

Title: Oral health self-care behaviours in serious mental illness: A systematic review and meta-analysis.

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Abstract (240 words)

Aim To understand the relationship between serious mental illness and oral health self-care behaviours using meta-analytic methods and a narrative synthesis of available literature.

Method The review followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines [PROSPERO reference: CRD42020176779]. Search terms pertaining to serious mental illness and oral health were entered into EMBASE, PsycINFO, Medline and CINAHL. Eligible studies included a sample of people with a serious mental illness and a quantitative measure of an oral health self-care behaviour (e.g. dental visits, toothbrushing). The Effective Public Health Practice Project tool was utilised to appraise the quality of the literature. Studies in the meta-analysis contained a non-clinical or general population comparator sample.

Results People with a serious mental illness were significantly less likely to visit the dentist (OR 0.46, 95% CI 0.32-0.65, $p > 0.001$) or brush their teeth (OR 0.19, 95% CI 0.08-0.42, $p < 0.001$) when compared to non-clinical comparator samples. Few studies explored other oral health self-care behaviours (e.g. flossing, mouth-washing etc.), but uptake was generally low in people with a serious mental illness. The study quality of included studies was variable.

Conclusions The research showed a reduced uptake of oral health self-care behaviours in people with a serious mental illness. Sub-optimal oral health can negatively impact on physical, social and psychological functioning. Further research is needed to understand the reasons for low rates of oral health self-care behaviours in this population.

3-5 key words: Oral health, psychotic disorders, bipolar disorders, dental care.

Summations

- People with a serious mental illness were less likely to visit the dentist.
- They were also less likely to brush their teeth.
- There was limited evidence around the use of dental floss and mouthwash

Limitations

- The quality of the available literature was variable.
- Few studies explored the use of dental floss and mouth wash.
- Research typically did not distinguish between routine and emergency dental visits.

Introduction

There is evidence that people with a serious mental illness (SMI; i.e. psychosis, bipolar disorder) experience worse oral health outcomes than the general population. ¹ For example, past research has indicated that people with SMI are 2.8 to 3.4 times as likely to be edentulous (complete loss of all teeth) and have significantly higher rates of decayed, missing or filled teeth (DMFT) or surfaces (DMFS) in comparison to the general population. ²⁻⁴ Suboptimal oral health can have a detrimental impact on physical and psychological functioning. ⁵ The oral cavity plays a crucial role in the overall well-being of a person and damage thereof can cause considerable suffering by affecting basic and essential functions like eating and speaking. ⁶ Severe caries (tooth decay) leads to pain, discomfort, disfigurement, acute and chronic infections, and eating and sleeping disruption as well as a higher risk of hospitalisation, high treatment costs and lost workdays. ⁷ Research suggests that there is a link between poor oral health and chronic disease, such as diabetes and cardiovascular diseases. ^{8,9} The ability to smile can also be affected ⁵, which can impact on self-esteem ¹⁰ and the ability to socialise with others. ⁶

The reasons for poor oral health outcomes in people with SMI are likely complex and may include higher rates of drug misuse, ¹¹ smoking, ¹² and medication side effects (e.g. xerostomia). ¹³ Poor oral health in this population may also be due to reduced levels of oral health self-care behaviours (e.g. dental care, toothbrushing). Some, but not all, studies have suggested that people with a SMI are less likely to attend routine dental visits and, when they do, are more likely to have teeth extracted rather than filled ²⁻⁴. This could explain the high rate of edentulous in this population. An increased focus on preventative practices has improved oral health outcomes in the general population. ¹⁴ Further research is needed to understand levels of oral health behaviours in people with SMI, which could inform future presentation and intervention strategies, leading to better outcomes. It may help to understand oral health inequalities in people with SMI.

Aims of the study

The aim of this review was to better understand utilisation of oral health self-care behaviours in people with SMI. It used meta-analytic methods to synthesise the size and consistency of differences in oral health self-care behaviours between people with a SMI and non-clinical comparator samples. It also aimed to narratively review studies without a non-clinical comparator sample to better summarise the existing literature.

Material and methods

This review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-analyses standards with a protocol published on PROSPERO [CRD42020176779].

Eligibility criteria

The inclusion criteria were: i) a case-control, cohort, cross-sectional, longitudinal and epidemiological design study; ii) publication in an English language peer reviewed academic journal; and iii) a quantitative measure of an oral health self-care behaviour. We defined oral health self-care behaviours as actions that individuals take to improve or preserve good oral health.¹⁴ This included owning a toothbrush, dental care attendance, and frequency of tooth-brushing.

Studies were required to include a sample of at least 75% of people diagnosed with a SMI in accordance with the Diagnostic and Statistical Manual (DSM-III or later) or International Classification of Disease (ICD-9 or ICD-10) criteria. SMI is a contentious, but widely used term often including a range of diagnoses such as personality disorders, major depression disorder and dementia.^{2,3} However, for the purpose of this review SMI has been defined as the collective term for people with a diagnosis of a psychotic or a bipolar spectrum disorder to maintain consistency with the UK-based National Institute for Health and Care Excellence (NICE) guidance and the majority of past literature¹⁵ Specific diagnostic criteria included schizophrenia, schizophreniform, schizoaffective disorder, delusional disorder, bipolar I and bipolar II. Participants who met the operational criteria for an early intervention service for first episode psychosis were included to allow for diagnostic uncertainty in younger age groups. For the purpose of the meta-analysis, eligible studies were required to include valid comparator group (e.g. general population sample, non-clinical comparator).

