

Oral health inequalities concerning socially vulnerable population groups in the United Kingdom: a scoping review

Renato Venturelli,^{*1} Alex Blokland,¹ Georgios Tsakos,¹ Michelle Stennett,¹ Semina Makhani,² Kate Jones,² Richard G. Watt¹ and Anja Heilmann¹

Key points

Highlights excessive oral health inequalities for socially vulnerable groups in the UK, particularly among homeless and prisoner populations who experience very high levels of oral diseases and very low levels of dental care. Studies consistently show that vulnerable groups have much worse clinical and subjective oral health outcomes than the general population, though most research failed to offer direct comparisons.

There was a notable lack of research on the oral health of Gypsy, Roma and Traveller communities, sex workers, asylum seekers and refugees. Understanding the extent of oral health inequalities affecting vulnerable groups in the UK is further hindered by methodological limitations of existing research, such as small and non-random samples.

This review underscores the pressing need for robust, larger-scale, high-quality research that not only addresses methodological limitations but also expands the focus to include a wider range of vulnerable groups. Such research is essential to inform targeted policies and interventions, ensuring equitable oral healthcare for all, especially those most in need.

Abstract

Background Marginalised and socially excluded groups face discrimination, multiple health risk factors, and barriers to accessing care, leading to poor health outcomes and substantial inequalities.

Aim This scoping review synthesises evidence on the oral health of socially vulnerable populations in the United Kingdom, including people experiencing homelessness, prisoners, Gypsy, Roma and Traveller communities, looked-after children, sex workers, and asylum seekers and refugees.

Methods A systematic search of quantitative studies published between January 2000 and December 2021 was conducted, including clinical and subjective measures of oral health, as well as oral health-related behaviours and dental service use. Peer-reviewed articles were searched using Medline, Embase, PsycInfo, PubMed, and the Cochrane Database of Systematic Reviews. Grey literature was also included.

Results Of the 22 included studies, most focused on homeless and prisoner populations. Overall, studies reported a high prevalence of caries (61–67%), periodontal disease (56–92%), and poor self-reported oral health (71–87%), as well as overall low and mainly symptomatic dental attendance. Studies were predominantly local and based on small samples. The search did not identify any publications for sex workers, asylum seekers and refugees.

Conclusions Socially vulnerable groups in the United Kingdom experience significant oral health inequalities. There is a need for more comprehensive research and targeted policies to address these inequalities.

Background

Despite ample evidence on the poorer health of vulnerable populations in the literature, no agreement exists as to what is meant by vulnerability.^{1,2,3} It has been described as an

inherent element of the life of all individuals, as it recognises that everyone may lack the capacity or the means to protect themselves, their health, or their wellbeing at some point in time.⁴ Vulnerability might result from a variety of factors, and while some groups of people may be vulnerable in one situation but not in another, others can be considered vulnerable due to the context in which they live and/or the lack of opportunities they have.⁴

From a health perspective, while everyone is potentially vulnerable, some population groups are more likely to experience poorer health than others.⁵ Typically referred to as vulnerable, socially excluded, marginalised, or inclusion health groups, these are diverse groups of people at greater risk of poor health,

impaired quality of life and earlier mortality than the general population.⁶

For the purposes of this review, we adopted a working definition of socially vulnerable populations as those groups commonly recognised in public health literature and policy as experiencing pronounced health inequalities and structural barriers to care. Specifically, we included studies focused on people experiencing homelessness; prisoners; Gypsy, Roma and Traveller communities; looked-after children; sex workers; and asylum seekers and refugees.

As with general health conditions, oral diseases are socially patterned and closely linked to socioeconomic position.⁷ Oral diseases disproportionately affect those who are

¹Department of Epidemiology and Public Health, University College London, London, UK; ²Primary and Community Health Care, Department of Health and Social Care, London, UK.

