

Mental Disorders And Oral Diseases: Future Research Directions

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Abstract

The poor physical health (including oral health) of people with mental disorders is a global problem. The burden of oral diseases amongst this group is substantial given their high prevalence and ability to increase the personal, social and economic impacts of mental disorders. This paper summarises causes of mental disorders and oral diseases, critically reviews current evidence on interventions to reduce the burden of oral diseases in people with mental disorders, and suggests future research directions. The relationship between mental disorders and oral diseases is complex due to the shared social determinants and bidirectional interaction mechanisms that involve interconnected social, psychological, behavioural and biological processes. Research has, to date, failed to produce effective and scalable interventions to tackle the burden of oral diseases amongst people with mental disorders. Transformative research and actions informed by a dynamic involvement of biological, behavioural and social sciences are needed to understand and tackle the complex relationship between mental disorders and oral diseases, and inform the design of complex interventions. Examples of future research on complex public health, health service, and social care interventions are provided. The design and testing of these interventions should be carried out in real world settings, underpinned by the principles of coproduction and systems thinking, and conducted by transdisciplinary team. We propose this starts with setting research priorities and developing complex intervention theory, which we report to support future research to improve oral health and hence physical and mental health in this disadvantaged group.

Key words:

Mental illness, dental diseases, dental care utilisation, multimorbidity, inequalities, research agenda.

Introduction

The poor physical health of people with mental disorders is a global problem (Firth et al. 2019). People with mental disorders have increased risks of physical multimorbidity (such as cardiovascular diseases, diabetes, respiratory diseases and cancers) and reduced access to adequate healthcare (Firth et al. 2019). These physical health inequalities increase the personal, social and economic burdens of mental disorders borne across the life course and drastically reducing life expectancy (Firth et al. 2019). For example, people with severe mental illness (SMI) have up to 60% higher chances of dying prematurely (WHO 2013). They die 10–20 years younger than the general population in high-income countries, and 30 years younger in low-income countries. The majority of this mortality is due to preventable and treatable chronic conditions.

Oral diseases are part of the physical multimorbidity experienced by people with mental disorders. Despite this, very little is known about effective and scalable interventions to tackle such a burden. To address this gap, this paper discusses future transformative directions for research to address comorbid oral diseases in people with mental disorders. This will take a stepwise approach. We initially define mental disorders and highlight their increasing global burden. Next, we summarise the burden of oral diseases amongst people with mental disorders; and outline the shared social determinants and bidirectional interaction mechanisms between mental disorders and oral diseases. Then, we provide an overview of evidence on interventions designed to tackle oral diseases in people with mental disorders. Finally, we suggest actions to advance dental research to deal with the burden of oral diseases in this group of people.

What are mental disorders?

Mental disorders are syndromes characterised by clinically significant disturbances in an individual's cognition, emotion regulation, or behaviour that reflects a dysfunction in the psychological, biological, or developmental processes underlying mental functioning (American Psychiatric Association 2013). Clark et al. (2017) provided a critical review of the three international systems that are currently in use to classify and define what mental disorders consist of. For the purpose of this review, the focus will be on common mental disorders (CMD) and SMI. CMDs

1 include depression, generalised anxiety disorder, panic disorder, obsessive-
2 compulsive disorder, post-traumatic stress disorder and simple phobias (Kendrick
3 and Pilling 2012). SMI is a group of primarily psychotic disorders that are chronic and
4 associated with complex needs (Ruggeri et al. 2000). They include schizophrenia,
5 schizoaffective disorder, bipolar affective disorder and other non-organic psychotic
6 disorders. Sometimes major depression is included within SMI. The term 'mental
7 disorders' is used hereafter to refer to CMD and SMI.

9 **Burden of mental disorders**

10 The burden of mental disorders is an increasingly major public health problem
11 globally (GBD 2019 Mental Disorders Collaborators 2022). Mental disorders
12 accounted for nearly 5% of the global burden of disease (measured in disability-
13 adjusted life-years, DALYs) and 15% of years lived with disability (YLDs). The top
14 causes of the global burden of mental disorders were: depressive disorders, anxiety
15 disorders, schizophrenia, personality disorders and bipolar disorder.