Screening Procedure

Systematic searches were conducted in Medline, EMBASE, PsycINFO and CINAHL to identify peer-reviewed articles published between January 1980 and April 2020. Search terms were entered in blocks relating to serious mental illness (severe mental or serious mental or chronic mental or schizo* or psychoti* or psychos* or hallucinat* or paranoi* or bipolar or mania or manic) and oral health (oral health or oral hygiene or tooth* or teeth* or dent*). The

search terms were developed based on the authors' clinical experience and relevant past reviews.^{2-4, 16} In cases where papers were unavailable or the data was insufficient to confirm eligibility or generate an effect size, information was requested from the primary or corresponding author. The first author (ET) screened the reference lists of eligible articles, citing articles, and relevant reviews.^{2-4, 16} Ten percent (805 studies) of titles and abstracts were double rated by another author (TV), with high levels of agreement ($k= 0.84$). At least two of the authors screened each of the full articles to confirm eligibility with discrepancy resolved through consensus.

Data extraction

Relevant study information (e.g. study design, sample size, type of sample) was extracted by the first author (ET). For the meta-analysis, outcome data was independently extracted by two authors (ET and JPC) to calculate an effect size ($ICC = 0.95, p>0.001$). If multiple time points were presented (e.g. dental visit within one year and dental visit within two years), the lower timescale analysis was selected to ensure consistency. When possible, we extracted analyses that controlled for covariates (e.g. adjusted odds ratios).

Quality assessment

An adapted version of the Effective Public Health Practice Project (EPHPP) tool¹⁷ was used to evaluate the overall quality of the included articles due to its suitability for assessing public health focused quantitative studies. The EPHPP has demonstrated good construct and content validity and interrater reliability.¹⁸ Consistent with previous review papers,^{19 20} the tool was adapted to account for the observational design of eligible studies. Domains that were not considered relevant (design; blinding; intervention integrity; withdrawals and drop-outs) to the included studies were omitted. The design domain pertained to randomisation procedures for intervention evaluations and was therefore not relevant to the reviewed literature and excluded.

The adapted version of the EPHPP consisted of four domains: selection bias, confounders, data collection methods and analyses. Each domain was rated as strong, moderate or weak and from this, a global rating was derived based on ratings in each domain. In the original EPHPP, analyses ratings were not used to calculate the global rating. However, consistent with previous adaptations²¹ a decision was made to include analyses scores in the overall global rating as appropriateness of analysis was deemed to be integral to the quality of the study. Articles were

rated by two authors (ET and TV; 79% agreement) and, in cases of discrepancy, consensus was reached with input from a third author.

Statistical analysis

Meta-analysis

We used Comprehensive Meta-Analysis (CMA, v3) ²² to generate effect sizes and conduct analysis for all outcomes with $K > 3$. Study effect sizes were transformed into odds ratios and a random effects model was utilised as statistical heterogeneity was expected across studies. ²³ Heterogeneity was explored through use of the Q-test and I^2 statistic and a sensitivity analysis was conducted to assess whether any individual study had great influence over the overall effect size.

Narrative synthesis

In order to appraise the wider literature in this area, all studies without a comparator group were narratively synthesised using the Synthesis Without Meta-Analysis (SWiM) ²⁴ guidelines. Outcomes were grouped according to oral health self-care behaviours and the corresponding literature was tabulated using the population, intervention, comparator and study type (PICOS) framework to summarise the literature and explore clinical heterogeneity. A weighted average was calculated for key outcomes, using all available data, even those without a clinical comparator.

Results

The PRISMA flowchart (Figure 1.) displays the screening process. Thirty-three studies ²⁵⁻⁵⁷ were eligible for inclusion. The total sample comprised of 446,932 people with a SMI and 6,284,176 controls. Further information was provided by seven authors ^{26, 29, 35, 38, 44, 48, 57} to either confirm eligibility or produce an effect size. Table 1 displays the descriptive information on the included studies.

Quality appraisal

Findings from the quality assessment are summarised in Table 2. Six studies obtained strong scores, seven moderate and 20 weak. Limitations of the methodology predominantly related to data collection as outcome measures used were typically not validated and the reliability of the measures was poor. Studies tended to have a broader focus than oral health self-care

behaviours. Therefore, the analysis in this area tended to be basic (e.g. percentages) and did not account for confounders, leading to higher rates of weak ratings.

