Abstract]) OR ("Emotional"[Title/Abstract]) OR ("Depression"[Title/Abstract] AND "Emotional"[Title/Abstract]) OR ("Depressions"[Title/Abstract] AND "Emotional"[Title/Abstract]) OR ("Symptoms"[Title/Abstract] AND "Depressive"[Title/Abstract]) OR ("Emotional"[Title/Abstract]) OR ("Depression"[Title/Abstract] AND "Emotional"[Title/Abstract]) OR ("Depressions"[Title/Abstract] AND "Emotional"[Title/Abstract]) |
| Web of Sciences | TOPIC: (Depressions OR "Depressive Symptoms" OR "Depressive Symptom" OR "Depressive Symptoms" OR (symptoms AND depressive) OR "Emotional Depression" OR (Depression AND Emotional) OR (Depressions AND Emotional) OR (Depressions AND Emotional) OR (Emotional Depression OR Depression OR "mental health" OR mental disorder) AND TOPIC: (MSM OR Men who have sex with men OR "Homosexual men" OR "homosexuality") |
| Embase    | (depressions OR depressive symptom/exp OR depressive symptom/EXP OR depressive symptom/"Depressive Symptoms") AND "Depressive Symptoms" OR depressive symptom/"Depressive Symptoms") AND (msm:JT OR "Men who have sex with men" OR "Homosexual men" OR "homosexuality") |
| Scopus    | (TITLE-ABS-KEY: (Depressions OR "Depressive Symptoms" OR "Depressive Symptoms") OR (symptoms AND depressive) OR (symptoms AND depressive) OR ("Emotional Depression") OR (depression AND emotional) OR (depressions AND emotional) OR (Emotional Depression) OR depression OR mental health OR "mental disorder") AND TITLE-ABS-KEY: (msm OR Men who have sex with men OR "Homosexual men" OR "Homosexuality" OR "homosexual") )
Inclusion and exclusion criteria
This study aimed to determine the global prevalence of depression among MSM. All descriptive and analytical cross-sectional studies were reviewed, and other studies (case studies, cohorts, clinical trials, letters to the editor, case reports, and review studies) were excluded. Articles in languages other than English, and ones which reported the outcome of depression as a mean score with standard deviation and indicators other than percentage or frequency were excluded from the study. In addition, studies with the statistical population of MSM or men who had sex with men were included. These articles were excluded from the study if the statistical population was gay, bisexual, transgender, or other high-risk groups.

Data extraction
After selecting articles in the screening stage based on their titles, abstracts, and full texts regarding the inclusion criteria, a checklist prepared with the opinion of experts was used to retrieve their information according to the purpose of the study. The checklist components included the author name, study type, publication year, total sample size, country, population type, age, sampling method, depression frequency, continent, and tool for measuring depression.

Risk of bias
The Newcastle–Ottawa Quality Assessment Scale (NOS) checklist was used to assess the quality of the articles. This checklist is designed to evaluate the quality of cross-sectional studies. Each of these items is given a score of one if observed in the study, and the maximum score for each study is nine points. Scores are ranged from zero stars (the worst case) to nine stars (the best case). Studies with a score of zero to four were categorized as low quality, five to seven as moderate, and more than seven as high quality [13].

Statistical analysis
According to the study checklist, the total sample size and frequency of depressed MSM were extracted for all studies. Based on the extracted data, the MetaProp command was used to calculate the pooled prevalence, and the results were analyzed [14]. The analysis model was a random effect model. Cochrane Q and I² tests were used to investigate the heterogeneity and variance between the studies selected for meta-analysis [15–18]. To quantitatively determine heterogeneity or as a percentage, the I² square index whose range of changes is between zero and 100%, is used. When zero, it indicates the homogeneity of the results, and the larger this value, the greater the heterogeneity between studies. In the Cochrane classification, four levels are considered for heterogeneity: 0–25% (might not be important), 30–60% (may represent moderate heterogeneity), 50–90% (may represent substantial heterogeneity), 75–100% (considerable heterogeneity). Funnel plot and Egger tests were applied to evaluate the publication bias [17, 18]. The aim of this method is to detect and correct the asymmetry of the funnel plot resulting from publication bias Also, trim-and-fill tests were used to determine the effect of publication bias on the estimated pooled prevalence. [19, 20]. Also, the meta-regression analysis and diagram were applied to examine the Association between variables of age and the publication year of selected studies with the estimated pooled prevalence. Subgroup analysis used to find the source of heterogeneity was conducted based on the population type (healthy or HIV infected), age, continent, measuring tools, sampling type, and quality assessment score. The sensitivity analysis was performed by the Metainf command, and statistical analysis using STATA 16.0 while the statistical significance was set at P<0.05.

Results
Qualitative results
Initially, 8723 articles were obtained from four databases (PubMed, Web of Science, Scopus, and Embase), of which 1384 were from PubMed, 4577 from Scopus, 499 from Embase, and 2263 from the Web of science. After removing similar items in the Endnote software, 7290 articles were selected for screening their titles and abstracts. Then, the full texts of 276 selected studies were reviewed. Finally, 71 studies were included in the analysis [1, 12, 21–89] (Table 2 and Fig. 1), all of which were cross-sectional with the statistical population of MSM. Table 2 shows the lowest mean age (20 years old) was related to the three studies of Bruce et al., Holloway et al. and Kipke et al. [27, 41, 44] while the highest mean age (57 years old) was related to the study of Zepf et al. [86]. Also, the overall mean age in the meta-analysis was 32 years. In the present meta-analysis, the first study to report the prevalence of depression in MSM was the article of Mills et al. [55], and the most recent study which measured the prevalence of depression in MSM was the article of Clark et al. [32]. The highest number of studies was related to 2018 with 14 articles [26, 31, 34, 46, 47, 50, 58, 60, 62, 69, 71, 77, 84, 89] and 2017 with 11 articles [28, 30, 38, 40, 41, 43, 54, 56, 67, 70, 73]. The smallest sample size was related to the study of Armstrong et al. [25] with 56 people, and the highest was related to the study of Tomori et al. [71] with 11,771 people.

