

# Mental health under pressure: a scoping review of suicide in the dental workforce

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## Key points

Some studies found that dentists have elevated suicide rates compared to the general population, while others indicate lower or comparable rates.

Suicide in the dental profession is multifactorial, shaped by occupational stress, access to lethal means, and mental health stigma.

Lowering the suicide rate among dentists requires profession-wide action to reduce stigma, enhance support systems, and develop tailored interventions.

## Abstract

**Aims** Suicide among healthcare professionals is a growing concern. Despite evidence of high psychological distress in dental practice, suicide in dentists remains underexplored. This scoping review systematically examined the literature on suicide and suicidal ideation among dentists, including prevalence, risk factors, and temporal trends.

**Methods** Searches of PubMed, Scopus, Web of Science, and Dentistry and Oral Sciences Source identified English-language studies reporting suicide, suicidal ideation, or related mental-health risks in dental professionals. Duplicates were removed; titles/abstracts and full texts were screened against predefined criteria. Data were extracted and thematically analysed.

**Results** Fourteen studies met the inclusion criteria and were mostly retrospective or observational studies. Findings on suicide rates were mixed: three studies reported elevated risk among dentists versus the general population, while two found no difference or declining trends. Reported risk factors included occupational stress, access to lethal means, substance misuse, mental-health stigma, sex, and age.

**Conclusions** Suicide in dentistry is multifactorial. Reducing stigma, strengthening surveillance, and implementing targeted supports and interventions are needed to safeguard dentists' wellbeing.

## Introduction

Mental health challenges among healthcare professionals are a growing global concern, with a greater awareness of the emotional toll of clinical work.<sup>1</sup> While physicians and nurses have received considerable attention, the mental health of dental professionals has been comparatively overlooked in academic and public discourse.<sup>2</sup> Suicide is a major global public health issue, responsible for more than 700,000 deaths each year according to the World Health Organization, making it a

leading cause of death.<sup>3</sup> Global suicide rates have declined only modestly over the past two decades; in some regions, particularly among working-age adults, they remain high.<sup>4</sup> Beyond the tragic loss of life, suicide imposes profound emotional and economic burdens on families, communities, and healthcare systems.<sup>5</sup> It is a complex, multifactorial phenomenon shaped by psychological, social, biological, and environmental influences; prevention depends on early recognition, stigma reduction, and timely access to care. These considerations are particularly relevant to dentistry, where emerging research suggests a distinct mix of occupational and personal stressors that heighten the risk for anxiety, depression, suicidal ideation, and suicide.<sup>6</sup> Understanding these risks within the dental profession is timely and essential to safeguard practitioner well-being and maintain high-quality patient care.

Dentistry is widely recognised as a high-stress occupation. Dentists face a distinctive blend of demands: technical precision, emotional labour, time pressure, financial strain (especially in private practice), and professional

isolation.<sup>7</sup> Unlike many team-based healthcare settings, dentists often work in solo or small-group practices, limiting peer support and heightening emotional strain.<sup>8</sup> These factors are compounded by perfectionism and fear of errors or complaints, creating persistent pressure and performance anxiety.<sup>9</sup>

Several studies identify ready access to prescription medications as a distinct risk factor in suicide deaths.<sup>10</sup> Stigma surrounding mental illness within healthcare settings, including dentistry, often deters timely help-seeking.<sup>11</sup> Concerns about confidentiality, reputation, and career implications may lead practitioners to conceal symptoms of distress. As a result, problems may go undetected and untreated, increasing the risk of suicidal behaviour.

Despite the widespread belief that dentistry has among the highest suicide rates, the evidence is mixed.<sup>12</sup> Some studies report significantly higher suicide rates among dentists compared to the general population, while others have found no increase or even lower rates.<sup>13</sup> Variability in findings reflects differences in study design, data sources,

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cultural context, and shifting attitudes toward mental health.<sup>14</sup> Evolving support services, workplace policies, and awareness initiatives may also shape trends, underscoring the need to reassess and synthesise the current evidence.