17 **Burden of oral diseases in people with mental disorders**

18 Evidence on the higher prevalence of oral diseases in people with mental disorders
19 has been recently synthesised in an umbrella review of eleven meta-analyses (Choi
20 et al. 2021). For example, compared with the general population, people with
21 depression and anxiety have significantly higher experiences of decayed teeth and
22 tooth loss (DMFT mean difference (MD): 0.76; odds ratios (OR): 1.32, respectively).
23 Levels are highest in people with SMI compared to the general population (DMFT
24 MD: 4.96; OR: 2.81, respectively). Findings for periodontal disease were equivocal.
25 Incidence of oral cancer in people with mental disorders was not higher than that in
26 the general population.

28 Oral diseases can increase the rates of mortality and morbidity, and thereby the
29 personal, social and economic burdens of mental disorders. In terms of increased
30 rates of mortality, evidence showed that oral cancer patients with mental disorders
31 had nearly a two-time increased risk of death compared to their counterparts without
32 mental disorders (Chang et al. 2013). Although oral cancer incidence in people with
33 mental disorders is not higher than that in the general population, they are more

likely to have late detection, leading to more advanced staging at diagnosis, and less likely to receive specialised cancer treatments (Chang et al. 2013).

Oral diseases can have profound impacts on the quality of life of people with mental disorders. They may lead to pain, functional limitations, physical, psychological and social disabilities and handicap. Few studies have reported on the impacts that oral conditions have on the quality of life of people with SMI (Denis et al. 2020; Patel and Gamboa 2012). Tooth loss and xerostomia were of particular interest in these studies. The most frequently reported impacts of oral diseases were pain and discomfort on eating, which were translated into physical disabilities related to difficulties in eating (Patel and Gamboa 2012). Other reported functional limitations were difficulties in speaking, smiling and tasting. Oral pain together with the abovementioned functional limitations and resultant physical disabilities were accompanied by reported psychological discomfort and disabilities, including the inability to relax or have a satisfactory diet and having meal interruptions (Patel and Gamboa 2012). Difficulties in eating can be especially problematic in the presence of motor movement abnormalities related to the extra-pyramidal effects of antipsychotic medication.

Oral diseases bear substantial financial costs to the wider healthcare system and society. For example, dental conditions are the third most common reason for preventable hospital admissions in people with mental disorders (Jayatilleke et al. 2018). People with mental disorders were 72% more likely to experience avoidable dental presentations at the emergency department including toothache, dental abscess, stomatitis and gum disease compared to their counterparts without mental disorders (Kisely et al. 2021).

Causes of mental disorders and oral diseases

Mental disorders and oral diseases are closely interconnected and have a dose-response relationship (O'Neil et al. 2014). Interestingly, mental disorders and oral diseases share the same broader social and intermediate determinants and are the product of the interplay amongst social, psychological, behavioural and biological processes (Gomaa et al. 2019; Marmot et al. 2020; Peres et al. 2019). Furthermore,

1 mental disorders and oral diseases can also interact with each other through several
2 bidirectional social, psychological, behavioural and biological pathways.

3
4 Understanding these bidirectional interaction mechanisms holds a specific
5 significance, as it would place oral diseases firmly within the global multimorbidity
6 research agenda (Watt and Serban 2020). Unfortunately, much of the available
7 evidence on these mechanisms has limitations including cross-sectional designs,
8 high risk of selection bias and lack of ability to control for unobserved confounders.
9 Recent studies have addressed some of these shortcomings by adopting new
10 approaches, such as the instrument variable approach, and found that tooth loss
11 may causally increase depression (Matsuyama et al. 2021). Furthermore, a recent
12 experimental study reported improved treatment outcomes in people with substance
13 use disorders following comprehensive dental care encompassing dentition
14 restoration and oral rehabilitation. This included treatment completion, increased
15 employment, drug abstinence and a reduction in homelessness (Hanson et al.
16 2019). Such findings lend support to the potential benefit of comprehensive dental
17 care provision to the treatment outcomes in other mental disorders such as SMI and
18 depression. The following provides a summary on shared social determinants and
19 bidirectional interactions mechanisms between oral diseases and mental disorders.