Dental service use

Twenty-three studies reported data on dental visiting behaviour. These studies were of mixed quality. However, more than half of the studies entered into the meta-analysis were of strong quality. Studies were conducted in Europe (52%, K=12), North America (26%, K=6), Asia (13%, K=13), South America (4%, K=1) and Australasia (5%, K=1). Sixteen studies focused on people with a psychotic disorder, one on bipolar disorder and six on mixed SMI samples. A weighted average of data from eight^{28, 33, 40, 41, 43, 45, 52, 57} cross-sectional and case control studies indicated that 34% of participants with SMI had visited the dentist in the previous year. One epidemiological study⁴⁷ indicated that 43% of participants had visited the dentist within one year.

Two studies had higher rates of dental attendance compared to the rest of the literature, potentially explained by their samples of people with early psychosis²⁵ (80% within 2 years) and bipolar disorder²⁹ (85% within 2 years). Data was split into diagnostic groups (psychotic disorders and bipolar disorder) in one study³⁷, which looked at dental attendance across a five-year period. Although levels of attendance were high across both groups, they were greater in bipolar disorder (79% in comparison to 68%). One small-scale cross-sectional study⁵⁷ explored the impact of a partnership between mental health and dental services and found that 90% of individuals with a SMI had attended the dentist within one year. Baseline data was not provided to explore the difference between outcomes before and after the integration of services.

Dental Service Use Meta-Analysis

Nine studies^{29, 30, 33, 36, 41, 43, 47, 52, 55} of mostly strong quality explored dental service usage in comparison to a non-clinical comparator and were analysed using random effects meta-analysis (Figure 2). One study²⁵ was omitted from this analysis as the measure of dental service use was not consistent across the case sample and non-clinical comparator. The analysis (Figure 2) showed an overall OR of 0.46 (95% CI 0.32-.065, $p > 0.001$), indicating that individuals with a SMI were significantly less likely to access dental services in comparison to non-clinical controls. Separate analyses were conducted to explore differences between case-control and epidemiological studies. Although, statistically there was no significant difference in the strength of effect sizes between the two types of study ($Q(1) = 0.70$ $p = 0.400$), the five case-

control studies (OR 0.32, 95% CI 0.08-1.29, $p=0.109$) indicated no significant difference in dental service usage between SMI in comparison to non-clinical controls, whereas the four epidemiological studies (OR 0.60, 95% CI 0.38-0.96, $p=.003$) did show a significant difference between these populations.

The Q-test and I^2 statistic were used to explore statistical heterogeneity. Results indicated high levels of statistical heterogeneity across studies ($Q(8)=2097.61, p<.001, I^2=99.62$), suggesting that the strength of the relationship between SMI and dental service use was highly variable across studies. A sensitivity analysis, which removed each study in turn to explore the impact on the overall effect size, the results indicated that one study⁴³ exerted some influence over the overall effect size (OR 0.65, 95% CI 0.46-0.93, $p=.019$).

[Figure 2 goes around here]

Oral hygiene

Toothbrushing Frequency

Twenty-one studies provided data on toothbrushing frequency. An even proportion of studies were conducted in Europe and Asia (43%, $K=9$) and the remaining studies were conducted in North America (9%, $K=2$) and Australasia (4%, $K=1$). Fifteen studies were conducted in people with a psychotic disorder only (75%, $K=15$), whereas six (25%, $K=6$) studies were conducted in mixed SMI samples. A weighted average of 10 studies^{25, 26, 39, 40, 43, 51-54, 56} indicated that only 39% of people with a SMI brushed their teeth twice a day.

The results and measures used to assess toothbrushing frequency were greatly variable. Results indicated that toothbrushing habits were often reduced in inpatient samples of people diagnosed with schizophrenia. Two studies^{38, 56} found that the uptake of toothbrushing behaviours was low in 50% of participants. Similarly, in one study, “habitual brushing” (undefined) was recorded in only 22% of participants.²⁷ In mixed SMI inpatient samples^{43, 46, 54} participants were more likely to clean their teeth. Studies of better quality^{38, 56} were more likely to report reduced toothbrushing behaviours.

Toothbrushing Frequency Meta-Analysis

Five case-control studies ^{25, 39, 43, 52, 56} of predominantly weak quality included a non-clinical comparator group and were entered into a random effects meta-analysis (Figure 3) to produce an overall effect size. Outcomes for two studies were dichotomised to generate an effect size. ^{43, 56} The overall effect size (OR 0.19, 95% CI 0.08-0.42, $p < 0.001$) suggested that people with a SMI were significantly less likely to brush their teeth than controls.

The Q-test and I^2 statistic ($Q(4) = 23.13$, $p < .001$) indicated high levels of heterogeneity. 82% of the variance was due to statistical heterogeneity. A sensitivity analyses was conducted to identify outliers. The results indicated that two studies ^{25, 39} exerted some influence over the overall effect size. When one study ²⁵ was removed the effect size reduced to OR 0.07, CI 0.01-0.55, $p = 0.012$. Similar effects were observed when the other study ³⁹ was removed (OR 0.06 CI 0.01-0.44, $p = 0.005$). However, the effects of neither study were great enough to impact overall statistical significance.