This scoping review systematically examined the literature on suicide and suicidal ideation in dentistry. It identifies reported suicide rates, catalogues risk factors, describes demographic and occupational patterns, and assesses changes over time and across regions. By mapping current research, the review clarifies the mental health landscape in dentistry and informs targeted prevention, intervention, and support strategies.

### Methods

This scoping review followed the methodological framework developed by Arksey and O'Malley,<sup>15</sup> with enhancements and modifications by Levac *et al.*<sup>16</sup> Reporting adhered to the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guideline,<sup>17</sup> including a flow diagram of study selection. The aim of this scoping review was to map the existing literature on suicide and suicidal ideation among dental professionals, identify the extent and nature of the available evidence, and summarise key findings related to prevalence, risk factors, and trends. A scoping approach allows for the inclusion of diverse study designs and captures both quantitative and qualitative insights from varied geographic and professional contexts.

A systematic search of four major electronic databases – PubMed, Scopus, Web of Science, and Dentistry and Oral Sciences Source (Table 1) – was performed. The search strategy combined keywords and controlled vocabulary related to suicide and the dental profession. Search terms included combinations of 'dentist', 'suicide', 'oral surgeon', 'orthodontist', 'endodontist', 'paediatric dentists', and 'prosthodontist' Boolean operators (AND, OR) were used to maximise search sensitivity. The search applied no date limits to ensure comprehensive coverage.

Studies were eligible for inclusion if they met the following criteria:

1. Reported on suicide, suicide attempts, suicidal ideation, or related risk factors among dentists or dental professionals
2. Were original research articles, including retrospective, observational, cross-sectional, or qualitative studies

**Table 1 Database search strategy**

Database (Search date)	Search terms	Results
PubMed 13/12/2024	('Suicide' [Mesh] OR 'Suicide' [tiab]) AND ('Dentist'[tiab] OR 'Dentists'[tiab] OR 'Dentists'[Mesh] OR 'Oral Surgeon'[tiab] OR 'Maxillofacial Surgeon'[tiab] OR 'Endodontist'[tiab] OR 'Orthodontist'[tiab] OR 'Periodontist'[tiab] OR 'Prosthodontist'[tiab] OR 'Paediatric Dentist'[tiab] OR 'Oral Surgeons'[tiab] OR 'Maxillofacial Surgeons'[tiab] OR 'Endodontists'[tiab] OR 'Orthodontists'[tiab] OR 'Periodontists'[tiab] OR 'Prosthodontists'[tiab] OR 'Paediatric Dentists'[tiab] OR 'Specialties, Dental'[Mesh])	128
Scopus 13/12/2024	TITLE-ABS(('Suicide') AND ('Dentist' OR 'Dentists' OR 'Oral Surgeon' OR 'Maxillofacial Surgeon' OR 'Endodontist' OR 'Orthodontist' OR 'Periodontist' OR 'Prosthodontist' OR 'Paediatric Dentist' OR 'Oral Surgeons' OR 'Maxillofacial Surgeons' OR 'Endodontists' OR 'Orthodontists' OR 'Periodontists' OR 'Prosthodontists' OR 'Paediatric Dentists')) AND (LIMIT-TO (LANGUAGE, 'English'))	92
Web of Science 13/12/2024	(TI= (('Suicide') AND ('Dentist' OR 'Dentists' OR 'Oral Surgeon' OR 'Maxillofacial Surgeon' OR 'Endodontist' OR 'Orthodontist' OR 'Periodontist' OR 'Prosthodontist' OR 'Paediatric Dentist' OR 'Oral Surgeons' OR 'Maxillofacial Surgeons' OR 'Endodontists' OR 'Orthodontists' OR 'Periodontists' OR 'Prosthodontists' OR 'Paediatric Dentists')) OR AB= (('Suicide') AND ('Dentist' OR 'Dentists' OR 'Oral Surgeon' OR 'Maxillofacial Surgeon' OR 'Endodontist' OR 'Orthodontist' OR 'Periodontist' OR 'Prosthodontist' OR 'Paediatric Dentist' OR 'Oral Surgeons' OR 'Maxillofacial Surgeons' OR 'Endodontists' OR 'Orthodontists' OR 'Periodontists' OR 'Prosthodontists' OR 'Paediatric Dentists'))	33
Dentistry and Oral Sciences Source 12/12/2024	TI (('Suicide') AND ('Dentist' OR 'Dentists' OR 'Oral Surgeon' OR 'Maxillofacial Surgeon' OR 'Endodontist' OR 'Orthodontist' OR 'Periodontist' OR 'Prosthodontist' OR 'Paediatric Dentist' OR 'Oral Surgeons' OR 'Maxillofacial Surgeons' OR 'Endodontists' OR 'Orthodontists' OR 'Periodontists' OR 'Prosthodontists' OR 'Paediatric Dentists')) OR AB (('Suicide') AND ('Dentist' OR 'Dentists' OR 'Oral Surgeon' OR 'Maxillofacial Surgeon' OR 'Endodontist' OR 'Orthodontist' OR 'Periodontist' OR 'Prosthodontist' OR 'Paediatric Dentist' OR 'Oral Surgeons' OR 'Maxillofacial Surgeons' OR 'Endodontists' OR 'Orthodontists' OR 'Periodontists' OR 'Prosthodontists' OR 'Paediatric Dentists'))	26