20 21 *Shared social determinants*

22 There are several models of the social determinants of mental disorders, oral
23 diseases and the underlying social, psychological, behavioural and biological
24 processes (Marmot et al. 2020; Peres et al. 2019). Both mental disorders and oral
25 diseases share the same social determinants such as poverty, unemployment and
26 social capital. In these models, macro structural and commercial determinants, such
27 as policies and commercial powers, influence the intermediate determinants such as
28 socioeconomic position, living and working conditions, psychosocial factors and
29 healthcare services. These, in turn, affect proximal determinants such as health
30 behaviours, microbiome, genetics, exposure to pathogens or injuries,
31 neuroendocrine, autonomic and immune responses, and medication (Figure 1). Age,
32 ethnicity and gender intersect with these intermediate and proximal determinants
33 adding to the complexity and creating variations in risks for mental disorders and oral
34 diseases amongst different subgroups.

Oral diseases as causes of mental disorders

Oral diseases can be a risk and prognostic factor for mental disorders through the following mechanisms: (i) neuroinflammation, (ii) secondary chronic psychological stress via impacts on quality of life, discrimination and stigma, and (iii) poor nutrition (Figure 2).

Oral diseases might induce neuroinflammation by three possibilities: inducing chronic systemic inflammation, direct invasion of oral bacteria or bacterial molecules to the brain via a more permeable blood-brain barrier, and communication between oral bacteria or bacterial molecules and brain-resident microglia through the leptomeninges (Hashioka et al. 2019). For example, oral inflammation sites were found to release inflammatory mediators (including pro-inflammatory cytokines) into the blood stream, which can induce chronic systemic inflammation (Hajishengallis 2015). There is growing evidence of a contribution of the latter to neuroinflammation implied in depression and schizophrenia (Miller and Raison 2016; Muller 2018). Neuroinflammation can also occur at advanced stages of periodontal diseases or oral abscess when oral bacteria and/or their toxins manage to invade the blood and/or cranial nerves (Hashioka et al. 2019). Whilst compelling evidence exists regarding the presence of oral bacterial species in atherosclerotic plaques, more empirical evidence is needed to support the potential role of oral bacteria or bacterial molecules in causing neuroinflammation in mental disorders via direct invasion and/or communication with brain-resident microglia (Chhibber-Goel et al. 2016; Hashioka et al. 2019). Evidence is needed on the role of Oral-Gut-Brain AXIS in mental disorders.

Oral diseases, through their physical, psychological and social impacts, can be debilitating and may lead to lower self-esteem and self-confidence, reduced social interaction and social support and increased loneliness (Davis et al. 2000; Rouxel et al. 2017). These can be precipitating and perpetuating factors for many mental disorders. According to the diathesis-stress model, such chronic stressors can interact with diatheses (e.g. genetic predisposition) to bring about mental disorders (Pruessner et al. 2017). Evidence showed difficulties in speaking, smiling and eating with others may increase the risk of depressive symptoms (Kuroda et al. 2015; Kusama et al. 2021). Compared to other diseases and conditions, society tends to

1 blame disadvantaged people for their oral diseases suggesting a potential for
2 discrimination and stigma relative to dental appearance (Moeller et al. 2015). Such
3 discrimination and stigma may in turn impact job opportunities, social circles and
4 career success, potentially leading to or perpetuating mental disorders. The resultant
5 stigma might also impact access to adequate healthcare, potentially leading to
6 underutilisation, poor quality of medical care and low adherence with treatment
7 recommendations amongst people with mental disorders (Stangl et al. 2019).

8
9 Eating difficulties caused by oral conditions, particularly tooth loss, can reduce intake
10 of nutrients including non-starch polysaccharides, protein, minerals and vitamins
11 (Sheiham et al. 2001). The latter is a risk and prognostic factor for many mental
12 disorders (Stein et al. 2019).

13 14 *Mental disorders as causes of oral diseases*

15 In the opposite direction, mental disorders may cause, or exacerbate, oral diseases
16 through oral health risk behaviours, poor access to adequate dental care,
17 dysregulation of the hypothalamic-pituitary-adrenal and sympathoadrenal medullary
18 axes, and the iatrogenic effects of some psychotropic medications.

19
20 Mental disorders are associated with tobacco and alcohol use, poor diet and oral
21 hygiene. People with mental disorders may use tobacco (nicotine) and alcohol to
22 self-medicate (Stein et al. 2019). Mental disorders such as depression may be
23 associated with sugar craving, eating dysregulation and poor diet (Firth et al. 2020).
24 A recent systematic review concluded that people with SMI were less likely to brush
25 their teeth compared to their counterparts without SMI (Turner et al. 2021). Only 39%
26 of individuals with SMI cleaned their teeth twice a day compared to the 75% reported
27 in the general population (NHS Digital 2009; Turner et al. 2021). Other oral health
28 self-care behaviours such as flossing and mouthwash use were also lower in this
29 group of people (Turner et al. 2021).