Quality assessment (risk of bias)
As shown in Table 1, the risk of bias in the study results ranged from five to eight. The quality score of four
| Authors [year]          | Year | Sample size | Country            | Study populations | Age (mean or median) | Method of sampling                      | Depression | Continents | Measuring tools        | NOS score |
|-----------------------|------|-------------|--------------------|-------------------|----------------------|----------------------------------------|------------|------------|------------------------|-----------|
| Ahaneku, H. et al. [2014] [21] | 2014 | 117         | Los Angeles        | MSM               | 45                   | NR                                     | 15         | America    | Beck Depression Inventory II | 5         |
| Ahaneku, H. et al. [2016] [22] | 2016 | 205         | Tanzania           | MSM               | 25                   | Respondent-driven sampling             | 95         | Africa     | PHQ-9                  | 6         |
| Aliy, L. et al. [2011] [23] | 2011 | 1,540       | US                 | MSM               | NR                   | NR                                     | 929        | America    | CES-D                 | 7         |
| An, X et al. [2020] [24] | 2020 | 334         | China              | MSM               | 29                   | Convenience                           | 116        | Asia       | CES-D                 | 6         |
| Armstrong, R et al. [2020] [25] | 2020 | 56          | Zambia             | MSM               | 22                   | Snow-ball                             | 28         | Africa     | CES-D                 | 7         |
| Brown, M. J et al. [2018] [26] | 2018 | 337         | US                 | MSM living with HIV | NR                   | NR                                     | 198        | America    | CES-D                 | 6         |
| Bruce, D. et al. [2014] [27] | 2014 | 200         | US                 | YMSM              | 20.9                 | NR                                     | 64         | America    | CES-D                 | 6         |
| Chakrapani, V et al. [2017] [28] | 2017 | 300         | India              | MSM               | 30                   | Convenience                           | 105        | Asia       | Beck Depression Inventory | 6         |
| Chandler, C. et al. [2020] [29] | 2020 | 3294        | US                 | MSM               | NR                   | NR                                     | 1278       | America    | CES-D                 | 6         |
| Chen, Y. H et al. [2017] [30] | 2017 | 322         | California         | MSM               | NR                   | NR                                     | 42         | America    | PHQ-9                  | 7         |
| Cherenack, E. et al. [2018] [31] | 2018 | 92          | US                 | MSM living with HIV | 31                   | NR                                     | 45         | America    | CES-D                 | 6         |
| Clark, K. et al. [2021] [32] | 2021 | 488         | Lebanon            | MSM               | NR                   | Respondent-driven sampling             | 258        | Asia       | CES-D                 | 8         |
| Deuba, K. et al. [2013] [33] | 2013 | 339         | Nepal              | MSM               | NR                   | Snow-ball                             | 206        | Asia       | CES-D                 | 8         |
| Du, M. et al. [2018] [34] | 2018 | 321         | China              | MSM living with HIV | 30                   | NR                                     | 179        | Asia       | CES-D                 | 6         |
| Dyer, T. et al. [2013] [35] | 2013 | 798         | US                 | BMSMO             | 35                   | NR                                     | 319        | America    | CES-D                 | 7         |
| Fendrich, M. et al. [2013] [36] | 2013 | 177         | Chicago            | MSM               | 37                   | Probability                           | 40         | Asia       | CES-D                 | 6         |
| Ferro, E. G. et al. [2015] [37] | 2015 | 302         | Peru               | MSM               | 32                   | Convenience                           | 134        | America    | CES-D                 | 6         |
| Feuillet, P et al. [2017] [38] | 2017 | 1078        | France             | MSM living with HIV | NR                   | NR                                     | 334        | Europe     | CIDI-SF                | 6         |
| Ha, H. X et al. [2014] [39] | 2014 | 451         | Vietnam            | MSM               | 30                   | Respondent-driven sampling             | 249        | Asia       | CES-D                 | 6         |
| Holloway, I. et al. [2017] [40] | 2017 | 150         | California         | MSM living with HIV | 45                   | NR                                     | 96         | America    | CES-D                 | 7         |
| Holloway, I. et al. [2017] [41] | 2017 | 526         | California         | YMSM              | 20                   | Stratified                            | 52         | America    | CES-D                 | 8         |
| Authors [year] | Year | Sample size | Country | Study populations | Age (mean or median) | Method of sampling | Depression | Continents | Measuring tools | NOS score |
|---------------|------|-------------|---------|------------------|--------------------|--------------------|------------|------------|----------------|----------|
| Hu, Y.et al.[2019] [42] | 2019 | 1518        | China   | MSMO             | 27                 | Non-probability sampling | 534        | Asia       | CES-D         | 6        |
| Hylton, E.et al. [2017] [43] | 2017 | 1376        | Russia  | MSM              | 30                 | Respondent-driven sampling | 505        | Europe     | CES-D         | 7        |
| Kipke, M. Diet al. [2007] [44] | 2007 | 526         | US      | yMSM             | 20                 | Venue-based probability sampling | 110        | America    | CES-D         | 7        |
| Klein, H.et al.[2014] [45] | 2014 | 332         | US      | MSM              | 43                 | Random              | 86         | America    | CES-D         | 7        |
| Kunzweiler, C. Pet al. [2018] [46] | 2018 | 711         | Kenya   | MSM              | 24                 | Respondent-driven sampling | 81         | Africa     | PHQ           | 7        |
| Levine, E. C.et al. [2018] [47] | 2018 | 176         | New York | MSM              | 34                 | Stratified          | 120        | America    | CES-D         | 7        |
| Li, J.et al. [2016] [48] | 2016 | 321         | China   | MSM living with HIV | 30                 | NR                  | 179        | Asia       | CES-D         | 6        |
| Liu, Y.et al. [2018] [50] | 2018 | 807         | China   | MSM              | NR                 | Respondent-driven sampling | 267        | Asia       | SDS           | 6        |
| Maragh-Bass, A. C.et al. [2020] [51] | 2020 | 357         | US      | MSM              | 48                 | NR                  | 180        | America    | PHQ           | 7        |
| Mayer, K. Het al. [2014] [52] | 2014 | 1553        | US      | MSM              | 40                 | NR                  | 698        | America    | CES-D         | 7        |
| Mayer, K. Het al. [2015] [53] | 2015 | 307         | India   | MSM              | 30                 | NR                  | 67         | Asia       | CES-D         | 6        |
| Mgopa, L. Ret al. [2017] [54] | 2017 | 345         | Tanzania | MSM              | 31                 | Driven sampling technique | 245        | Africa     | PHQ           | 6        |
| Mills, T. C.et al. [2004] [55] | 2004 | 2,678       | US      | MSM              | NR                 | Household-based probability sample | 461        | America    | CES-D         | 7        |
| Miltz, A. Ret al. [2017] [56] | 2017 | 1340        | United Kingdom | MSM              | NR                 | NR                  | 166        | Europe     | PHQ           | 6        |
| Mimiaga, M. Jet al. [2013] [57] | 2013 | 150         | India   | MSM              | 25                 | NR                  | 43         | Asia       | MINI          | 6        |
| Mo, P. Ket al. [2018] [58] | 2018 | 225         | China   | MSM              | 32.2               | NR                  | 109        | Asia       | DASS          | 7        |
| Mu, Ket al. [2016] [59] | 2016 | 807         | China   | MSM              | NR                 | Respondent-driven sampling | 55         | Asia       | DSM           | 5        |
| Murphy, Patrick.et al. [2018] [60] | 2018 | 278         | United Kingdom and Ireland | MSM living with HIV | 44                 | NR                  | 161        | Europe     | HADS          | 6        |
| O’Cleirigh, C.et al. [2009] [61] | 2009 | 503         | New England | MSM              | 42                 | NR                  | 43         | Europe     | PHQ           | 6        |
Table 2 (continued)