**Table 2 Inclusion and exclusion criteria of article selection**

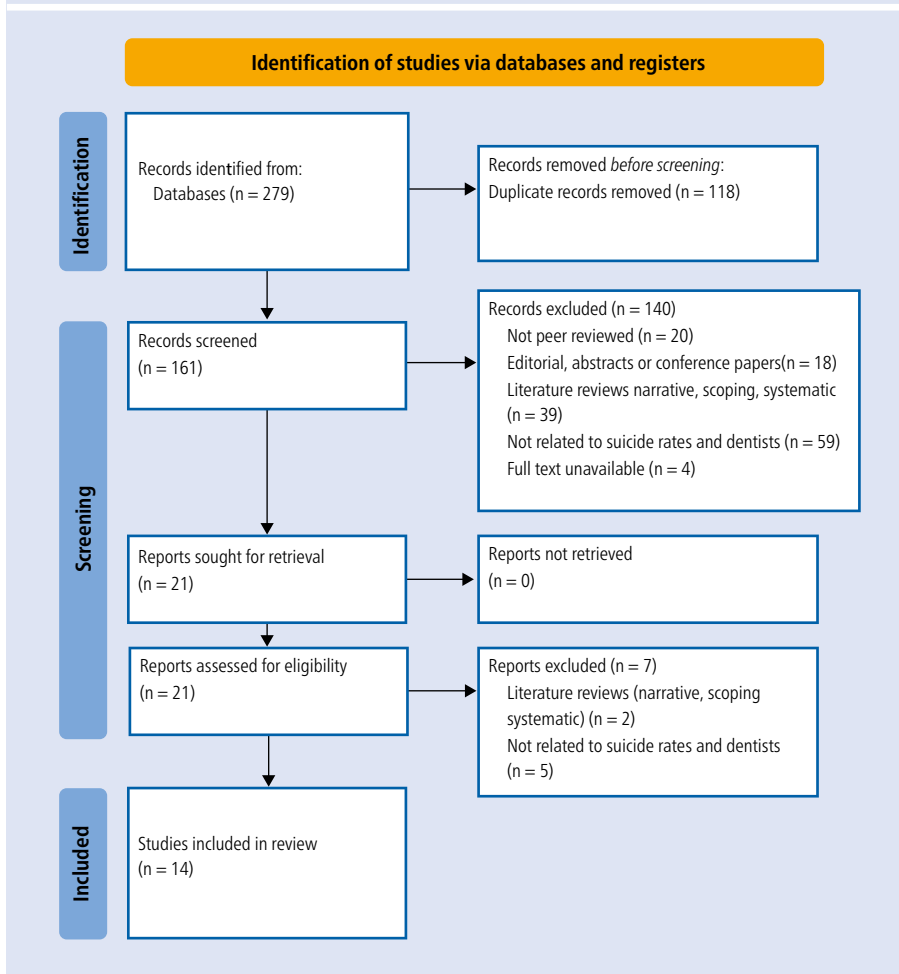
Category	Inclusion criteria	Exclusion criteria
Population	Licensed dentists/dental professionals (generalists and specialists)	Non-dental samples; mixed samples without dentist-specific data; students-only
Outcomes	Suicide deaths, attempts, ideation; suicide risk/protective factors	Mental health without suicide/ideation (e.g., stress/burnout only)
Design	Original empirical studies: retrospective/registry, cohort, cross-sectional, qualitative	Reviews/editorials/letters; grey literature (dissertations, abstracts); case reports/series without rates
Timeframe and geography	No date limits; any country/region	-
Reporting	Sufficient extractable data (population, design, outcomes, risk factors)	Insufficient data; unclear dentist-specific results
Duplicates	Most complete/primary report retained	Duplicates; secondary analyses without novel outcomes

