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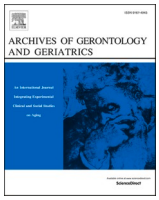

Review

Oral frailty dissected and conceptualized: A scoping review

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ABSTRACT

Objectives: The aim of this scoping review was threefold: 1. to identify existing definitions of oral frailty and similar terms in gerodontology literature; 2. to assess the oral frailty definitions and analyze whether these are well formulated on a conceptual level; and 3. in the absence of existing definitions meeting the criteria for good conceptual definitions, a new conceptual definition of oral frailty will be presented.

Methods: A search was performed in electronic databases and internet search engines. Studies explaining or defining oral frailty or similar terms were of interest. A software-aided procedure was performed to screen titles and abstracts and identify definitions of oral frailty and similar terms. We used a guide to assess the quality of the oral frailty definitions on methodological, linguistic, and content-related criteria.

Results: Of the 1,528 screened articles, 47 full-texts were reviewed. Thirteen of these contained seven definitions of oral frailty and ten definitions of similar terms. We found that all definitions of oral frailty contain the same or equivalent characteristics used to define the concepts of 'oral health', 'deterioration of oral function', and 'oral hypofunction'. Between the seven definitions, oral frailty is described with a different number and combination of characteristics, resulting in a lack of conceptual consistency. None of the definitions of oral frailty met all criteria.

Conclusion: According to our analysis, the current definitions of oral frailty cannot be considered 'good' conceptual definitions. Therefore, we proposed a new conceptual definition: *Oral frailty is the age-related functional decline of orofacial structures.*

1. Introduction

Worldwide, the proportion of older adults in the population will steadily increase. According to the World Health Organization,(World Health Organization, 2018) nearly 434 million people will be 80 years and older by 2050.

For many people, aging comes with health problems, care dependency, and an elevated frailty risk (Abdi et al., 2019; Longobucco et al., 2019; Suzuki, 2018). According to Gobbens et al. (2010), frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (viz., physical, psychological, social) that are caused by the influence of a range of variables and which increases the risk of adverse outcomes. In their review, Clegg et al. (2013) clearly illustrate this risk by explaining that a seemingly minor event (e.g., a new drug, a "minor" infection, or a "minor" surgery) can lead to a disproportionate change in health status; potentially

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transforming an older person from independent to dependent. Frailty and care dependency are often accompanied by a higher need for oral hygiene support because many dependent older adults have difficulty taking care of their mouth (Chen et al., 2019; Hayes et al., 2016; Petersen et al., 2010; Shin & Choi, 2019). Formal and informal caregivers must often deal with a combination of natural teeth, dental restorations, crowns, bridges, dental implants, and implant-supported prosthetics. These multiform dentition types are becoming more common among older adults (Allen, 2019; Bakker et al., 2021; Müller, 2014; Müller et al., 2017; Polzer et al., 2010). Since it is not easy for caregivers to take care of another person's mouth, it is often left unattended (Delgado et al., 2016; Jones et al., 2019; Petti, 2018). In addition, professional oral health care is less accessible to some frail older adults due to mobility limitations and a reduced physical condition. In many cases, this leads to a decrease in dental service use and oral health deterioration (AlZarea, 2017; Niesten et al., 2017). Consequently, the oral health of this older population is mostly poor.(Chalmers & Ettinger, 2008; Delwel et al., 2017; Farias et al., 2020; Murray Thomson, 2014; Petersen et al., 2010; Petersen & Yamamoto, 2005) Globally, the prevalence of coronal dental caries, root surface caries, periodontal disease, tooth loss, halitosis, xerostomia, oral pain, and orofacial discomfort is high in the population of frail older adults (Petersen et al., 2010; Petersen & Yamamoto, 2005). Moreover, the oral health of older people with dementia is worse when compared to older people without neurodegenerative diseases (Delwel et al., 2017; Dioguardi et al., 2019; Nakamura et al., 2021). According to Weijenberg et al. (2019), a bidirectional relationship may exist between cognition and oral health. All of this emphasizes that although highly complex, it is crucial to maintain good oral health in frail older adults. The consequences of poor oral health are most pronounced in frail older adults, negatively impacting overall health and quality of life.(Aida et al., 2012; da Mata et al., 2019; Niesten et al., 2016; Puturidze et al., 2018; van de Rijt et al., 2020; van der Putten et al., 2014; Weijenberg et al., 2019) The aforementioned underlines the fact that good solutions to problems in geriatric oral care are still absent.

In gerodontology research, there is a strong emphasis on measuring and reporting the oral health of older adults and its relationship to general health. Unfortunately, there is less attention for defining key concepts and theory-building in this domain, which are instrumental in explaining and understanding the oral health of older adults and its impact on general health. However, these concepts and theories enable field professionals and researchers to be more explicit and accurate when referring to the oral health of older adults. Concepts can be defined as abstract terms that specify the features, attributes, or characteristics of a phenomenon in the natural or phenomenological world they are meant to represent and that distinguish them from other related phenomena.(Podsakoff et al., 2016) According to Wacker,(Wacker, 2004) theory is defined as an explained set of conceptual relationships. It is important to note that a theory is as good as its underlying concepts. The notion that conceptual definitions are fundamental in 'good' theory-building and metrics is not new. Bunge stated in 1967 that concepts provide the elements for factual systems, such as classifications and theories.(Bunge, 1967) Conceptual definitions are used in theory-building as they provide definable attributes that can lead to measures of abstract concepts.(Wacker, 2004) However, what is not precisely defined cannot be precisely measured.