| Authors [year] | Year | Sample size | Country | Study populations | Age (mean or median) | Method of sampling | Depression | Continents | Measuring tools | NOS score |
|----------------|------|-------------|---------|-------------------|---------------------|-------------------|------------|------------|----------------|-----------|
| Pan, X.et al. [2018] [62] | 2018 | 454 | China | MSM | 33 | Respondent-driven sampling | 157 | Asia | CES-D | 6 |
| Parker, R. Det al. [2015] [63] | 2015 | 265 | Estonia | MSM | 32 | Random | 34 | Europe | EST-Q | 7 |
| Peng, L.et al. [2020] [64] | 2020 | 578 | China | MSM | 28 | Convenience | 189 | Asia | CES-D | 6 |
| Prabhu, S.et al. [2020] [65] | 2020 | 1454 | India | MSM | 37 | Respondent-driven sampling | 241 | Asia | PHQ | 6 |
| Reisner, S. Let al. [2009] [66] | 2009 | 197 | Massachusetts | MSM | 38 | Respondent-driven sampling | 65 | America | CES-D | 7 |
| Rüütel, K.et al. [2017] [67] | 2017 | 265 | Estonia | NR | 32 | NR | 84 | Europe | EST-Q | 7 |
| Safren, S. A.et al. [2009] [68] | 2009 | 210 | India | MSM | 28 | NR | 115 | Asia | CES-D | 6 |
| Secor, A. Met al. [2014] [69] | 2014 | 112 | Kenya | MSM | 26 | NR | 18 | Africa | PHQ | 7 |
| Sivasubramanian, M.et al. [2011] [70] | 2011 | 150 | India | MSM | 25 | NR | 43 | Asia | DSM | 7 |
| Su, X.et al. [2018] [71] | 2018 | 507 | China | MSM | NR | Convenience | 136 | Asia | CES-D | 6 |
| Tao, J.et al. [2017] [72] | 2017 | 364 | China | MSM living with HIV | 28 | NR | 131 | Asia | HADS | 7 |
| Tomori, C.et al. [2018] [73] | 2018 | 11,771 | India | MSM | 26 | Respondent-driven sampling | 1502 | Asia | PHQ | 7 |
| Wagner, G.Jet al. [2019] [74] | 2019 | 226 | Beirut | YMSM | 24 | NR | 36 | Asia | PHQ | 7 |
| Wang, Y.et al. [2017] [75] | 2017 | 547 | China | MSM | 30 | NR | 285 | Asia | CES-D | 6 |
| Wei, Det al. [2020] [76] | 2020 | 578 | China | MSM | NR | NR | 208 | Asia | CES-D | 5 |
| Wendi, D.et al. [2016] [77] | 2016 | 316 | Lesotho | MSM | 23 | Respondent-driven sampling | 69 | Africa | PHQ | 8 |
| White, J.Jet al. [2020] [78] | 2020 | 256 | US | MSM | 39 | NR | 96 | America | CES-D | 6 |
| Wilkerson, J.M.et al. [2018] [79] | 2018 | 421 | India | MSM | NR | Respondent-driven sampling | 242 | Asia | CES-D | 7 |
| Williams, J.Ket al. [2015] [80] | 2015 | 1522 | US | MSM | NR | NR | 615 | America | CES-D | 7 |
| Wm, V.B.et al. [2014] [81] | 2014 | 591 | Belgium | Men who have sex with men | 34 | NR | 171 | Europe | CES-D | 6 |
| Wu, Y.et al. [2015] [82] | 2015 | 184 | China | MSM living with HIV | 31 | NR | 79 | Asia | CES-D | 6 |
| Authors [year] | Year | Sample size | Country | Study populations | Age (mean or median) | Method of sampling | Depression | Continents | Measuring tools | NOS score |
|---------------|------|--------------|---------|-------------------|----------------------|--------------------|-------------|------------|-----------------|-----------|
| Yan, H. et al. [2014] [81] | 2014 | 204          | China   | MSM               | NR                   | Respondent-driven sampling | 94          | Asia       | CES-D           | 6         |
| Yan, H. et al. [2019] [82] | 2019 | 347          | China   | MSM living with HIV | 34                   | Convenience         | 134         | Asia       | CES-D           | 6         |
| Yang, C. et al. [2013] [83] | 2013 | 188          | Baltimore | MSM               | 38                   | Random              | 35          | America    | CES-D           | 7         |
| Yu, L.et al. [2018] [84] | 2018 | 807          | China   | MSM               | NR                   | Respondent-driven sampling | 267         | Asia       | SDS             | 6         |
| Zeng, X. et al. [2016] [85] | 2016 | 1235         | China   | MSM               | 31.6                 | Non-probability     | 563         | Asia       | CES-D           | 7         |
| Zepf, R. et al. [2020] [86] | 2020 | 281          | San Francisco | MSM living with HIV | 57                   | NR                  | 77          | America    | PHQ             | 8         |
| Zhang, S. et al. [2019] [87] | 2019 | 547          | China   | MSM               | 30                   | Snowball            | 169         | Asia       | CES-D           | 6         |
| Zhao, Y. et al. [2020] [88] | 2020 | 338          | Malawi  | MSM               | 25                   | Respondent-driven sampling | 102         | Africa     | NR              | 6         |
| Zhu, Y. et al. [2018] [89] | 2018 | 342          | China   | MSM               | 28                   | Convenience         | 153         | Asia       | GHQ             | 7         |
cross-sectional studies included in the meta-analysis was five. It was six, seven, and eight for 35, 27, and five studies. Most of the studies included in the meta-analysis had good quality for the analysis (Table 2).

**Quantitative results**

**Prevalence of depression among MSM:**

The sample size of MSM in a total of 71 articles was 51,541 people, of whom 15,171 had depressive symptoms. After combining these studies, the pooled prevalence of depression in MSM was 35% (95% CI 31–39%, I²: 98.95%). The prevalence range in the studies varied from 7% to 71%, with the lowest prevalence equal to 7% (95% CI 5–9%) related to the study of Mu, H. et al. [59], and the highest prevalence equal to 71% (95% CI 66–76%) related to the study of Mgopa L.R. et al. [54] (Table 3). The Eggers test results showed publication bias in calculating the pooled prevalence of depression in MSM (B = 10.71, SE = 0.197, P < 0.001). To show the publication bias, the funnel plot diagram (Fig. 2) was used. The trim-and-fill test showed publication bias had no considerable effect on the final overall estimate (P = 0.347, CI = 0.308—0.385) (Fig. 2). Meta-regression analysis was also used to investigate the association between the age of MSM and the publication year of the studies included in the meta-analysis, the results of which are shown in Figs. 3 and 4.

**Subgroup analysis** In this study, subgroup analysis was performed based on the population type, continent, age

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**Fig. 1** The flowchart of search strategy and syntax
of MSM, measuring tools, and sampling type; the results are shown in Table 3.

**Subgroup analysis based on the population type** The subgroup analysis results for the population type showed the sample size of MSM living with HIV in 11 studies was 3753 individuals, and the pooled prevalence of depression was 47% (95% CI 39–55%, $I^2$: 95.76%). Also, in 60 studies with a sample size of 47,788 healthy MSM without HIV, the prevalence of depression was 33% (95% CI 28–37%, $I^2$: 99.02%) (Table 3). Heterogeneity in the population type subgroup was at the considerable level. The observed difference between the prevalence of depression in the MSM population with HIV and healthy ones was statistically significant (Table 3).