3. Were published in English. The review excluded studies that aggregated dentists with other healthcare professionals without disaggregated data, as well as review articles, editorials, letters, and grey literature (e.g., dissertations or conference abstracts).

Table 2 summarises the inclusion and exclusion criteria.

Study selection occurred in two stages: 1) title/abstract screening; followed by 2) full-text review. Two authors (SJ and NB) independently screened articles by title/abstract for relevance and then assessed the full-text articles that met the inclusion criteria or where eligibility was unclear. The reviewers resolved disagreements through discussion; when unresolved, a third reviewer (MH) adjudicated.

Fig. 1 PRISMA flow diagram of article selection



Two authors (SJ and NB) extracted data from each included study using a standardised data extraction form. Extracted data included author(s), year of publication, country of study, study design, sample size, population characteristics (including age range), key outcomes (e.g., suicide deaths, suicidal ideation, suicide attempts), identified risk factors, and main conclusions. The extracted data were tabulated in a summary table and analysed thematically. A third reviewer (MH) audited the selection process and summary table to ensure accuracy and consistency.

Given the heterogeneity of the study designs, outcome measures, and populations, a meta-analysis or formal risk-of-bias assessment was not appropriate. Instead, a narrative, descriptive synthesis was used to present the findings. This approach enabled the identification of common patterns, key differences, and notable trends across time and regions. Findings were organised by core themes: suicide prevalence, risk factors, and temporal or geographic patterns.

## Results

The database search identified a total of 279 records. After removing 118 duplicates, 161 unique records remained. Applying the predefined inclusion and exclusion criteria at title/abstract screening, 140 records were excluded (e.g., irrelevance, no full text), and seven additional records were excluded after full-text review, resulting in 14 included studies (Fig. 1). Figure 1 presents the PRISMA-ScR flow diagram of study selection and reasons for exclusion.

### Represented studies

This scoping review identified 14 studies representing research from Australia, Austria, Denmark, Norway, South Africa, Sweden, the USA and the UK. The publication dates ranged from 1960 to 2024, offering a broad perspective on suicide and suicidal ideation within the dental profession. Findings varied by region, time period, and design (Table 3) While three studies<sup>13,18,19</sup> reported elevated suicide risks among dentists, two studies<sup>20,21</sup> found rates comparable to or lower than those

in the general population or among other healthcare professionals.

### Suicide rate

Retrospective studies examining suicide mortality among dentists revealed mixed results. For example, Dalum *et al.*<sup>20</sup> (Norway) reported lower suicide rates among dentists than veterinarians, physicians, and pharmacists, and lower than the general population without higher education. Similarly, Pilgrim *et al.*<sup>22</sup> (Australia) and Zimmermann *et al.*<sup>21</sup> (Austria) found no statistically significant increase versus the general population. In contrast, multiple US studies suggested a heightened risk: Stack<sup>13</sup> estimated a 564% higher risk than the general population after sociodemographic adjustment and Ji *et al.*<sup>23</sup> found a 79% higher rate versus the general population, though lower than surgeons and other physicians.

### Temporal trends

Temporal trends emerged, suggesting a decline in recent decades. Roberts *et al.*<sup>24</sup> observed a 59% reduction in England from 1979 to 2005, attributed to enhanced mental-health support and prevention. Stefansson *et al.*<sup>25</sup> noted Swedish rates peaking in the 1970s and declining by the 1980s, likely reflecting improved working conditions and national initiatives.