*Correspondence to: Renato Venturelli
Email address: renato.venturelli@ucl.ac.uk

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most vulnerable, with the slope of oral health inequalities becoming a 'cliff edge' for the most marginalised and socially excluded groups in society.⁸ These groups also face substantial barriers to accessing dental services, further compounding their challenge to achieve good oral health.⁹

In the United Kingdom (UK), despite overall improvements in the population's oral health, stark inequalities persist.¹⁰ Given the need to reduce these inequalities and improve access to oral healthcare for vulnerable populations, Public Health England (PHE) commissioned a scoping review into inequalities in oral health in the UK, covering relevant literature between January 2000 and June 2017.¹⁰ This scoping review has been further updated to include literature published until December 2021 and this paper summarises the evidence on inequalities with regards to socially vulnerable population groups in the UK.

Methodology

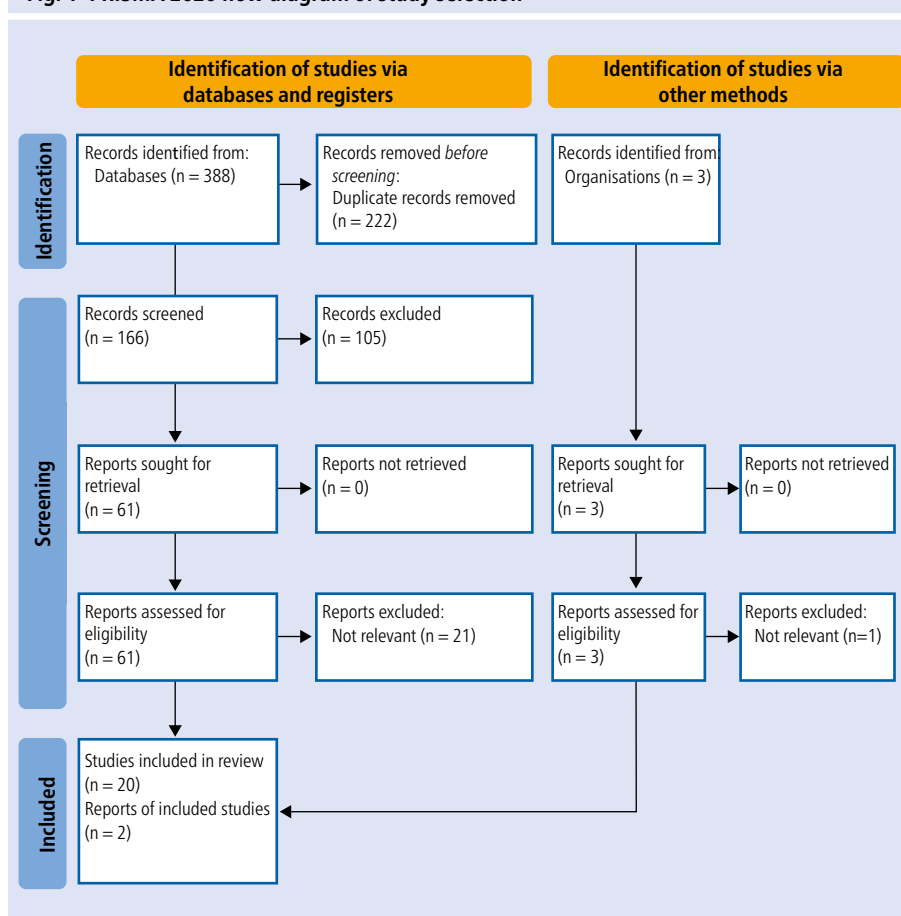
Design

A scoping review methodology was employed,¹¹ including relevant research of various study designs and a broad range of oral health-related outcomes. A protocol was developed by the research team to guide the review process, but it was not publicly registered. The review was conducted and reported in accordance with the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) Extension for Scoping Reviews (PRISMA-ScR).¹² A completed PRISMA-ScR checklist is provided in the online Supplementary Information (online Supplementary File 1).

Eligibility criteria

Studies focusing on oral health outcomes among socially vulnerable populations (i.e., people experiencing homelessness; prisoners; Gypsy, Roma and Traveller communities; looked-after children; sex workers; asylum seekers and refugees) in the UK were included. Eligible quantitative studies comprised cross-sectional, case-control, and cohort studies, as well as baseline data from intervention studies. Qualitative studies and literature reviews were excluded; although, references from previous reviews were screened. Grey literature was also considered. There were no exclusions based on article quality. The outcomes were categorised into: a) clinical oral health measures; b) subjective oral health measures; c) oral health-related behaviours; and d) dental service

Fig. 1 PRISMA 2020 flow diagram of study selection



use. The review was restricted to English-language publications from January 2000 to December 2021.