### Table 3: The pooled prevalence of depression among MSM (over all prevalence, subgroup analysis of depression)

| Depression                  | No. of study(ss) | No. of depression | Pooled prevalence | Heterogeneity assessment | Z Score (P Value) |
|-----------------------------|------------------|------------------|-------------------|--------------------------|------------------|
| Overall                     | 71 (51541)       | 15171            | %35 (%31 - %39)   | %98.95 <0.00             |                  |
| Population                  |                  |                  |                   |                          |                  |
| Healthy                     | 60 (47788)       | 13558            | %33 (%28 - %37)   | %99.02 <0.00             | 9.21 (0.001)      |
| HIV                         | 11 (3753)        | 1613             | %47 (%39 - %55)   | %95.76 <0.00             |                  |
| Continent                   |                  |                  |                   |                          |                  |
| Asia                        | 33 (27841)       | 7280             | %37 (%31 - %43)   | %99.07 <0.00             | 2.96 (0.400)      |
| Africa                      | 7 (2083)         | 638              | %34 (%17 - %53)   | %98.69 <0.00             |                  |
| America                     | 23 (15921)       | 5755             | %35 (%29 - %42)   | %98.68 <0.00             |                  |
| Europe                      | 8 (5696)         | 1498             | %26 (%17 - %37)   | %98.65 <0.00             |                  |
| Age                         |                  |                  |                   |                          |                  |
| ≥30                         | 28 (23350)       | 5388             | %33 (%26 - %39)   | %98.84 <0.00             | 0.79 (0.001)      |
| <30                         | 26 (11122)       | 4027             | %37 (%30 - %43)   | %98.01 <0.00             |                  |
| Not                         | 17 (17069)       | 5756             | %36 (%27 - %44)   | %99.25 <0.00             |                  |
| Measuring tools             |                  |                  |                   |                          |                  |
| DASS                        | 1 (225)          | 109              | %48 (%42 - %55)   | –                        | 458.26 (0.001)    |
| PHQ                         | 13 (17943)       | 2795             | %23 (%16 - %31)   | %98.74 <0.00             |                  |
| ESTQ                        | 2 (530)          | 118              | %22 (%18 - %25)   | 0.00 <0.00               |                  |
| MINI                        | 1 (150)          | 43               | %29 (%22 - %37)   | –                        |                  |
| DSM                         | 2 (957)          | 98               | %29 (%28 - %40)   | 0.00 <0.00               |                  |
| HADS                        | 2 (642)          | 292              | %45 (%42 - %49)   | 0.00 <0.00               |                  |
| CES-D                       | 43 (27305)       | 10473            | %40 (%36 - %44)   | %97.99 <0.00             |                  |
| SDS                         | 2 (1614)         | 534              | %33 (%31 - %35)   | 0.00 <0.00               |                  |
| CIDI                        | 1 (1078)         | 334              | %31 (%28 - %34)   | –                        |                  |
| GHQ                         | 1 (342)          | 153              | %45 (%39 - %50)   | –                        |                  |
| Becks depression inventory  | 2 (417)          | 120              | %28 (%24 - %32)   | 0.00 <0.00               |                  |
| Not                         | 1 (338)          | 102              | %36 (%25 - %35)   | –                        |                  |
| Method of sampling          |                  |                  |                   |                          |                  |
| Driven sampling technique   | 17 (21152)       | 4494             | %34 (%25 - %43)   | %99.32 <0.00             | 10.98 (0.030)     |
| Convenient                  | 7 (2710)         | 967              | %36 (%32 - %41)   | %96.62 <0.00             |                  |
| Non-probability             | 5 (3695)         | 1500             | %44 (%35 - %53)   | %96.42 <0.00             |                  |
| Probability sample          | 8 (4868)         | 938              | %23 (%15 - %32)   | %97.21 <0.00             |                  |
| Not                         | 34 (19116)       | 7272             | %36 (%31 - %42)   | %98.18 <0.00             |                  |
| Score of NOS                |                  |                  |                   |                          |                  |
| SCORE=5                     | 4 (2049)         | 447              | %20 (%17 - %39)   | %98.76 <0.00             | 3.56 (0.31)       |
| SCORE=6                     | 35 (19684)       | 6777             | %37 (%33 - %42)   | %97.94 <0.00             |                  |
| SCORE=7                     | 27 (27858)       | 7285             | %34 (%27 - %42)   | %99.32 <0.00             |                  |
| sSCORE=8                    | 5 (1950)         | 662              | %33 (%15 - %55)   | %98.97 <0.00             |                  |
Subgroup analysis based on the continent  The results of the subgroup analysis based on the continent showed 33 studies were conducted in Asia with a sample size of 27,841 MSM, according to the results of which 7280 of these people were suffering from depression. The pooled prevalence in Asian MSM was 37% (95% CI 31–43%, I²: 99.07%). In addition, eight studies were conducted in Europe with a sample size of 5696 MSM, of whom 1498 had depression. The pooled prevalence in European MSM was 26% (95% CI 17–37%, I²: 98.65%). There were seven studies in Africa with a sample size of 2083 MSM; according to the results, 638 people were depressed. The meta-analysis results showed the pooled prevalence in African MSM was 34% (95% CI 17–53%, I²: 98.69%). Finally, 23 studies were performed in the Americas, the results of which showed out of 15,921 MSM participants, 5755 had depression, and the pooled prevalence in the present meta-analysis was 35% (95% CI 29–42%, I²: 98.68%). Asia had the highest prevalence of depression (Table 3). Heterogeneity in the continent subgroup was at the considerable level. The difference between the geographical areas in terms of the prevalence of depression was not statistically significant (Table 3).

Subgroup analysis based on age  The results of subgroup analysis based on the age showed 28 studies had a sample size of 23,350 MSM aged 30 and less than 30 years, and out of the total participants, 5388 people had depression. The pooled prevalence of depression in MSM aged 30 and less than 30 years was 33% (95% CI 26–39%, I²: 98.84%). The total sample size of 26 studies was 11,122 MSM older than 30 years, of whom 4027 were depressed, and the pooled prevalence of depression was 37% (95% CI 30–43%, I²: 98.01%) (Table 3).
Heterogeneity in the age subgroup was at the considerable level. The difference in the prevalence of depression between MSM aged more and less than 30 years was statistically significant (Table 3).

Subgroup analysis based on the measurement tool After combining the studies which used CES-D tools, the pooled prevalence of depression was 40% (95% CI 36–44%, I²:97.99%). Also, by combining the studies which used PHQ tools to diagnose depression, the pooled prevalence was 23% (95% CI 16–31%, I²: 98.74%). The present study showed the prevalence of depression was higher in studies which used the CES-D tool (Table 3). Heterogeneity in the measurement tool subgroup was at the considerable level. The results showed the differences in the prevalence of depression in MSM based on the different diagnostic tools were statistically significant (Table 3).

Subgroup analysis based on the sampling method Seventeen articles with a sample size of 21,152 MSM, of whom 4494 were depressed, used the driven sampling method and showed a pooled prevalence of 34% (95% CI 25–43%, I²:99.32%). Also, after combining the studies which used the conventional method, the pooled prevalence was 36% (95% CI 32–41%, I²:86.20%). Five articles with a pooled prevalence of 44% (95% CI 35–53%, I²: 96.42%) used the non-probability sampling method. Also, eight studies with a pooled prevalence of 23% (95% CI 15–32%, I²: 97.21%) applied probability sampling (Table 3). Heterogeneity in the sampling type subgroup was at a considerable level. The observed differences in the prevalence of depression in the MSM community based on the sampling method of the initial studies were statistically significant (Table 3).

Sensitivity analysis Sensitivity analysis in this study was performed to investigate the effect of separate removal of the studies included in the meta-analysis on the outcome of the prevalence of depression in MSM. Its results are shown in Table 3. Each of 13 studies out of the total number of ones included in the meta-analysis, if separately removed from the final analysis, the final pooled estimate would increase from 35% to nearly 36% in the present meta-analysis. However, the rest of the studies did not change the overall pooled estimate if omitted. This confirmed the overall result of the present meta-analysis and its high accuracy so that a large number of selected studies, if considered or not in the analysis, did not make any significant changes in the final pooled estimate (Table 4).