### Suicide ideation

Studies focusing on suicidal ideation and non-fatal attempts also provided important insights. Hopcraft *et al.*<sup>26</sup> (Australia) reported 31.4% lifetime ideation, and 5.6% lifetime attempts among dentists. Möller *et al.*<sup>27</sup> (South Africa) found severe ideation over twice as common in private practitioners (10.23%) versus non-private (4.76%), highlighting workplace influences.

### Risk factors

Across studies, several recurrent risk factors were identified. Occupational stress emerged as a predominant contributor, appearing in nearly all studies. Factors such as high workload, financial pressure, professional isolation, and perceived low occupational status were commonly associated with psychological distress.<sup>28</sup> Access to lethal means was frequently cited as a significant risk factor, as dentists often have access to potent drugs and tools that could be used for self-harm.<sup>12,29</sup> Mental health challenges, particularly depression and burnout, were also strongly linked to suicide risk in this population.<sup>21,22</sup>

Table 3 Study summaries

Study	Country	N (age)	Design	Outcomes	Key factors	Main finding
Dalum <i>et al.</i> , 2024 <sup>20</sup>	Norway	Not reported	Retrospective	Suicide rates	Occupational stress; mid-career; lethal means; male sex	Dentists had lower suicide rates than veterinarians, physicians, pharmacists, and the less-educated general population
Hawton <i>et al.</i> , 2011 <sup>29</sup>	Denmark	20,826 (18–67)	Retrospective	Suicide rates	Lethal means; male sex	>2× risk versus general population and teachers; declined over time
Hem <i>et al.</i> , 2005 <sup>18</sup>	Norway	15,705 (20+)	Retrospective	Suicide rates	Mid-career; lethal means; substance use	Male dentists elevated (second to physicians); no increase for females.
Hilliard-Lysen <i>et al.</i> , 1988 <sup>28</sup>	USA	25 (26–60)	Qualitative	Suicide and ideation	Occupational/financial/psych stress; mid-career; male sex	Economic pressure and low perceived status linked to stress → depression, substance use, family strain
Hopcraft <i>et al.</i> , 2023 <sup>26</sup>	Australia	1,474 (<30-61+)	Cross sectional	Ideation and attempts	Occupational stress; mid-career; male sex; mental illness; substance use	31.4% reported past ideation; 5.6% had attempted at least once
Ji <i>et al.</i> , 2020 <sup>23</sup>	USA	170,030 (24–98)	Retrospective	Suicide rates	Mid-career; male sex; mental illness; substance use	79% higher risk versus general population; lower than surgeons and non-surgical specialties
Möller <i>et al.</i> , 1996 <sup>27</sup>	South Africa	311	Observational	Ideation	Financial/occupational stress; mental illness; marital factors	Severe ideation: private practice 10.23% versus non-private 4.76%
Petersen <i>et al.</i> , 2008 <sup>12</sup>	Austria	2,627 (21–65)	Retrospective	Suicide rates	Occupational stress; mental illness; male sex; substance use; financial; lethal means	Most male dentists did not have elevated risk versus general population
Pilgrim <i>et al.</i> , 2017 <sup>22</sup>	Australia	404 (18–79)	Retrospective	Drug-related deaths and suicide	Mental illness; occupational stress; substance use; lethal means; financial	Lower drug-related mortality and suicide versus other health professionals; stress and medication access remain risks
Roberts <i>et al.</i> , 2012 <sup>24</sup>	England	4,551	Retrospective	Suicide rates	Lethal means; occupation; mental illness; male sex	Suicide rates among dentists fell 59% from 1979–2005, attributed to better support/ prevention
Simpson <i>et al.</i> , 1983 <sup>19</sup>	USA	16,406 (24+)	Retrospective	Suicide rates	Mid-career; occupation	Iowa dentists 24–44 and >65 had higher rates versus general population; middle-aged slightly lower
Stack, 2004 <sup>13</sup>	USA	15,025 (21–64)	Retrospective	Suicide rates	Occupation; male sex; race; marital status; mental illness	5.64× higher risk versus general population after adjustment; points to occupational stress
Stefansson <i>et al.</i> , 1991 <sup>25</sup>	Sweden	18,887 (0–64)	Retrospective	Suicide and undetermined deaths	Male sex; age; mental illness; occupational stress; lethal means	Elevated for both sexes; peak in 1970s, decline in 1980s likely from improved conditions/ policies
Zimmermann <i>et al.</i> , 2023 <sup>21</sup>	Austria	224 (0–65)	Retrospective	Suicide rates	Male sex; occupational stress; mental illness; substance use	Male dentists below average risk; female dentists higher; overall no significant increase versus general population