30
31 People with mental disorders are less likely to access adequate dental care. Turner
32 et al. (2021) reported in their systematic review that people with SMI were less likely
33 to visit the dentist compared to their counterparts without SMI. Nearly 39% of people
34 with SMI visited the dentist at least annually, far below levels in the general

population (61%) (Center for Disease Control 2020). The under-use of dental services is due to factors related to both demand and supply sides. In the case of the former, people with mental disorders are less likely to seek care and adhere to treatment recommendations. At the same time, dental professionals are not equipped with the required knowledge, skills and attitudes to understand the needs of people with mental disorders and apply the principles of trauma informed care that accommodates for the cognitive changes, emotional dysregulation and/or impulsivity associated with many mental disorders (Scrine et al. 2019). This in turn may lead to stigmatisation of people with mental disorders by dental professionals, with suboptimal care and potentially traumatic experiences such as being treated by tooth extraction rather than more complex preventative and restorative care (Brondani et al. 2017).

Mental disorders can lead to hypothalamic-pituitary-adrenal and sympathoadrenal medullary axes' dysregulation with its cascade of hormonal, neurotransmitters and inflammatory mediators (Stein et al. 2019). This in turn can lead to oral microbiome dysbiosis, impaired immune response, altered salivary phenotype and bruxism, which are risk factors for a wide range of oral diseases such as dental caries, periodontal diseases and tooth wear (Gomaa et al. 2019; Senusi et al. 2018).

Side effects of psychotropic medicines such as antidepressants, the first generation of antipsychotics and mood stabilisers include xerostomia and eating dysregulation, which are risk factors for oral diseases (Correll et al. 2015). Additionally, the side effects of the first generation of antipsychotics include tremulous movements, which can in turn impede oral hygiene (Correll et al. 2015).

Evidence-based interventions to reduce the burden of oral diseases in people with mental disorders

Oral diseases, as risk factors for mental disorders, can be potentially managed through improved self-care behaviours, addressing social inequalities, better information and tailored dental care. Actions to improve oral health are important for self-esteem and self-efficacy and likely to be associated with reduced chronic systemic inflammation, managing diet and weight, being more active and securing

1 more social support with meaningful activities, and thereby might contribute to better
2 mental and general health and quality of life amongst people with mental disorders.

3
4 Interventions to address the burden of oral diseases amongst people with mental
5 disorders may include public health, health service and social care measures. The
6 former can be integrated within early intervention packages and young people
7 mental health programmes (including school-based programmes). Yet, a recent
8 rapid review highlighted the lack of evidence-informed effective school-based
9 behavioural interventions to improve oral health amongst children aged 3-18 years
10 (Shakir et al. 2021).

11
12 Very little is known about evidence-based interventions to tackle oral diseases in
13 people with mental disorders. For example, a Cochrane review concluded that
14 providing oral health education alone for people with SMI does not lead to a clinically
15 meaningful improvement in oral health outcomes (Khokhar et al. 2016). These
16 findings were consistent with the findings of recent evidence syntheses showing
17 educational, behavioural and other combined interventions delivered to people with
18 mental disorders did not have clinically meaningful effects (Kuipers et al. 2021;
19 Macnamara et al. 2021). A summary of these interventions is presented in Table 1.
20 This is not surprising given that the provision of dental health education without
21 addressing the broader causes of oral diseases in disadvantaged groups (such as
22 people with mental disorders) has been found to be ineffective (Watt et al. 2019). It is
23 also possible that more intensive outreach is needed such as the 'Dental as
24 Anything' programme in Melbourne for people with SMI (Burchell et al. 2006).
25 Furthermore, the little consideration of theory in the development and evaluation of
26 these oral health interventions was a major limitation (Macnamara et al. 2021).
27 McGrath (2019) has called to improve the consideration, use and application of
28 behaviour change theories and models in the development and evaluation of
29 interventions to bring about changes in oral health, especially amongst people that
30 require special care. Thus, there remains a need for transdisciplinary research to
31 develop, co-design and test complex interventions within real world settings that are
32 theory-driven and can be deployed by health and social care professionals and by
33 people with mental disorders, their families and communities.