| Study omitted         | Coef  | [95% Conf. Interval] |
|-----------------------|-------|----------------------|
| Mo et al. [2018]      | 0.354 | 0.316–0.392          |
| Mgopa et al. [2017]   | 0.351 | 0.313–0.388          |
| Mills et al. [2004]   | 0.359 | 0.319–0.398          |
| Mimiaga et al. [2013] | 0.357 | 0.318–0.395          |
| Mu et al. [2016]      | 0.360 | 0.322–0.398          |
| Murphy Patrick et al. [2018] | 0.353 | 0.314–0.391    |
| Ahaneku et al. [2016] | 0.354 | 0.316–0.393          |
| Alvy et al. [2011]    | 0.352 | 0.315–0.389          |
| An et al. [2020]      | 0.356 | 0.317–0.394          |
| Armstrong et al. [2020] | 0.354 | 0.316–0.392       |
| Brown et al. [2018]   | 0.352 | 0.314–0.391          |
| Bruce et al. [2014]   | 0.356 | 0.318–0.395          |
| Chakrapani et al. [2017] | 0.356 | 0.317–0.394      |
| Chen et al. [2017]    | 0.359 | 0.321–0.398          |
| Clark et al. [2021]   | 0.353 | 0.315–0.391          |
| Deuba et al. [2013]   | 0.352 | 0.314–0.390          |
| Miltz et al. [2017]   | 0.359 | 0.320–0.398          |
| Wei et al. [2020]     | 0.356 | 0.317–0.394          |
| Rtel et al. [2017]    | 0.356 | 0.318–0.395          |
| Yan et al. [2019]     | 0.355 | 0.317–0.394          |
| Zepf et al. [2020]    | 0.357 | 0.318–0.395          |
| Zeng et al. [2016]    | 0.354 | 0.316–0.393          |
| Yu et al. [2018]      | 0.356 | 0.318–0.395          |
| Yang et al. [2013]    | 0.358 | 0.320–0.397          |
| Wu et al. [2015]      | 0.355 | 0.316–0.393          |
| Zhao et al. [2020]    | 0.357 | 0.318–0.395          |
| Dyer et al. [2013]    | 0.355 | 0.317–0.394          |
| Hyton et al. [2011]   | 0.356 | 0.317–0.394          |
| Wang et al. [2017]    | 0.353 | 0.315–0.392          |
| Tao et al. [2017]     | 0.356 | 0.317–0.394          |
| Pan et al. [2018]     | 0.356 | 0.317–0.394          |
| Hu et al. [2019]      | 0.356 | 0.317–0.395          |
| Wirm et al. [2014]    | 0.357 | 0.318–0.395          |
| Cherenack et al. [2018] | 0.354 | 0.316–0.392      |
| Prabhu et al. [2020]  | 0.359 | 0.320–0.398          |
| O‘Cleirigh et al. [2009] | 0.360 | 0.321–0.398   |
| Ha et al. [2014]      | 0.353 | 0.315–0.391          |
| Du et al. [2018]      | 0.353 | 0.315–0.391          |
| Feuillet et al. [2017] | 0.356 | 0.318–0.395     |
| Kunzweiler et al. [2018] | 0.359 | 0.321–0.398 |
| Li et al. [2016]      | 0.353 | 0.315–0.391          |
| Li R et al. [2016]    | 0.356 | 0.318–0.395          |
| Liu et al. [2018]     | 0.356 | 0.318–0.395          |
| Maragh-Bass et al. [2020] | 0.354 | 0.315–0.392 |
| Williams et al. [2015] | 0.355 | 0.317–0.394   |
| Wlkerson et al. [2018] | 0.353 | 0.315–0.391  |
| White et al. [2020]   | 0.356 | 0.317–0.394          |
| Wendi et al. [2016]   | 0.358 | 0.319–0.396          |
| Kipke et al. [2007]   | 0.358 | 0.319–0.397          |
The present meta-analysis showed depression had a significant prevalence among MSM populations worldwide. The MSM community and other sexual minorities suffer from depression due to rejection by families and others, as well as increased discrimination preventing them from accessing health services. Therefore, screening programs are essential for early diagnosis of mental disorders in these communities. According to previous studies, the determinants of depression in MSM communities include HIV-related stigma, unemployment, sleep disorders, smoking, racism against blacks, birth abroad, initiation of ART, and lack of access to mental health care. Aging, internalized stigma, and lack of self-efficacy, and social support are also important in this complication [55, 90, 91]. However, the prevalence of depression in MSM and other key populations can be influenced by the factors mentioned in the study of Mohamad Faisal et al. [90]. In this study, various factors were mentioned to be effective in increasing the incidence or prevalence of depression in the MSM community, the most important of which was their infection with infectious diseases, especially HIV/AIDS. Fear of stigma due to HIV/AIDS and the decline in referrals for prevention and supportive care services exacerbate their loneliness and isolation. Isolation from the society predisposes MSM to mental disorders, especially depression. Infection with HIV/AIDS and being a sexual minority are two critical factors exacerbating depressive symptoms in MSM.

The pooled prevalence of depression was 35% in this meta-analysis, confirming the high prevalence of depression in MSM communities compared to the general population whose depression prevalence, according to the previous studies, was reported at 13% [92], 14.4% [93], 11.3% [94], and 4.4% [95]. In other high-risk groups like female sex workers (FSWs), the depression prevalence was higher than in the MSM population [96, 97] because the women were more vulnerable than men for several reasons, including factors of biological origins, differences in physical strength, and personality traits [98].

All sexual minorities, especially MSM, have insufficient social support and experience more mental disorders, especially depression. The results of previous studies showed improving social support and its components could lead to reducing depressive symptoms among MSM [99]. In the studies of Shao Bing et al. [100], and Huamei Yan [82], the results showed lack of social support and rejection by families and friends were critical and significant factors in the development of mental disorders, especially depression, in the MSM community. To confirm this association, studies showed if there were adequate and appropriate family or community support for people of sexual minorities, especially MSM, the risk of mental disorders such as depression, anxiety, or suicide would reduce [2, 8, 101]. Also, in 69 low- or middle-income countries, sexual minorities, especially MSM, are considered criminal. So, these communities are exposed to severe stigma and discrimination [102, 103].

If the MSM community suffers from acute or stigmatized diseases or infections such as HIV/AIDS or other sexually transmitted diseases, the incidence or chance of developing mental disorders, especially depression, will be multiplied. In line with this hypothesis, the result of the subgroup analysis showed depression prevalence in MSM living with AIDS/HIV (47%) was higher than that in healthy ones. A meta-analysis conducted to determine the prevalence of HIV/AIDS in the MSM community in 2020 reported a prevalence of 43% [104]. One of the reasons for the increase in depression in MSM living with HIV/AIDS compared to healthy ones is the decrease in the number of their sexual partners after disclosing HIV/AIDS [105]. Following the decline in the number of their partners, MSM living with HIV are also losing their peers’ support. In this case, these people are prone to depression and even suicide. On the other hand, in addition to stigma, discrimination, and lack of social support from families, friends, and the community due to their sexual identity, MSM also faces the stigma associated
with HIV/AIDS, increasing depression in this group compared to healthy MSM or those without HIV [22, 66].

The results showed depression was more prevalent among MSM aged more than 30 years than younger ones. Older MSM experience stigma, discrimination, and lack of social support from families. They also face high-stress levels leading to mental disorders such as depression [106]. Geographically, this meta-analysis showed Asian MSM had a higher depression prevalence than those living in other continents. Asians are more prone to depression and other mental disorders due to different cultures, how they deal with homosexuality, rejection by families and friends, and social isolation [107].

On the contrary, in Europe, due to the acceptance of the sexual identity of sexual minorities, especially MSM, and treating them better, they are less likely to suffer from depression and mental disorders. In the initial studies, various tools were used to measure the prevalence of depression in the MSM community, the most widely used of which was CES-D. Therefore, in subgroup analysis, after combining the results of these initial studies, the prevalence was higher than that of studies which used other measurement tools. It can be noted that the CES-D tool has become increasingly popular among researchers for measuring and reporting depression prevalence in the MSM community.

Subgroup analysis based on the checklist of different NOS scores in this study and the results in Table 3 showed the depression prevalence in MSM was 20% with a confidence interval of 7% to 39% after combining the results of cross-sectional studies with a score of five. In contrast, after combining the results of cross-sectional studies with a high score of eight, this prevalence was 33% with a confidence interval of 15% to 55%. This indicates an underestimation of the depression prevalence in MSM in low-quality cross-sectional studies. The highest depression prevalence in the MSM community was related to several studies with the quality scores of six and seven. Also, more studies in these two categories created a narrower confidence interval than those in the other two categories (i.e., the scores five and eight).