Search strategy

The literature search strategy was developed and refined with the assistance of a scientific librarian and in consultation with the research team and the PHE oral health inequalities task group. Searches using relevant MESH (medical subject headings) terms and free-text terms were conducted in Medline, Embase, PsycInfo, PubMed, and the Cochrane Library between April and June 2017, and updated from November 2021 to January 2022 (see online Supplementary File 2). In addition to searching peer-reviewed articles, grey literature was identified through searches in Google Scholar.

Selection of studies

Potential articles were exported, de-duplicated, and screened by title and abstract. Two independent reviewers conducted the abstract and full-text screening based on the inclusion criteria, resolving any disagreements in team meetings.

Data extraction and evidence synthesis

Data extraction was conducted using a standardised template that captured papers' author(s), year of publication, dataset/study population, sample size, study design, outcomes, findings, and evidence of inequalities. One reviewer extracted data from all included studies. To enhance rigour and ensure accuracy, a second reviewer independently checked a sample of the extracted data. Extracted information was then charted for each identified outcome.

Results

Overall, a total of 388 records were identified through literature searches. After removal of duplicates and initial screening, 85 studies were reviewed in full for eligibility. Across all searches, 22 articles met the criteria for inclusion and were included in the final synthesis. Two articles from the grey literature were also incorporated. Figure 1 illustrates the selection process at each stage of the review.

All studies were observational and most employed a cross-sectional design (n=20). Only one study used a comparison group

Table 1 Characteristics of included peer-reviewed studies for Gypsy, Roma and Traveller Communities, grouped by outcomes

	Author/ year	Dataset/study population	Sample size	Study design	Outcome(s) as described by authors	Findings	Evidence for inequalities?
Clinical outcomes	Dental caries						
	Doughty <i>et al.</i> 2016 ³²	Traveller children aged 1 to 16 years based in Hackney, London	37	Observational, cross-sectional (pilot study)	Obvious caries experience	More than half of participants had obvious caries	No
Oral health- related behaviours	Oral hygiene/toothbrushing						
	Doughty <i>et al.</i> 2016 ³²	Traveller children aged 1 to 16 years based in Hackney, London	37	Observational, cross-sectional (pilot study)	Toothbrushing frequency	Less than half of participants (40%) reported brushing twice daily, 60% reported brushing at least once per day or less	No
	Sugar consumption						
	Doughty <i>et al.</i> 2016 ³²	Traveller children aged 1 to 16 years based in Hackney, London	37	Observational, cross-sectional (pilot study)	Sugar intake	Most children had a moderate to highly cariogenic diet	No
Service use	Service use						
	Doughty <i>et al.</i> 2016 ³²	Traveller children aged 1 to 16 years based in Hackney, London	37	Observational, cross-sectional (pilot study)	Time since last visit; reason for dental visit	Most children reported being seen by a dentist for a routine examination within the past two years	No

from the general population; however, some compared their results against available data from national dental health surveys. Table 1 and Table 2, and online Supplementary Tables 1 and 2 provide a summary of the findings, categorised by oral health outcomes for each vulnerable group examined.

People experiencing homelessness

Ten studies on clinical oral health outcomes and homelessness were included.^{13,14,15,16,17,18,19,20,21,22,23} In addition, the 2017 Groundswell Healthy Mouth report²⁴ was included from the grey literature (online Supplementary Table 1).