[Figure 3 goes around here]

Toothbrush ownership and maintenance

Two studies of weak quality reported on toothbrush ownership ^{25, 44} and found similar levels in people with a SMI (70% and 66%). Results from three studies ^{26, 27, 43} of weak to moderate quality indicated variable levels of toothbrush maintenance in people with a SMI. One study ⁴³ suggested that only 1.8% of people with SMI changed their toothbrush every three months, but this was higher at 33% in a second study. ²⁶ A key difference between these two studies was that one study ⁴³ included an inpatient sample and the other ²⁶ (which indicated a much higher rate of upkeep) included an outpatient sample. A third study of weak quality ²⁷ found that 25% of subjects “maintained their hygiene tools” over an unspecified timescale.

Toothbrush technique

Three studies of moderate to weak quality investigated toothbrushing technique ^{26, 43, 56} and found between 72.6% and 98.2% of people with a SMI used the incorrect brushing technique. Agarwal and colleagues ²⁶ defined the correct technique as sulcular (also known as bass), which has been found to be more effective. ⁵⁸ The other studies did not define the correct tooth brushing technique and are therefore difficult to interpret.

Materials used for oral health self-care behaviours

Two studies ^{26, 50} of weak and moderate quality explored the uptake of oral hygiene tools in people with a SMI. Both were conducted in India with participants diagnosed with schizophrenia. Results indicated that 21.6% of participants used a tongue cleaning aid. ²⁶ One study ⁵⁰ highlighted that 34% of the sample used their finger to clean their teeth.

Flossing frequency

In three studies ^{45, 52, 57} of weak quality, uptake of flossing behaviour ranged from 11%-20%. One study ⁵² found that flossing behaviour was 50% lower in an sample with SMI compared to non-clinical controls. No studies investigated flossing technique.

Mouthwash

Three studies ^{40, 45, 57} of weak quality explored the uptake of mouthwash in people with a SMI. In one study ⁴⁰ 4.7% of participants reported that their oral care routine solely consisted of using mouthwash. One study ⁴⁵ found that 23% of individuals with SMI used mouthwash as part of their oral care routine, which was similar to a non-clinical comparator group. A further study ⁵⁷ found that 35% of people with a SMI used mouthwash, but there was no non-clinical comparator group.

Discussion

This is the first meta-analysis to comprehensively explore the uptake of oral health behaviours in people with SMI. We systematically reviewed 33 studies comprised of 446,932 people with a SMI and 6,284,176 controls. Findings indicated that people with SMI are significantly less likely to access dental services and frequently brush their teeth than the general population. There is also some tentative evidence to suggest that other behaviours such as flossing, mouth washing and ownership and maintenance of materials for oral health self-care behaviours are low in individuals with a SMI.

Recent research has suggested that people with a SMI are more likely to experience sub-optimal oral health in comparison to the general population.²⁻⁴ This review builds on existing literature by finding that oral health self-care behaviours are significantly reduced in people with a SMI. Results indicate that between 34-43% of people with a SMI visit the dentist at least annually. This is stark contrast to past research indicating that approximately 61% of the general population visit the dentist at least once per year.⁵⁹ Similarly, the finding that 39% of individuals with a SMI clean their teeth twice a day is much lower than what is typically recorded for the general population.⁶⁰ More research is needed to ascertain the difference between SMI and the general population when key confounders (e.g. socio-economic status, access to dental care) are considered. Two of the included studies^{36, 55} controlled for income and access to dental care and found similarly low rates of dental service utilisation in SMI. Research in non-clinical samples has indicated an association between dental behaviours and outcomes.⁶¹ However, further research is required to establish whether the uptake of oral health self-care behaviours mediates the relationship between SMI and oral health outcomes.

Overall, the quality of the literature was variable with a high number of studies receiving a weak rating on the EPHPP tool. Outcomes of interest were seldom the focal point of included studies. Therefore, outcome measures were often unvalidated and analyses typically neglected to include key confounders (e.g. severity of illness, socio-economic status, access to dental care). It is also noteworthy that some studies used survey data as the comparator group and did not employ matching criteria. Although the quality of the available literature was variable, we were able to extract descriptive data from the majority of identified studies.

In the available literature, mental health diagnoses were often retrieved from the medical notes and in some cases the method of confirming diagnoses was unstated. Further information was required from some authors to ascertain the diagnostic system used. Future studies should

address this issue by ensuring that diagnoses are determined through more rigorous processes. Maintenance behaviours and dental attendance were poorly defined in the majority of studies. Most failed to distinguish between routine and emergency care. This is important given that people with a SMI may be more likely to utilise emergency care in crisis and less likely to attend routine dental visits.³⁰ Future research should carefully define dental visiting to provide a better understanding of pathways to care.

The literature predominantly focused on individuals with a psychotic disorder. However, one study²⁹ explored dental visiting behaviours in people with a diagnosis of bipolar disorder only, where there were high rates of dental attendance similar to the control group. High rates of dental attendance were also found across a longer time period in a study that separately assessed dental attendance in bipolar disorder and psychotic disorders.³⁷ It is possible therefore that dental visiting behaviours may not be as disrupted in people with bipolar disorder. No studies looked at toothbrushing in bipolar disorder, which poses as an important area for future research.