In this study, heterogeneity was high, and the authors decided to perform a subgroup analysis based on the essential variables such as the population type, depression diagnosis tools, geographical areas, sampling methods, age, and finally, different scores of quality evaluation. As can be seen in Table 3, heterogeneity decreased in some classes, but it was not justifiable due to the small number of articles. Therefore, it can be concluded the mentioned and intended variables for subgroup analysis cannot be considered as the heterogeneity factor in the final results of the present meta-analysis because they have not reduced heterogeneity in the subgroup analysis.

Finally, other variables and factors unfortunately not considered in the initial studies selected for the meta-analysis can cause fundamental differences between the selected studies and increase heterogeneity. So, we could not perform subgroup analysis based on these variables or factors.

**Limitations**

One of the limitations of this meta-analysis was the lack of reporting the mean age in many initial studies. On the other hand, because this meta-analysis aimed to determine the prevalence, and only cross-sectional studies were used, after combining these articles, heterogeneity was high. This can be considered as one of the main limitations of prevalence meta-analyses. In addition, this study tried to identify the sources of heterogeneity using subgroup analysis, but due to the lack of reporting other essential variables such as the number of sexual partners, having or not having social relationships and family supports, the place where they live, and living with family or single, identifying these sources was not possible. Also, in the initial studies, the diseases to which MSM people are exposed have not been reported. So, subgroup analysis was not possible based on those variables to compare the prevalence of depression in different groups of MSM. Due to the lack of reporting these variables in the initial studies, and the lack of accurate identification of the heterogeneity sources in the present meta-analysis, the results should be prudently considered, and more detailed studies with appropriate sample sizes are needed to determine the exact prevalence of depression in this community.

**Strengths**

In the present meta-analysis, the prevalence of depression in all the MSM population was studied and analyzed for the first time with an impressive number of preliminary studies. Finally, based on the results of the present meta-analysis, the prevalence of depression in the MSM community seems to be increasing which can be considered a warning. This meta-analysis also confirmed the need to design and provide a mental health package, especially for depression, when providing services to these people. This package of mental health services can include screening, treatment, care, and follow-up programs.

**Conclusion**

The pooled prevalence of depression in the at-risk group of MSM was approximately three times higher than that of the general population. Therefore, it is necessary to pay special attention to screening MSM and to plan some interventions such as treatment of mental disorders,
especially depression. Special preventive measures and interventions are needed to better treat and manage psychological problems such as depression in MSM, especially at younger ages. Also, creating a supportive and friendly culture in the general population toward MSM reduces their isolation, rejection, and the probability of depression.

Abbreviations
MSM: Men who have sex with men; BDI: The Beck Depression Inventory; PHQ: The Patient Health Questionnaire; CES-D: The Center for Epidemiology Studies Depression; HADS: Hospital Anxiety and Depression Scale; DASS: Depression Anxiety Stress Scales; NOS: New Castle–Ottawa Quality Assessment.

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Author contributions
Study concept and design: EN, GM, and YM. Data collection: GM, YM, and EN. Data analysis and interpretation: YM, EN, GM, and YM. Drafting of the manuscript: YM, GM, and EN. Critical revision of the manuscript for important intellectual content: YM, EN. Project administration: GM. All authors read and approved the final manuscript.

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Availability of data and materials
The data extracted for analyses are available from the corresponding author upon reasonable requests.

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Ethics approval and consent to participate
Not applicable.

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Competing interests
All the authors declare they have no conflict of interest.

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References
1. Secor AM, et al. Depression, substance abuse and stigma among men who have sex with men in coastal Kenya. AIDS. 2015;29:5251–9.
2. Mayer KH, et al. Comprehensive clinical care for men who have sex with men: an integrated approach. Lancet (London, England). 2012;380(9839):378–87.
3. Chard AN, Metheny NS, Sullivan PS, Stephenson R. Social stressors and intoxicated sex among an online sample of men who have sex with men (MSM) drawn from seven countries. Substance Use & Misuse. 2018;53(1):42–50.
4. Safren SA, Blashill AJ, O’ Cleirigh CM. Promoting the sexual health of MSM in the context of comorbid mental health problems. AIDS Behav. 2011;15(1):30–4.
5. Desyani NLI, Waluyo A, Yona SJE. The relationship between stigma, religiosity, and the quality of life of HIV-positive MSM in Medan Indonesia. Enfermeria Clinica. 2019;29:510–4.
6. McKinnan DJ, et al. Health care access and health behaviors among men who have sex with men: the cost of health disparities. Health Educ Behav. 2013;40(1):32–41.
7. Akersa D, et al. Comparing the accuracy of brief versus long depression screening instruments which have been validated in low and middle-income countries: a systematic review. BMC Psychiatry. 2012;12(1):1–7.
8. Stahlman S, et al. Depression and social stigma among MSM in Lesotho: implications for HIV and sexually transmitted infection prevention. AIDS Behav. 2015;19(8):1460–9.
9. Brown AL, et al. Discrimination, coping, and depression among black men who have sex with men. Am J Community Psychol. 2018;12(6):9.
10. Corboz and J. Corboz, Feeling Queer and Blue: A review of the Literature on Depression and Related Issues among Gay, Lesbian, Bisexual and other Homosexually Active People: Executive Summary. 2008: Beyondblue.
11. Herek GM, Garnets LD. Sexual orientation and mental health. Annu Rev Clin Psychol. 2007;3:353–75.
12. Safren SA, et al. Depressive symptoms and human immunodeficiency virus risk behavior among men who have sex with men in Chennai, India. Psychol Health Med. 2009;14(6):705–15.
13. Peterson J, Welch V, Losos M, Tugwell PJ. The Newcastle–Ottawa scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: Ottawa Hospital Research Institute. 2011;2(1):1–2.
14. Nyaga VN, Arbyn M, Aerts M. Meta-proper: A stata command to perform meta-analysis of binomial data. Archives of Public Health. 2014;72(1):1–10.
15. Barendregt JJ, et al. Meta-analysis of prevalence. J Epidemiol Community Health. 2013;67(11):974–8.
16. Biggerstaff BJ, Jackson D. The exact distribution of Cochran’s heterogeneity statistic in one-way random effects meta-analysis. Stat Med. 2000;19(2):455–63.
17. Shi L, Lin L. The trim-and-fill method for publication bias: practical guidelines and recommendations based on a large database of meta-analyses. Medicine. 2019;98(23):e15987–e15987.
18. Ahaneku H, Myers HF, Williams JK. Depression among black bisexual men with early and later life adversities. Cultur Divers Ethnic Minor Psychol. 2014;20(1):128–37.
19. Ahaneku H, et al. Depression and HIV risk among men who have sex with men in Tanzania. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2016;28:140–7.
20. Alvy LM, et al. Depression is associated with sexual risk among men who have sex with men, but is mediated by cognitive escape and self-efficacy. AIDS Behav. 2011;15(6):1171–9.
21. An X, et al. The prevalence of Depression associated with the infection status and sexual behaviors among men who have sex with men in Shenzhen, China: a cross-sectional study. Int J Environ Res Public Health. 2020;17(1):127.
22. Armstrong R, Siembewe A, Zulu JM. Mental health, coping and resilience among young men who have sex with men in Zambia. Culture Health Sexuality. 2020;23:1626.
23. Brown MJ, Serovich JM, Kimberly JA. Perceived intentional transmission of HIV infection, sustained viral suppression and psychosocial outcomes among men who have sex with men living with HIV: a cross-sectional assessment. Sexually Transmitted Infections. 2018;94(7):483–6.
24. Bruce D, et al. Modeling minority stress effects on homelessness and health disparities among young men who have sex with men. J Urban Health. 2014;91(3):568–80.
28. Chakrapani V, et al. Syndemics of depression, alcohol use, and victimisation, and their association with HIV-related sexual risk among men who have sex with men and transgender women in India. Glob Public Health. 2017;12(2):250–65.