Studies reported that people experiencing homelessness had high levels of untreated dental caries, with 71–76% of participants requiring restorative treatment.^{16,17} Compared to the general population, people experiencing homelessness had more missing and carious teeth and fewer filled teeth.^{13,15,16,17} The mean number of decayed, missing, and filled permanent teeth (DMFT) among the samples ranged from 15.5 to 16.9, with most studies showing that the largest DMFT component was missing teeth.^{13,14,15,17,18,19} Additionally, the Groundswell study revealed that 46% of its participants reported having ‘holes in teeth’.²⁴

Periodontal disease was examined in four studies.^{15,16,17,19} They pointed to very high levels of periodontal disease among people experiencing homelessness, with the majority needing periodontal treatment. One study found that only 15% of people experiencing homelessness showed no signs of debris,

bleeding, or pocketing,¹⁶ while another observed that only 8% showed no apparent symptoms of gingival or periodontal disease,¹⁵ while the Groundswell study indicated that 56% reported ‘bleeding gums,’ 45% experienced ‘bad breath,’ and 44% had ‘loose teeth’.²⁴

Three studies on tooth loss were identified.^{13,17,19} In the largest (n = 853), the prevalence of edentulousness was 6% among relatively young adults (mean age 34 years).¹³ In another study on a smaller cohort of older people experiencing homelessness (mean age 55 years), the prevalence of edentulousness was about 30%, with most not using dentures.¹⁹ According to the Groundswell study, seven-in-ten participants reported having lost teeth since becoming homeless. Of these, 17% attributed tooth loss to acts of violence, and 12% to accidents.²⁴

Only two small-scale studies were identified for odontogenic infections^{18,19} and the same was the case for oral cancer.^{13,15} One study on odontogenic infections (n = 44) reported that 4.6% of participants had abscesses,¹⁸ while the other study (n = 70) found that 54% of individuals had one or more teeth with obvious pulpal involvement.¹⁹ Regarding oral cancer, one study reported that out of 853 participants, 61 had suspicious oral mucosal lesions, with five requiring referral.¹³ Another study (n = 317) reported that 5% of the sample had soft tissue lesions, with two cases ultimately diagnosed as oral cancer.¹⁵

Six peer-reviewed articles focused on subjective oral health, including

oral health-related quality of life (OHRQoL).^{13,14,15,17,18,20} Comparisons with the general population revealed that a higher proportion of people experiencing homelessness experienced poorer OHRQoL.^{13,14,17,18} The most frequently reported oral impacts were physical pain, psychological discomfort, and psychological disability. For instance, a study from Scotland found that 25% of participants frequently felt self-conscious and 23% felt embarrassed about their mouth’s appearance.¹³ The Groundswell study highlighted that 87% of participants reported experiencing oral impacts occasionally or more frequently, a contrast to the 39% reported in the Adult Dental Health Survey (ADHS) 2009.²⁴

Three papers were found in relation to oral health-related behaviours.^{13,21,22} The Groundswell study found that only 35% of people experiencing homelessness brushed their teeth twice-daily, a much lower prevalence than the 75% reported in the ADHS 2009. Additionally, 60% of the participants were categorised as high sugar users, compared to 50% in the wider population.²⁴

Five papers examined dental service use among people experiencing homelessness.^{13,16,19,21,23} One study on 853 participants revealed that 41% had visited a dentist in the previous year, primarily due to dental pain.¹³ This finding aligns with a London-based study (n = 201), where over 40% attended a dentist due to pain,¹⁶ and another study using patient records data (n = 349), where 40% presented with pain.²³

Table 2 Characteristics of included peer-reviewed studies for looked-after children, grouped by outcomes