Only a limited number of studies could be statistically analysed using meta-analytic methods as the majority did not include a non-clinical comparator. Consequently, post-hoc analyses were not conducted to assess selection and publication bias.^{62, 63} Substantial levels of heterogeneity reduce confidence in the size of the effect produced. The observed heterogeneity may have been due to differences in methods and quality across the included studies. Study design had an impact on the dental visiting results. Statistically, there was no difference between case-control and epidemiological findings. However, when analysed separately, epidemiological studies indicated a significant difference between dental visiting in people with a SMI compared to controls, whereas case-control studies did not.

We restricted our inclusion criteria to peer-reviewed papers published in the English language which may have introduced bias. Studies with significant findings may be more likely to be published, which could skew the results to significant findings.⁶⁴ Accessing English language publications may also reduce diversity across study samples. Requests for further information to confirm diagnoses or generate an effect size were sent to multiple authors and responses were only received by seven authors, which limited the ability to include some studies.

The disparity between the physical health of people with a SMI and the general population has been well documented.^{65, 66} Growing evidence suggests disparities exist in oral health.^{2-4, 67} The reasons for this are likely to be multifactorial and may include medication,^{68, 69} systemic

issues, ^{70, 71} and personal capability ⁷². Literature indicates that education alone does not improve oral health outcomes in this client group, despite guidance published by the British Society of Disability and Oral Health (BSDH). ⁷¹ One study ²⁵ adapted the checklist from BSDH guidelines and found no significant improvements between the intervention and control group. Similarly, a Cochrane review ¹⁰ did not provide evidence to suggest that education alone would improve outcomes in people with a SMI. National guidelines in the UK and Australia ^{73, 74} have indicated a need for increased oral health support for people with complex and early psychosis promoting assessment, monitoring and additional support to maintain oral health. This review indicates that such guidelines should be adopted more broadly to include all people who experience psychosis. However, further research is needed to better understand what factors impact on oral health self-care behaviours to ensure interventions and support is targeted accordingly.

Conclusion

In conclusion, findings from this review indicate that oral health self-care behaviours are reduced in people with an SMI. Further research is needed to explore which factors affect the uptake of behaviours and how mental health difficulties are a risk factor for poor oral health outcomes. The recent Lancet Commission ⁶⁵ called for better integration of mental and physical care. The results from this review indicate that this should also encompass dental care to meet the wide-ranging and complex needs of this client group to ensure effective early screening, monitoring and intervention in oral health.

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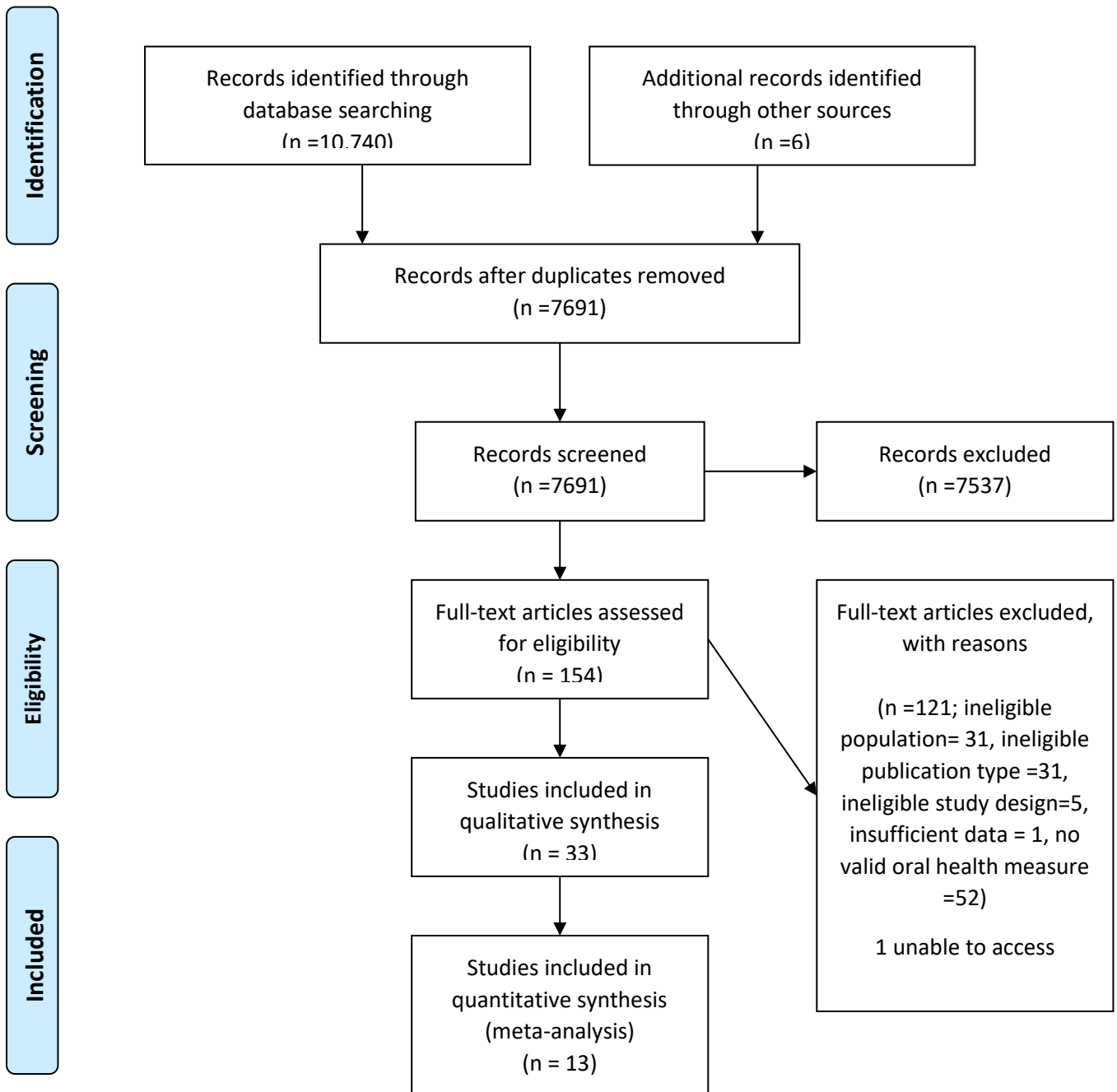