29. Chandler CJ, et al. Examining the Impact of a psychosocial syndemic on past six-month HIV screening behavior of black men who have sex with men in the United States: results from the POWER study. AIDS Behav. 2020;24(2):428–36.

30. Chen YH, Raymond HF. Associations between depressive syndromes and HIV risk behaviors among San Francisco men who have sex with men. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2017;29(12):1538–42.

31. Cherenack EM, et al. Avoidant coping mediates the relationship between self-efficacy for HIV disclosure and depression symptoms among men who have sex with men newly diagnosed with HIV. AIDS Behav. 2018;22(10):3130–40.

32. Clark K, et al. Stigma, displacement stressors and psychiatric morbidity among displaced Syrian men who have sex with men (MSM) and transgender women: a cross-sectional study in Lebanon. BMJ Open. 2021;11:e046969.

33. Deuba K, et al. Psychosocial health problems associated with increased HIV risk behavior among men who have sex with men in Nepal: a cross-sectional survey. PLoS ONE. 2013;8(3):e58095.

34. Du M, et al. Depression and social support mediate the effect of HIV/self-stigma on condom use intentions among Chinese HIV-infected men who have sex with men. AIDS Care. 2018;30(9):1197–206.

35. Dyer TP, et al. Differences in substance use, psychosocial characteristics and HIV-related sexual risk behavior between Black men who have sex with men only (BMSMO) and black men who have sex with men and women (BMSMW) in six US cities. J Urban Health. 2019;96(6):1181–93.

36. Fendrich M, et al. Depression, substance use and HIV risk in a probability sample of men who have sex with men. Addict Behav. 2013;38(3):1715–8.

37. Ferro EG, et al. Alcohol use disorders negatively influence antiretroviral medication adherence among men who have sex with men in Peru. AIDS Care. 2015;27(1):93–104.

38. Feuillet P, et al. Prevalence of and factors associated with depression among people living with HIV in France. HIV Med. 2017;18(6):383–94.

39. Ha HX, et al. Determinants of homosexuality-related stigma among men who have sex with men in Hanoi Vietnam. Int J Sexual Health. 2014;26(3):200–16.

40. Holloway IW, et al. Network support, technology use, Depression, and HIV risk behaviors among San Francisco men who have sex with men. AIDS Care. 2018;30(10):1246–51.

41. Holloway IW, et al. Psychological distress, health protection, and behavioural outcomes associated with anxiety and Depression among HIV-positive men who have sex with men in the United Kingdom and Ireland. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2018;30(9):1173–9.

42. Hu Y, et al. Comparison of Depression and anxiety between HIV-negative men and MSM and women who have sex with men only (MSMO): a cross-sectional study in Western China. BMJ Open. 2019;9(9):e023498.

43. Hylton E, et al. Sexual identity, stigma, and depression: the role of the “Anti-gay Propaganda Law” in mental health among men who have sex with men in Moscow Russia. J Urban Health. 2017;94(3):319–29.

44. Kipke MD, et al. The health and health behaviors of young men who have sex with men. J Adolesc Health. 2007;40(4):342–50.

45. Klein H. Depression and HIV risk among men who have sex with other men (MSM) and who use the internet to find partners for unprotected sex. J Gay Lesbian Ment Health. 2014;18(2):164–89.

46. Kunzweiler CP, et al. Depressive symptoms, alcohol and drug use, and physical and sexual abuse among men who have sex with men in Kisumu, Kenya: the Anza Mapema Study. AIDS Behav. 2018;22(2):1517–29.

47. Levine EC, et al. Child sexual abuse and adult mental health, sexual risk behaviors, and drinking patterns among Latino men who have sex with men. J Child Sex Abus. 2018;27(3):237–53.

48. Li J, et al. Prevalence and associated factors of depressive and anxiety symptoms among HIV-infected men who have sex with men in China. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2016;28(4):465–70.

49. Li R, et al. Psychosocial syndemic associated with increased suicidial ideation among men who have sex with men in Shanghai China. Health Psychol. 2016;35(2):148–56.

50. Liu Y, et al. Association of recent gay-related stressful events with depressive symptoms in Chinese men who have sex with men. BMC Psychiatry. 2018; https://doi.org/10.1186/s12888-018-1787-7.

51. Maraghi-Bass AC, et al. Exploring individual-level barriers to HIV medication adherence among men who have sex with men in the HIV Prevention Trials Network (HPTN 065) study. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2020. https://doi.org/10.1080/09540121.2020.1828799.

52. Mayer KH, et al. Differing identities but comparably high HIV and bacterial sexually transmitted disease burdens among married and unmarried men who have sex with men in Mumbai India. Sex Transm Dis. 2015;42(11):629–33.

53. Mayer KH, et al. Concomitant socioeconomic, behavioral, and biological factors associated with the disproportionate HIV infection burden among Black men who have sex with men in 6 US cities. PLoS ONE. 2014;9(1):e87298.

54. Mgopa LR, et al. Violence and Depression among men who have sex with men in Tanzania. BMC Psychiatry. 2017;17(1):296.

55. Mills TC, et al. Distress and depression in men who have sex with men: the urban men’s health study. Am J Psychiatry. 2004;161(2):278–85.

56. Mittz AR, et al. Clinically significant depressive symptoms and sexual behaviour among men who have sex with men. BJPsych Open. 2017;3(3):127–37.

57. Mimiaga MJ, et al. Psychosocial risk factors for HIV sexual risk among Indian men who have sex with men. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2013;25(9):1109–13.

58. Mo PK, Lau JT, Wu X. Relationship between illness representations and mental health among HIV-positive men who have sex with men. AIDS Care. 2018;30(10):1246–51.

59. Mu H, et al. Prevalence and risk factors for lifetime suicide ideation, plan and attempt in Chinese men who have sex with men. BMC Psychiatry. 2016. https://doi.org/10.1186/s12888-016-0830-9.

60. Murphy PJ, et al. HIV-related stigma and optimism as predictors of anxiety and Depression among HIV-positive men who have sex with men in the United Kingdom and Ireland. AIDS Care - Psychological and Socio-Medical Aspects of AIDS/HIV. 2018;30(9):1173–9.

61. O’Cleirigh C, et al. Functional impairment and health care utilization among HIV-infected men who have sex with men: the relationship with Depression and post-traumatic stress. J Behav Med. 2009;32(5):466–77.

62. Pan X, et al. Sexual risk behaviour, sexual victimisation, substance use and other factors related to Depression in men who have sex with men in Wenzhou China: a cross-sectional study. BMJ Open. 2018. https://doi.org/10.1136/bmjopen-2016-013512.

63. Parker RD, et al. Outcomes associated with anxiety and Depression among men who have sex with men in Estonia. J Affect Disord. 2015;183:205–9.

64. Peng L, et al. The mediating role of self-stigma and self-efficacy between intimate partner violence (IPV) victimization and Depression among men who have sex with men in China. BMC Public Health. 2020. https://doi.org/10.1186/s12889-019-8125-y.

65. Prabhu S, et al. Psychosocial barriers to viral suppression in a community-based sample of human immunodeficiency virus-infected men who have sex with men and people who inject drugs in India. Clin Infect Dis. 2020;70(2):304–13.

66. Reisner SL, et al. Clinically significant depressive symptoms as a risk factor for HIV infection among black MSM in Massachusetts. AIDS Behav. 2009;13(4):798–810.

67. Rüütel K, Valk A, Lõhmus L. Suicidality and associated factors among men who have sex with men in Estonia. J Homosex. 2017;64(6):770–85.

68. Sivasubramanian M, et al. Suicidality, clinical Depression, and anxiety disorders are highly prevalent in men who have sex with men in Mumbai, India: findings from a community-recruited sample. Psychol Health Med. 2011;16(4):450–62.