1 Conducting such research is challenging due to multiple barriers such as the
2 required added investments of time and efforts, pushing researchers beyond their
3 comfort zones, discipline-based differences in terminologies, schools of thought and
4 work styles, navigating varied organisational cultures, policies and work processes,
5 and limited funding and publishing venues (Vogel et al. 2014). Yet, funding agencies,
6 academic institutions and scholarly journals can facilitate transdisciplinary research
7 through funding and publishing opportunities and policies on cross-institution
8 collaboration and promotion. Models of transdisciplinary research developed by
9 other fields (e.g. cancer) could be used (Vogel et al. 2014).

11 **Future research directions**

12 Future transformative research is needed to address the burden of oral diseases and
13 reduce related inequalities experienced by people with mental disorders. Behavioural
14 and social sciences can inform such transformative research, as outlined in a recent
15 consensus statement (McNeil et al. 2022). For example, further research is needed
16 to understand more comprehensively the bidirectional mechanisms between mental
17 disorders and oral diseases (including potential syndemic effects), and how shared
18 social determinants intersect with these. Whilst future prospective longitudinal
19 quantitative research can support addressing this research gap, qualitative research
20 has a unique contribution. This is due to the complexity of these mechanisms and
21 their intersectionality with shared social determinants, a matter that quantitative
22 research fails to adequately address. Additionally, biological sciences could further
23 our understanding of the pathways via which oral diseases might cause
24 neuroinflammation.

26 Due to the aforementioned complexity, tackling the burden of oral diseases in people
27 with mental disorders requires complex interventions, examples of which are
28 summarised in Table 2. Designing and testing complex public health, health service
29 and social care interventions should be carried out in real world settings,
30 underpinned by the principles of coproduction and systems thinking, and conducted
31 by a transdisciplinary team including, but not limited to, public health, psychiatry,
32 psychology, special care dentistry and primary care (McNeil et al. 2022). Examples
33 of such transdisciplinary initiatives are “Closing the Gap” Network in England and the
34 ALIVE programme in Australia (ALIVE 2021; Gilbody et al. 2018). These projects

foster transdisciplinary and participatory approaches to co-design and evaluate interventions to improve mental health through evidence-based strategies for improving physical health and addressing behavioural, psychological, environmental and other determinants. This includes oral and mental health. Behavioural and social sciences play a role in designing and evaluating such complex interventions, starting with setting research priorities (key uncertainties) and developing theory for complex interventions. The following elaborates on these two transformative actions.

Setting research priorities for complex interventions

Setting research priorities through a systematic and transparent process can assist policy makers and research funding agencies in making investment decisions to fund important uncertainties that are relevant to the needs of people with mental disorders (Chalmers et al. 2014). One example is the on-going 'RESTART dental care' project, which brings together people with mental disorders, their carers, clinicians (of all levels) and other partners to identify and prioritise uncertainties, or 'unanswered questions', about dental care for this population. It aims to form a list of top ten questions for future research to answer and follows the methods of James Lind Alliance Priority Setting Partnerships, drawing on the strengths of several prioritisation tools such as online surveys and nominal group technique (The James Lind Alliance 2021).

Besides bringing consensus on research questions, priority setting processes can act as an advocacy tool to bring about changes in the priorities and commitments of mental and dental research funding organisations, commissioners, senior policymakers, charities and foundations (Chalmers et al. 2014). Furthermore, it can provide opportunities for mutual learning between different stakeholders and facilitate establishing transdisciplinary partnerships (Chalmers et al. 2014).

Developing complex intervention theory

An intervention theory is not a psychology or sociology theory. It is rather a pragmatic framework to describes how an intervention is expected to lead to its effects and under what condition (Skivington et al. 2021). It articulates the key components of the intervention and how they interact, the intervention's mechanisms of change, and how these mechanisms might influence and be influenced by the

1 features of the context within which the intervention is taking place. Developing
2 theory for complex interventions to tackle oral diseases in people with mental
3 disorders should follow a systematic process that draws on stakeholders' input as
4 well as on considering and using appropriate behaviour change theories and/or
5 models and research evidence from relevant disciplines (Glanz and Bishop 2010).
6 One example is the ongoing feasibility study to develop an intervention using mental
7 health support workers as mental health support workers to improve dental
8 attendance in people with SMI (Palmier-Claus et al. 2022). Whilst different
9 approaches to evidence synthesis to support developing intervention theory exist,
10 the use of realist reviews seems to be on the rise. The latter unravel what works for
11 whom and in what context (Pawson et al. 2005). Indeed, Kenny et al. (2020) called
12 for the use of realist reviews to inform the development of oral health interventions in
13 people with mental disorders.