Figure 1. PRISMA Flow Diagram of article screening.

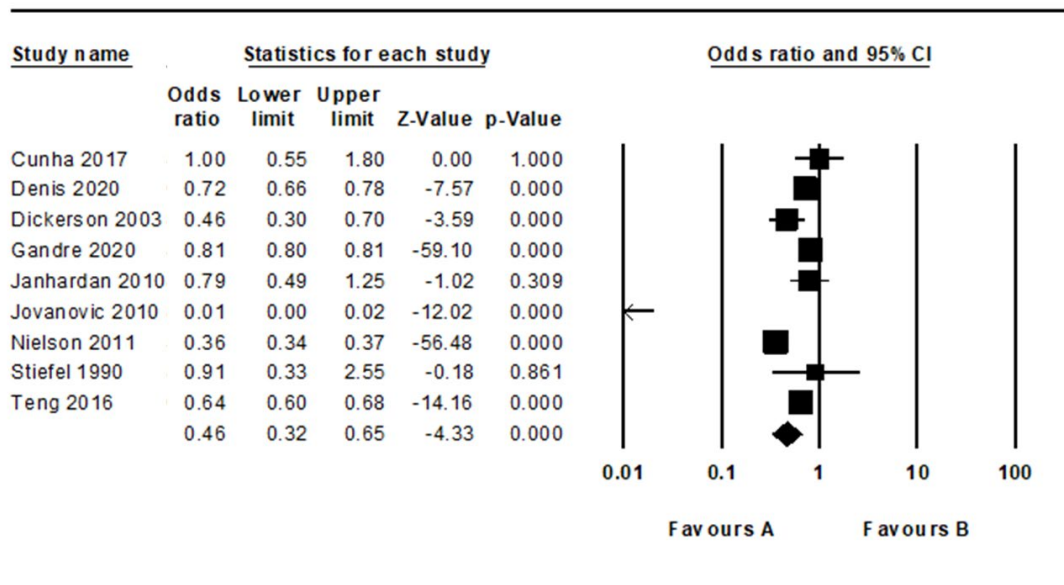


Figure 2. Forest plot with individual effect sizes for studies comparing access to dental services in people with severe mental illness to non-clinical comparator samples.

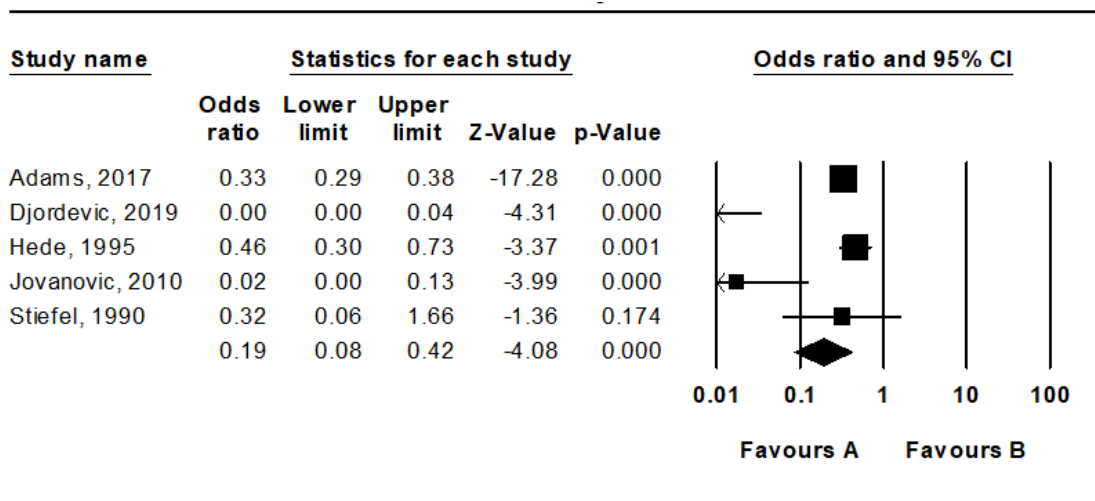


Figure 3. Forest plot with individual effect sizes for studies comparing rates of toothbrushing in people with severe mental illness to non-clinical comparator samples.