### Sex and age

Sex and age effects were also evident. Male dentists generally showed higher suicide rates than female dentists, though recent evidence suggests an elevated risk among women as well.<sup>18,21</sup> Age patterns varied; Simpson *et al.*<sup>19</sup> reported higher suicide rates in younger (24–44 years old) and older (65+ years old) dentists, suggesting a possible U-shaped distribution of risk across the lifespan. Substance use appeared repeatedly as both a coping mechanism and a risk amplifier for suicide.<sup>18,22</sup>

### Professional comparisons

When comparing dentists to other professional groups, results were mixed. Dalum *et al.*<sup>20</sup> and Pilgrim *et al.*<sup>22</sup> noted lower suicide rates for dentists than other health professionals (e.g., physicians and veterinarians), whereas other studies concluded dentists face a higher risk than the general population, particularly

when occupational stress and mental health needs go unaddressed.<sup>13,29</sup>

## Discussion

### Overview of findings

This scoping review examined suicide and suicidal ideation in the dental profession across diverse global contexts. Overall, the findings present a heterogeneous, evolving picture. Although the studies included in the review consisted of register-based data and survey-based information, it is unclear how suicide was defined or counted in these studies. Differences in data collection and reporting standards may have impacted comparisons among the studies. While some studies suggest that dentists have elevated suicide rates compared to the general population, others indicate lower or comparable rates, especially in recent years.<sup>12,18</sup> The literature demonstrates that suicide risk in the dental profession is multifactorial

(occupational, psychological, demographic), with variation by era and regions.<sup>21,28</sup>

A consistent theme across studies is the impact of occupational stress. Dentistry is characterised by the need for technical precision, intensive patient-facing work, financial strain (notably in private practice), and professional isolation. The clinician-owner role, often without multidisciplinary support, exacerbates these stressors. Studies by Hilliard-Lysen *et al.*<sup>28</sup> and Hopcraft *et al.*<sup>26</sup> link chronic occupational stress to burnout, depression, and suicidal ideation.

### Access to means and mental health stigma

Dentists' ready access to controlled sedation and anaesthesia agents can increase the lethality of suicide attempts.<sup>22,24</sup> Clinical familiarity with dosing, storage procedures, and in-office inventories may lower barriers to access, and solo/small-practice settings

can further heighten exposure. When paired with untreated mental health conditions or substance misuse, risk is further elevated.<sup>22,25</sup> Mitigation should emphasise safety practices in dental settings – secure storage, restricted access, routine inventory reconciliation, and clear diversion-reporting pathways – alongside proactive screening, brief intervention, and referral to care.

Mental health stigma remains a major barrier to help-seeking in the dental community. Fear of professional repercussions, licensure issues, or reputational harm may prevent dentists from disclosing distress or accessing care.<sup>22,23</sup> Underreporting likely biases estimates downward. Confidential, non-punitive access options (e.g., employee assistance programmes, clinician-health programmes, anonymous counselling) and clear 'safe-harbour' licensing language that distinguishes treatment-seeking from impairment might reduce stigmatisation and increase uptake. Training leaders and staff in gatekeeper skills, routine debriefing after adverse events, and peer-support networks can further reduce barriers. Encouraging temporal trends in the UK and Sweden show a marked decline in suicide rates among dentists over time, which may reflect sustained investment in these structural supports and workplace mental health strategies.<sup>24,25</sup>