69. Su X, et al. Depression, loneliness, and sexual risk-taking among HIV-Negative/Unknown men who have sex with men in China. Arch Sex Behav. 2018;47(7):1959–68.
70. Tao J, et al. Impact of depression and anxiety on initiation of antiretrovi-
tal therapy among men who have sex with men with newly diagnosed
HIV infections in China. AIDS Patient Care STDs. 2017;31(2):96–104.
71. Tomori C, et al. Is there synergy in syndemics? Psychosocial conditions
and sexual risk among men who have sex with men in India. Soc Sci
Med. 2018;206:110–6.
72. Wagner GL, et al. Major depression among young men who have
sex with men in Beirut, and its association with structural and sexual
minority-related stressors, and social support. Sex Res Social Policy.
2019;16(4):513–20.
73. Wang Y, et al. Association between a syndemic of psychosocial prob-
lems and unprotected anal intercourse among men who have sex with men
in Shanghai China. BMC Infect Dis. 2017. https://doi.org/10.1186/s12879-
016-2132-8.
74. Wei D, et al. Effects of emotion regulation and perpetrator-victim roles
in intimate partner violence on mental health problems among men
who have sex with men in China. Epidemiol Psychiatric Sci. 2020.
https://doi.org/10.1017/S2045796020000712.
75. Wendi D, et al. Depressive symptoms and substance use as mediators
of stigma affecting men who have sex with men in Lebanon: a structural
modeling approach. Ann Epidemiol. 2016;26(8):551–6.
76. White JJ, et al. Individual and social network factors associated with
high self-efficacy of communicating about men’s health issues
with peers among black MSM in an urban setting. J Urban Health.
2020;97(3):668–77.
77. Wilkerson JM, et al. Substance use, mental health, HIV testing, and
sexual risk behavior among men who have sex with men in the state
of Maharashtra India. AIDS Educ Prev. 2018;30(2):96–107.
78. Williams JK, et al. Relation of childhood sexual abuse, intimate
partner violence, and Depression to risk factors for HIV among black
men who have sex with men in 6 US cities. Am J Public Health.
2015;105(12):2473–81.
79. Wim VB, Christiana N, Marie L. Syndemic and other risk factors for
unprotected anal intercourse among an online sample of belgian HIV
negative men who have sex with men. AIDS Behav. 2014;18(1):50–8.
80. Wu Y, et al. Prevalence of suicidal ideation and associated fac-
tors among HIV-positive MSM in Anhui, China. Int J STD AIDS.
2015;26(7):496–503.
81. Yan H, et al. Association between perceived HIV stigma, social support,
resilience, self-esteem, and depressive symptoms among HIV-positive
men who have sex with men (MSM) in Nanjing, China. AIDS Care - Psy-
chological and Socio-Medical Aspects of AIDS/HIV. 2019;31(9):1069–76.
82. Yan H, et al. Social support and depressive symptoms among "money"
boys and general men who have sex with men in Shanghai. China
Sexual Health. 2014;11(3):285–7.
83. Yang C, et al. Informal social support and Depression among African
American men who have sex with men. J Community Psychol.
2013;41(4):435–45.
84. Yu L, et al. Association of recent gay-related stressful events and emo-
tional distress with suicidal behaviors over 12 months in Chinese men
who have sex with men. Asia Pac Psychiatry. 2018. https://doi.org/10.
1111/appy.12286.
85. Zeng X, et al. Prevalence and associated risk characteristics of HIV
infection based on anal sexual role among men who have sex with
men: a multi-city cross-sectional study in Western China. Int J Infect Dis.
2016;49:111–8.
86. Zep R, et al. Syndemic conditions and medication adherence in older
men living with HIV who have sex with men. AIDS Care - Psychological
and Socio-Medical Aspects of AIDS/HIV. 2020;32:1610–6.
87. Zhang S, et al. The Association between involuntary subordination and
common mental disorders among men who have sex with men (MSM)
in Shanghai. China BMC Psychiatry. 2019. https://doi.org/10.1186/s12888-
019-2329-7.
88. Zhao Y, et al. A structural equation model of factors associated with HIV
risk behaviors and mental health among men who have sex with men
in Malawi. BMC Infect Dis. 2020;20(1):391.
89. Zhu Y, et al. The relation between mental health, homosexual stigma,
childhood abuse, community engagement, and unprotected anal
intercourse among MSM in China. Sci Rep. 2018;8(1):1–7.
90. Mohamad Fisal ZA, et al. Biopsychosocial approach to understanding
determinants of Depression among men who have sex with men living
with HIV: a systematic review. PLoS ONE. 2022;17(3):e0264636.
91. Javanbakht M, et al. Interruptions in mental health care, cannabis use,
depression, and anxiety during the COVID-19 pandemic: findings from
a cohort of HIV-positive and HIV-negative MSM in Los Angeles Califor-
nia. J Urban Health. 2022. https://doi.org/10.1007/s11524-022-00607-9.
92. Lim GY, et al. Prevalence of depression in the community from 30
countries between 1994 and 2014. Sci Rep. 2018;8(1):2861–2861.
93. Daly M, Suitin AR, Robinson E. Depression reported by US adults in
2017–2018 and March and April 2020. J Affect Disord. 2021;278:131–5.
94. de Arias J, et al. Prevalence and age patterns of Depression in the
United Kingdom. A population-based study. J Affective Disorders.
2021;279:164–72.
95. Organization, WH, Depression and other common mental disorders:
global health estimates. 2017, World Health Organization.
96. Hong Y, et al. Depressive symptoms and condom use with clients
among female sex workers in China. Sexual health. 2007;4(2):90–104.
97. Rael C, Davis A. Depression and key associated factors in female sex
workers and women living with HIV/AIDS in the Dominican Republic.
Int J STD AIDS. 2016;28:433.
98. Albert PR Why is Depression more prevalent in women? J Psychiatry
Neuroscience. JPN. 2015;40(4):219–21.
99. Latkin CA, et al. Social network factors as correlates and predictors of
high depressive symptoms among black men who have sex with men
in HPTN 061. AIDS Behav. 2017;21(4):1163–70.
100. Shao B, et al. The relationship of social support, mental health, and
health-related quality of life in human immunodeficiency virus-positive
men who have sex with men: from the analysis of canonical correla-
tion and structural equation model: a cross-sectional study. Medicine.
2018;97(30):e11652.
101. Ulanja MB, et al. The relationship between Depression and sexual
health service utilization among men who have sex with men (MSM) in
Côte d'Ivoire, West Africa. BMC Int Health Hum Rights. 2019;19(1):11–11.
102. Wang N, et al. Association between stigma towards HIV and MSM and
intimate partner violence among newly HIV-diagnosed Chinese men
who have sex with men. BMC Public Health. 2020;20(1):1–8.
103. Garcia R, Ramos D. P4. 012 the impact of stigma and discrimination
in MSM HIV-Positive. Sexually Transmitted Infections. 2013;89(Suppl
1):A292.
104. Xiao L, et al. The prevalence of Depression in men who have sex with
men (MSM) living with HIV: a meta-analysis of comparative and epide-
miological studies. Gen Hosp Psychiatry. 2020;66:112–9.
105. Gómez F, Barrientos J, Cárdenas M. Relation between HIV status, risky
sexual behavior, and mental health in an MSM sample from three
Chilean cities. J Sexual Medicine. 2017;41:e4.
106. Yang X, et al. Intersectional stigma and psychosocial well-being among
MSM living with HIV in Guangxi. China AIDS care. 2020;32(sup2):5–13.
107. Kramer EJ, et al. Cultural factors influencing the mental health of Asian
Americans. Western J Med. 2002;176(4):227–31.

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