Table 1. Descriptive information on included studies.

| Study ID | Study design | Population-Diagnosis | Status | Country | Sample size | Comparator Type | Outcome |
|-----------------|------------------------------|---|--------------------------|---------|---------------------------------|--------------------------------------|--|
| Adams 2017 | Clustered RCT, baseline data | First episode psychosis | Outpatient | UK | Case: 1248 Control: 17849 | Adult Dental Health Survey (ADHS) | Dental service use, toothbrush frequency, technique and ownership |
| Agarwal, 2019 | RCT, Baseline data | Schizophrenia | Outpatient | India | 111 | N/A | Toothbrushing frequency, technique, maintenance of toothbrush, aid for cleaning tongue and mode for cleaning teeth |
| Corridore, 2017 | Cross-sectional | Schizophrenia, schizoaffective, borderline personality disorder | Therapeutic community | Italy | 67 | N/A | Dental service usage and toothbrushing frequency |
| Cunha 2017 | Case-control | Bipolar disorder | Outpatient | Brazil | Case: 176 Control: 176 | Existing study datasets | Dental service use |
| Denis, 2017 | Cross-sectional | Schizophrenia | Inpatient and outpatient | France | 90 | N/A | Dental service usage and toothbrushing frequency |
| Denis, 2019 | Cross-sectional | Schizophrenia | Inpatient and outpatient | France | 109 | N/A | Dental service usage and toothbrushing frequency |
| Denis 2020 | Epidemiological | Schizophrenia | Inpatient and outpatient | France | Case: 2,213 Control: 578,006 | General population database | Dental service usage (scaling) |
| Dickerson, 2003 | Case control | Schizophrenia, schizoaffective disorder | Outpatient | US | Case: 100 Control: 2705 | National health and nutrition survey | Dental service usage |

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|-------------------|--|---|--------------------------|------------------|-------------------------------------|--|---|
| Djordjevic, 2019 | Case control | Schizophrenia | Inpatient | Serbia | Case: 190 Control: 190 | Community sample of patients with localised or generalised chronic periodontitis | Toothbrush frequency and technique |
| Eltas, 2013 | Cross-sectional | Schizophrenia | Outpatient | Turkey | 53 | N/A | Toothbrush frequency |
| Eskelinen, 2017 | Cross-sectional | Schizophrenia, schizoaffective disorder, other schizophrenia spectrum disorder | Outpatient | Finland | 275 | | Dental service use |
| Gandre, 2020 | Epidemiological | Psychotic and bipolar disorder | Outpatient and inpatient | France | Case: 413,437 Control: 1,240,311 | French national health data system | Dental service use |
| Gurbuz, 2011 | Cross-sectional | Schizophrenia | Inpatient | Turkey | 330 | | Toothbrushing frequency |
| Hede, 1992 | Case-control | Schizophrenia, reactive psychosis, manic depression | Outpatient | Denmark | Case: 84 Control: 2548 | General population survey | Dental service use and toothbrushing frequency |
| Hsieh, 2011 | Pre-test post-test design, baseline data | Schizophrenia | Inpatient | Taiwan | 100 | N/A | Toothbrush frequency and maintenance of toothbrush |
| Janhardanan, 2011 | Case control | Schizophrenia | Outpatient | US | Case: 198 Control: 113 | Community comparison group | Dental service usage |
| Jovanovic, 2010 | Case-control | Schizophrenia, NOS psychosis, schizoaffective disorder, persistent psychotic disorder, bipolar disorder | Inpatient | Serbia | Case: 186 Control: 186 | Community comparison group | Dental service use, toothbrush frequency, technique and maintenance of toothbrush |
| Lynch, 2005 | Cross-sectional | Schizophrenia, other | Inpatient | Northern Ireland | 65 | N/A | Toothbrush ownership |
| McCreadie, 2004 | Case-control | Schizophrenia | Outpatient | Scotland | Case: 93 Control: 28,471 | General population survey | Dental service usage, toothbrushing frequency, |