### Sex and age dynamics

Sex and age emerged as salient modifiers of risk. Historically, male dentists experienced higher risk, but recent evidence indicates a rising risk among women.<sup>29</sup> Contributors may include disproportionate caregiving burdens, harassment/discrimination, and pressure to sustain productivity while navigating pregnancy, perinatal mental health needs, or return-to-work; conversely, masculine norms may suppress help-seeking among men.<sup>30</sup> This may reflect workforce shifts and role strain. Younger (<44 years old) and older (>65 years old) dentists appear more vulnerable, potentially due to early-career transition stress and late-career burnout, declining health, or support.<sup>31</sup> Early-career factors include educational debt, building a patient base, transition to ownership, and impostor feelings; late-career factors include physical strain, fine-motor decline, succession planning, and identity changes approaching retirement.<sup>32</sup> Risk also varies by practice model (solo versus group), sector (public versus private), and geography (rural/remote), indicating the need for stage- and context-specific prevention.<sup>33</sup>

These findings underscore the need for tailored interventions by sex and career stage. Examples include mentorship, flexible scheduling, childcare support, confidential care pathways, and routine screening around key transitions (residency/specialty training, ownership changes, parental leave, and pre-retirement).

### Future research directions

Several gaps warrant attention. First, there is a lack of recent, high-quality studies from low- and middle-income countries; future work should broaden geographical and practice diversity. Second, prospective longitudinal research is needed to track changes over time and to evaluate intervention impact. Third, in-depth qualitative work could elucidate lived experiences that quantitative data cannot capture. Finally, rigorous evaluations of dentist-specific interventions are needed to identify evidence-based best practices.

### Limitations

While this scoping review provides a comprehensive overview of the literature, it is important to note its limitations. First, the review included only English-language, peer-reviewed studies, which may have excluded relevant research published in other languages or grey literature. Second, substantial methodological heterogeneity among studies, ranging from large-scale retrospective studies to small qualitative reports, limits the ability to directly compare findings or conduct a meta-analysis. Suicide is also a sensitive and often underreported topic, which may have led to underestimation of actual rates or biased reporting. Furthermore, several studies did not differentiate between dentists and other healthcare workers or failed to account for confounding variables such as pre-existing mental health conditions or socio-economic status. Finally, recent, regionally diverse data are limited, with most studies from high-income countries.

### Public health implications

The findings underscore system-level changes to better support dental professionals' mental health. Dental education should embed structured training and normalise open dialogue. Professional bodies and regulators should uncouple help-seeking from punitive consequences. Workplace-level interventions are essential: practices, especially solo/private settings, should foster openness and provide clear access pathways. Peer

support, flexible scheduling, and evidence-based stress-management tools can mitigate burnout. At the policy level, strengthening controlled-substance protocols and enhancing occupational health surveillance may aid early detection and prevention

### Conclusion

Suicide in the dental profession is multifactorial, shaped by occupational stress, access to lethal means, and mental health stigma. Despite improvements in some regions, research gaps persist. Addressing these issues requires profession-wide action to reduce stigma, enhance supports, and tailor interventions. In addition to the dental profession, broader research indicates that other healthcare worker groups also face an elevated suicide risk. These occupations need continued research to better address the increased risk of suicide. Policy and research should embed mental health as a core element of dental practice and workforce sustainability.

#### Ethics declaration

*The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. Ethical approval was not required for this study as it was a review of published research and did not involve any intervention, or identifiable human data. Informed consent was not required for this study since it did not involve human participants, patient data, or identifiable personal information.*

#### Data availability

*This study was a scoping review based on published literature. All data found in the study were available through the databases (PubMed, Scopus, Web of Science, and Dentistry and Oral Sciences Source) described in the Methods section. No new data were generated or analysed in this study.*

#### Author contributions

*Conceptualisation, MH and MSL; methodology, MH, AM and MSL; software, MH, AM and CS; validation, MH, AM and MSL; formal analysis, M.H, SJ, NB, AM and MSL; investigation, MH, SJ, NB, AM, CS and MSL; resources, MH; data curation, MH, SJ, NB, AM and CS; writing – original draft preparation, MH, SJ, NB, AM and MSL; writing – review and editing, MH, SJ, NB, AM, CS and MSL; visualisation, MH, SJ, NB, AM and CS supervision, MH; project administration, MH; funding acquisition, MH All authors (AM, CS, MH, MSL, NB, SJ) have read and agreed to the published version of the manuscript.*

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