	Author/ year	Dataset/study population	Sample size	Study design	Outcome(s) as described by authors	Findings	Evidence for inequalities?
Clinical outcomes	Dental caries						
	Keene <i>et al.</i> 2015 ³³	2–11-year-olds subject to either a child protection plan or attending dental clinics in Bradford	158	Observational, cross-sectional	dmft and DMFT; caries-free children; care-index	dmft: significantly higher on children with a protection plan compared to those from the control group. DMFT: no difference between groups. Caries-free: 42% of children with a protection plan versus 68% of children from control group. The care-index: significantly lower on children with a protection plan.	Yes
	Sarri <i>et al.</i> 2012 ³⁴	15–16-year-olds attending secondary schools in three boroughs of North East London	965	Observational, cross-sectional	Dental caries experience	3.3% of children were classified as 'looked-after'. A higher proportion of looked-after children experienced dental caries (54%) compared to those living in families (41%)	Yes
	Dental trauma						
	Sarri <i>et al.</i> 2012 ³⁴	15–16-year-olds attending secondary schools in three boroughs of North East London	965	Observational, cross-sectional	Traumatic dental injuries experience	3.3% of children were classified as 'looked-after'. 10% of looked-after children experienced dental trauma compared to 4.5% of the children living in families	Yes
Subjective oral health	Dental pain						
	Sarri <i>et al.</i> 2012 ³⁴	15–16-year-olds attending secondary schools in three boroughs of North East London	965	Observational, cross-sectional	Dental pain experience	3.3% of children were classified as 'looked-after'. A higher proportion of looked-after children experienced dental pain (12.5%) compared to those living in families (7%)	Yes
Service use	Service use						
	Keene <i>et al.</i> 2015 ³³	2–11-year-olds subject to either a child protection plan or attending dental clinics in Bradford	158	Observational, cross-sectional	Having own dentist; visiting a dentist in last 12 months	Significantly less children with a protection plan had their own dentist or visited a dentist in the last year compared to the control children	Yes
	McMahon <i>et al.</i> 2018 ³⁵	Children in publicly funded schools in Scotland during the academic year 2011/12	633,204	Observational, cross-sectional	Attendance to primary care dental services	A statistically significant lower proportion of looked-after children regularly attended dental services compared to those not looked-after (51% versus 63%, respectively)	Yes
	Williams <i>et al.</i> 2001 ³⁶	5–16-year-old children in Welsh local authority care and matched control children	261	Case-control study	Regular dental attendance; treatment need	Among looked-after children, less reported visiting a dentist on a regular basis compared to controls. Control children were significantly less likely to need treatment when visiting the dentist than looked-after children	Yes

DMFT, decayed, missing, and filled permanent teeth; dmft, decayed, missing, and filled primary teeth

Other reasons for visiting the dentist included missing teeth, swellings and periodontal problems.²¹ Barriers for regular attendance included cost, lack of perceived need, fear, low priority, and fatalism.^{19,21} Barriers hindering people experiencing homelessness from accessing dental care reported by the Groundswell study included lack of motivation (about 30% believing their teeth were beyond repair), confusion regarding NHS entitlement (58%), cost concerns (23%), fear (24%), and previous negative treatment experiences (12%).²⁴

Prisoners

Six peer-reviewed papers relating to clinical outcomes among prisoners met the inclusion criteria (online Supplementary Table 2).^{25,26,27,28,29,30} These examined caries, oral sepsis, periodontal disease, and oral cancer. No studies assessed tooth loss or traumatic dental injuries. In addition, findings from grey literature, i.e., the 2019 Scottish Oral Health Improvement Prison Programme (SOHIPP) survey were also included (n = 559).³¹

Generally, prisoners had more decayed, fewer sound and fewer filled teeth compared to

the general population.^{25,27,30} Across studies, the DMFT index ranged from 12.3 to 15.6, with missing teeth being its largest component.

In relation to odontogenic infections, one study (n = 122) found that 16% of the sample exhibited signs of diffuse swelling or the presence of a chronic abscess or sinus.²⁶ Another study on female prisoners (n = 103) reported a significantly higher prevalence of oral sepsis (40%) compared to the general population (7%).³⁰ Prisoners also had a higher prevalence of gingival bleeding, calculus, and deep periodontal pocketing compared to

the general female population. For example, 62% of the prisoners had periodontal pockets of 4 mm or more, in contrast to 41% in the ADHS 2009.³⁰ Additionally, two other studies on relatively young prisoner populations indicated high periodontal treatment need.^{25,26}

While no peer-reviewed studies addressed tooth loss among prisoners, the 2019 SOHIPP report revealed that 75% of prisoners (mean age 32.1 years) retained at least 20 teeth, and 4% were edentulous.³¹

One study with 122 participants noted that three individuals were referred to secondary care due to suspicious oral lesions,²⁶ while the 2019 SOHIPP indicated that 8.3% of prisoners had at least one oral lesion that warranted monitoring or further referral.³¹