| | | | | | | | |
|-----------------|-----------------|---|--------------------------------|-----------|---------------------------------------|---------------------------------------|---|
| | | | | | | | flossing, mouthwash use |
| Nayak, 2020 | Cross-sectional | Schizophrenia, mania | Outpatient | India | 250 | N/A | Toothbrush frequency |
| Ngo, 2018 | Cross-sectional | Schizophrenia, Intellectual Disability, other | Inpatient | Singapore | 191 | | Toothbrushing frequency |
| Nielson, 2011 | Epidemiological | Schizophrenia | Inpatient and outpatient | Denmark | Case: 21,417 Control: 3,790,446 | National health insurance database | Dental service use |
| Pelletier, 2015 | Cross-sectional | Schizophrenia, schizotypal disorder, delusional disorder | Outpatient | Canada | 146 | | Toothbrushing frequency |
| Patrick, 1996 | Cross-sectional | Schizophrenia | Outpatient | US | 353 | N/A | Dental service use |
| Salsberry, 2005 | Cross-sectional | Schizophrenia, schizophreniform, schizoaffective disorder, delusional disorder, ICD-9 – Paranoid disorders | Outpatient | US | 230 | | Dental service use |
| Singh, 2017 | Cross-sectional | Schizophrenia | Outpatient | India | 71 | | Dental service use, toothbrushing frequency, mode and material for cleaning teeth |
| Singh, 2019 | Cross-sectional | Schizophrenia | Outpatient | India | 156 | | Dental service use, toothbrushing frequency, mode and material for cleaning teeth |
| Stiefel, 1990 | Case control | Schizophrenia, bipolar disorder, | Outpatient | US | Case: 37 Control: 29 | Community comparison group | Dental service use, toothbrushing |

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|---------------|-----------------|--|--------------------------|-----------|--------------------------------|--------------------------------------|---|
| | | other non-organic, personality disorder | | | | | frequency and flossing. |
| Tani, 2012 | Cross-sectional | Schizophrenia, schizoaffective disorder, delusional disorder, acute and transient psychotic disorder | Inpatient | Japan | 523 | N/A | Toothbrushing frequency |
| Teng, 2016 | Epidemiological | Schizophrenia, delusional disorders | Inpatient and outpatient | Taiwan | Case: 4298 Control: 623,175 | National insurance research database | Dental service use |
| Tredget, 2019 | Cross-sectional | Schizophrenia | Outpatient | Wales | 106 | N/A | Dental service usage, toothbrush frequency and mouthwash use |
| Wieland, 2010 | Cross-sectional | Schizophrenia, schizoaffective disorder, bipolar disorder, schizotypal personality disorder | Outpatient | Australia | 20 | | Dental service use, toothbrushing frequency, flossing and mouthwash use |
| Xiong, 2010 | Cross-sectional | Bipolar, psychotic disorder | Outpatient | US | 170 | N/A | Dental service usage |

Table 2. Quality assessment.

| Study ID | Selection Bias | Confounders | Data collection | Analysis | Global rating |
|-------------------|----------------|-------------|-----------------|----------|---------------|
| Adams 2017 | Moderate | Weak | Weak | Moderate | Weak |
| Agarwal, 2019 | Moderate | Moderate | Weak | Strong | Moderate |
| Corridore, 2017 | Weak | Weak | Weak | Moderate | Weak |
| Cunha 2017 | Moderate | Moderate | Weak | Strong | Moderate |
| Denis, 2017 | Moderate | Strong | Weak | Strong | Moderate |
| Denis, 2019 | Weak | Strong | Weak | Strong | Weak |
| Denis 2020 | Strong | Strong | Strong | Strong | Strong |
| Dickerson, 2003 | Moderate | Strong | Moderate | Strong | Strong |
| Djordjevic, 2019 | Moderate | Moderate | Weak | Strong | Moderate |
| Eltas, 2013 | Moderate | Weak | Weak | Moderate | Weak |
| Eskelinen, 2017 | Moderate | Weak | Weak | Strong | Weak |
| Gandre, 2020 | Strong | Strong | Strong | Strong | Strong |
| Gurbuz, 2011 | Moderate | Moderate | Weak | Moderate | Moderate |
| Hede, 1992 | Moderate | Weak | Weak | Weak | Weak |
| Hsieh, 2011 | Weak | Weak | Weak | Weak | Weak |
| Janhardanan, 2011 | Moderate | Strong | Weak | Moderate | Moderate |
| Jovanovic, 2010 | Moderate | Weak | Weak | Strong | Weak |
| Lynch , 2005 | Weak | Weak | Weak | Weak | Weak |
| McCreadie, 2004 | Moderate | Weak | Weak | Weak | Weak |
| Nayak, 2020 | Weak | Weak | Weak | Moderate | Weak |
| Ngo, 2018 | Strong | Weak | Weak | Moderate | Weak |

| | | | | | |
|-----------------|----------|----------|--------|----------|----------|
| Nielson, 2011 | Strong | Moderate | Strong | Strong | Strong |
| Patrick, 1996 | Weak | Weak | Weak | Moderate | Weak |
| Pelletier, 2015 | Weak | Weak | Weak | Weak | Weak |
| Salsberry, 2005 | Strong | Strong | Strong | Moderate | Strong |
| Singh, 2017 | Moderate | Weak | Weak | Strong | Weak |
| Singh, 2019 | Moderate | Weak | Weak | Strong | Weak |
| Stiefel, 1990 | Moderate | Weak | Weak | Moderate | Weak |
| Tani, 2012 | Moderate | Weak | Weak | Strong | Weak |
| Teng, 2016 | Strong | Strong | Strong | Strong | Strong |
| Tredget, 2019 | Moderate | Weak | Weak | Weak | Weak |
| Wieland, 2010 | Weak | Weak | Weak | Weak | Weak |
| Xiong, 2010 | Moderate | Strong | Weak | Moderate | Moderate |