15 **Conclusion**

16 The burden of oral diseases amongst people with mental disorders is substantial.
17 The shared social determinants and bidirectional interaction mechanisms between
18 mental disorders and oral diseases are complex. Current dental research has failed
19 to design effective and scalable interventions to tackle the burden of oral diseases
20 amongst people with mental disorders. Future transformative research informed by
21 biological, behavioural and social sciences were suggested to understand the
22 complex relationship between mental disorders and oral diseases and inform the
23 design of complex public health, health service and social care interventions to
24 improve oral health, and hence physical and mental health in this disadvantaged
25 group.

27 **Author Contributions**

28 E. Joury and K. Bhui, contributed to conception, design, data acquisition, analysis,
29 and interpretation, drafted and critically revised the manuscript; S. Kisely, contributed
30 to data acquisition, analysis, and interpretation, drafted and critically revised the
31 manuscript; R.G. Watt, J. Morris and F. Fortune contributed to data analysis, and
32 interpretation, and critically revised the manuscript; N. Ahmed, contributed to data
33 analysis, and interpretation, drafted and critically revised the manuscript. All authors
34 gave final approval and agree to be accountable for all aspects of the work.

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Table 1. Summary of oral health interventions in people with mental disorders identified in previous evidence syntheses.

<p>Oral health education delivered to people with mental disorders and/or their nursing staff by researchers or trained personnel (e.g. dental hygienists) using different delivery modes (e.g. video or slide show) with or without one or more of the following:</p> <ul style="list-style-type: none"> • Oral hygiene training • Oral health educational materials • Powered or manual toothbrush, toothpaste and/or mouthwash • Reminder system • Monitoring system • Motivational interviewing • Reinforcement • Incentive • List of local dentists and dental charge exemption form
Reinforcement therapy
Dietary change (provision of 2 mangosteen fruits daily) and non-surgical periodontal treatment
Completing an oral health checklist by mental care coordinators about current oral health conditions and routines, and provision of an oral hygiene information sheet including information on how to find a dentist.

Table 2. Examples of future research on complex interventions to improve oral health in people with mental disorders.

Examples of public health interventions
<ul style="list-style-type: none"> • Impact of sugar taxation on reducing oral health inequalities experienced by people with mental disorders • Impact of water fluoridation on reducing oral health inequalities experienced by people with mental disorders • Oral health interventions integrated within young people mental health programmes and early intervention packages
Examples of health service interventions
<ul style="list-style-type: none"> • Including oral health in regular physical health checks for people with mental disorders • Designing integrated referral pathways between mental health and dental services • Designing financial models to incentivise mental health services to include oral health within patient's care plan • Designing financial models to incentivise dental services for reasonable adjustments required for managing patients with mental disorders • Designing service models for delivering evidence-based prevention and oral health stabilisation care for people with mental disorders • Oral cancer screening for people with severe mental disorders • Oral health training packages for mental health workforce • Mental health training packages for dental workforce
Examples of social care interventions
<ul style="list-style-type: none"> • Healthy food and drink policy in residential mental health services and day centres • Toothbrushing and fluoridation schemes in residential mental health services and day centres • Training carers and peer support workers on supporting oral health in people with mental disorders.

Figure Legends

Figure 1. Shared social determinants of mental disorders and oral diseases with social, psychological, behavioural and biological linking pathways.

¹ Hypothalamic-pituitary-adrenal (HPA) axis

² Sympathoadrenal medullary (SAM) axis

Examples provided in the model are not exhaustive

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Figure 2. The bidirectional interaction mechanisms between mental disorders and oral diseases.

¹ Hypothalamic-pituitary-adrenal (HPA) axis

² Sympathoadrenal medullary (SAM) axis

Examples provided in the model are not exhaustive

(R) reinforcing loop; (+) polarity of the relationship between the variables

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