Four studies on subjective oral health measures were identified.^{25,26,29,30} They suggest that prisoners generally perceive their oral health as poor and express dissatisfaction with it. Two studies reported a significantly higher prevalence of oral impacts among prisoners compared to the ADHS 2009 population.^{29,30} For instance, 73% of prisoners experienced at least one oral impact on their daily life, in contrast to 34% in the ADHS 2009. The most common impacts related to difficulty eating (55%), problems smiling (37%), emotional stability (32%), and difficulty relaxing (30%).³⁰ The 2019 SOHIPP survey found that the most frequently reported oral impacts were 'feeling self-conscious' (38%) and 'feeling embarrassed' (32%).³¹

Three papers investigated oral health-related behaviours in prisoners.^{25,26,30} The 2019 SOHIPP report revealed that 44% reported using tobacco products. The study also inquired about toothbrushing habits, finding that 89% of participants brushed their teeth in prison, with 73% maintaining this habit both at home and in prison.³¹ One study found that high sugar intake was more prevalent among female prisoners (66%) than in the general population (16%).³⁰

In terms of service use, a large proportion of prisoners attended the dentist within the last year.^{25,26,29,30} However, they visited the dentist mainly when in trouble, which was also the case for this population before imprisonment. One study showed that compared to the general female population, the prevalence of regular dental attendance was considerably lower for female prisoners (67% versus 33%), whereas the prevalence of visiting the dentist only when in trouble was much higher (22% versus 41%).³⁰ The SOHIPP

2019 found that 78% of prisoners reported accessing dental services in prison, compared to 74% who had ever accessed dental care inside or outside prison. However, the study also highlighted barriers to accessing care, including difficulty securing appointments (40%), limited availability of treatment visits (32%), and dislike of the prison dental service (6%).³¹

Gypsy, Roma and Traveller communities

Only one small study on 37 Traveller children was identified (Table 1).³² Approximately two-thirds of the children had caries, assessed as visually obvious decay. The prevalence of twice-daily tooth brushing was low (40%) and a moderate to highly cariogenic diet was consumed by 95% of the children. Around 85% had visited a dentist within the last two years.³²

Looked-after children

Four articles, reporting on studies from different parts of the country and using different methodological designs, met the eligibility criteria for inclusion (Table 2).^{33,34,35,36}

Caries and dental trauma were the only clinical outcomes assessed, with evidence suggesting higher levels of both conditions among looked-after children. A study in Bradford found that only 42% of children under a child protection plan were caries-free, compared to 68% among the control group of children not under such a plan. Significant differences in primary dentition caries persisted even after adjusting for gender and area deprivation. Children with a protection plan also had more caries in permanent teeth than the control group, but the differences were not significant.³³ School-based epidemiological data in North East London showed that a higher proportion of looked-after children had caries (54%) and dental trauma (41%) than non-looked-after children, where the prevalence was 10% for caries and 4.5% for trauma.³⁴

With regards to subjective oral health measures, only the North East London-based study provided relevant information, with looked-after children experiencing higher levels of dental pain than those not looked after (12.5% versus 7%).³⁴

Service use measures were assessed in three studies.^{33,35,36} The Bradford study showed that children under a child protection plan were less likely to be registered with a dentist and attended dental services less frequently than non-looked-after children.³³ In a large data

linkage study in Scotland, a lower percentage of looked-after children regularly attended dental services compared to non-looked-after children (51% versus 63%). This study also found that at age five, looked-after children were more likely to need urgent dental treatment and were more often subject to teeth extractions under general anaesthesia than their counterparts (23% versus 10% and 9% versus 5%, respectively).³⁵ A case-control study in Wales reported that children in care visited the dentist less frequently and were more likely to require treatment upon these visits compared to non-looked-after children.³⁶

Sex workers, and asylum seekers and refugees

No articles were identified for these vulnerable groups.

Discussion

Although limited, the available evidence clearly suggests inequalities affecting socially vulnerable groups in relation to caries, tooth loss, periodontal disease, oral cancer, OHRQoL, and dental service use. These inequalities are characterised by poorer oral health outcomes and reduced access to dental care for vulnerable groups compared to the general population.

Most of the available studies focused on the oral health of people experiencing homelessness and prisoner populations, placing emphasis on clinical outcomes while giving less consideration to subjective measures such as OHRQoL. Research on Gypsy, Roma and Traveller communities was notably scarce, with only one study identified, and quantitative studies on sex workers and asylum seekers and refugees were completely absent. Geographically, most of the studies were conducted in England, with some representation from Scotland, albeit to a lesser extent, and even fewer studies from Wales and Northern Ireland.

A significant gap in the existing research is the scarceness of comparative studies between vulnerable groups and the general population. Most studies concentrate on specific vulnerable groups in isolation, which restricts the ability to fully grasp the existence and extent of oral health inequalities. This problem is compounded by methodological limitations, including the use of small, local, non-random samples, and a focus on a restricted set of outcomes.

As this review is based on literature published up to December 2021, more recent studies were not captured and the publication timeline should be considered when interpreting the findings.

Future research should aim to address these methodological issues and comprehensively assess the pathways or mechanisms by which vulnerable groups become disadvantaged in terms of their oral health and access to dental services.⁶ Further work is required to strengthen the evidence base to determine how oral health outcomes can be improved and dental services more effectively tailored to the needs of these populations. In addition, the lack of data on asylum seekers and refugees, sex workers, and other marginalised groups underscores an urgent need for inclusive research that encompasses all segments of society.³⁷

Gaining a full understanding of the complexity and significance of the issues faced by individuals from vulnerable groups calls for qualitative research.^{38,39,40} Such research allows for a deeper exploration of the specific needs and challenges these groups encounter. For instance, a qualitative study of asylum seekers and refugees in England provided insights into barriers and facilitators to oral healthcare delivery and access, some of which were unique to this vulnerable community.⁴¹ Qualitative studies can guide subsequent quantitative research, ensuring that interventions and policies are appropriately aligned with the needs of vulnerable populations and that access to care is equitable.⁴²

Comparing these findings with international evidence reveals similar patterns of oral health inequalities for socially excluded and marginalised groups. For example, an American study of people experiencing homelessness found that over half reported oral pain, a value more than three times higher than in the general population over 65 years.⁴³ Similarly, research in Australia highlighted substantial gaps and inequalities in oral health between Indigenous communities and non-Indigenous populations, particularly in rural areas.^{44,45,46} In Europe, a systematic review found that refugees experience a high burden of dental caries, with increasing severity due to factors such as pre-existing poor oral health, limited access to treatment, language barriers, and unfamiliarity with the healthcare systems.⁴⁷ These international findings reinforce the pattern observed in the UK and underline the global nature of oral health inequalities across vulnerable populations.

The findings of this review have broader implications for public health policy and practice, especially considering the diversity of the UK's population. The clear inequalities in oral health outcomes and service use among people experiencing homelessness and prisoners highlight the urgent need for tailored health policies for these groups.⁴⁸ Consideration to the broader social determinants of health, including factors such as housing, education, employment and social participation, is key.⁴⁹ Policies need to adopt a holistic approach that addresses these interconnected factors, thereby tackling the root causes of health inequalities.^{38,48,49,50} Collaborative efforts between healthcare providers, policymakers, and community organisations will be essential in developing and implementing strategies that are not only effective but also focus on equity and inclusivity for all segments of the UK population.

Conclusion

This review highlights the considerable oral health inequalities affecting socially vulnerable populations in the UK, especially among people experiencing homelessness and prisoner groups. It also reveals significant research gaps in our understanding of the oral health status of Gypsy, Roma and Traveller communities, looked-after children, sex workers, and asylum seekers and refugees. Future research addressing these gaps would better foster oral health interventions that are responsive to the needs of vulnerable groups and, ultimately, contribute to the reduction of the extreme oral health inequalities experienced by these communities.

Ethics declaration

The authors declare no conflicts of interest related to this research. Ethical approval was not required for this study, as it involved the review and synthesis of publicly available literature and did not include any identifiable personal data.

Data availability

This review is based on data from previously published studies. No new datasets were generated during the current study.

Author contributions

RV, AH, GT and RGW contributed to the conceptualisation of the study. Data collection, literature screening, and data synthesis and interpretation was conducted by RV, AH, GT, MS

and AB. Manuscript drafting was led by RV. SM and KJ contributed to the review and editing of the manuscript. All authors revised and approved the final version.

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