Within these premises, it is necessary to appropriately conceptualize the oral health condition of frail older adults to fully understand this phenomenon as well as its characteristics. Clear concept definitions precede the development of measuring instruments(Podsakoff et al., 2016) to quantify oral health and the impact of oral care. A deficiency in conceptual consistency and clarity will lead to the proliferation of different terms for the same concepts. Inconsistent conceptual definitions lead to divergent views and impeded communication among field professionals. They also lead to unwarranted variation in oral health practice, resulting in oral care that is not evidence-based, suited, or safe enough for frail older people.(Wennberg, 2002)

On the other hand, clear concepts enable us to convert complex phenomena into uniform language that eases communication between field professionals and enables scientific and therapeutic advancement in gerodontology. A good theoretical concept of oral health in older people and meaningful measurement instruments would enable us to better understand the relationship between oral health and frailty. In addition, knowledge of the association and the potential pathway between oral health and adverse health outcomes (e.g., high health care utilization, disability, and poor quality of life) could provide new preventive approaches to promote the quality of life of older people.

To describe the oral health condition of frail older adults, several terms have emerged. The term oral frailty has been increasingly adopted in recent years. This term could be at the foundation of understanding the relationship between oral health, frailty, and adverse health outcomes. However, what exactly does the term oral frailty mean from a conceptual standpoint? The development of 'good' conceptual definitions is discussed extensively in the work of Hemple, (Hempel, 1970) Podsakoff et al., (Podsakoff et al., 2016), and Wacker.(Wacker, 2004) To what extent do current definitions of oral frailty meet the criteria for good conceptual definitions? Despite the growing number of works of literature referring to oral frailty and similar terms, a lack of consensus still exists regarding these terms and their conceptual definitions.

This scoping review's aim was threefold: 1. to identify existing definitions of oral frailty and similar terms in gerodontology literature; 2. to assess the conceptual characteristics of oral frailty definitions and to analyze whether these are well formulated on a conceptual level; and 3. in the absence of existing definitions meeting the criteria of a good conceptual definition, we will propose a new conceptual definition of oral frailty. Regarding the second aim, we hypothesized a lack of conceptual consistency, proliferation in the current definitions of oral frailty and similar terms, and that the current definitions do not meet the criteria for 'good' conceptual definitions.

2. Methods

2.1. Study design and research protocol

This scoping review was conducted following the PRISMA-ScR guideline (Tricco et al., 2018) and aimed to examine the use of the term oral frailty and similar terms in gerodontology literature. The research protocol was registered in OSF Registries on January 21, 2021, and can be assessed at https://osf.io/hw57m/.

2.2. Eligibility criteria

Different types of scientific publications containing definitions of oral frailty and terms similar to oral frailty are accessible to and potentially used by professionals in gerodontology and related disciplines. For this reason, all types of scientific publications explaining or defining oral frailty or terms similar to oral frailty used to describe the oral health of older adults were of interest. Non-English articles resulting from the search were selected only if they included an English-language abstract and if the abstract contained the term "oral frailty" or a term similar to "oral frailty". Authors of non-English articles of interest that appeared in the reference list of the selected articles were contacted to inquire if an English abstract or full-text version of the article was available. If not, these articles were translated. Studies containing one or more of these terms were eligible: oral frailty; oral health; oral function; oral hypofunction; decrease in oral function; deterioration of oral function; oral health deterioration; decreasing oral function; decline in oral function; rapid oral health deterioration; decline in oral health; or loss of oral function in relation to old age. Studies focusing on children, adolescents, young adults, adults, middle-aged adults, intellectually disabled people, people with Down syndrome, and people with an acquired brain injury were considered not eligible. Studies focusing on

disease, trauma, prosthodontics, and oral health diseases, such as dental caries and periodontitis, were considered not eligible.

2.3. Search methods and information sources

A comprehensive search was performed in the bibliographic databases PubMed, Embase.com, the Cochrane Library, the Web of Science Core Collection, and Scopus from inception to April 30, 2021, in collaboration with a medical librarian (LS). Search terms included controlled terms (MeSH in PubMed and Emtree in Embase), as well as free text terms. The following terms were used (including synonyms and closely related words) as index terms or free text words: 'oral frailty' or 'oral health' and 'older adults' and 'concept'. The search was performed without language or date restrictions. A manual search using the same free text terms was also performed in Google Scholar and ResearchGate. Duplicate articles were excluded. The full search strategy is provided in appendix B (Table B.1).

2.4. Software-aided screening procedure

Relevant references were imported into a citation management application (Endnote X9.3.1., Clarivate Analytics, Philadelphia, PA, USA). In Endnote, duplicates were removed, and a database containing the titles, authors, and abstracts was generated. This database was imported into a text analysis application (MAXQDA 11.0.3, VERBI Software, Berlin, Germany), which was used for software-aided title and abstract screening. Using keywords and search strings following the literature search, MAXQDA was used to search for literal matches of the relevant keywords in the title and abstract database. This resulted in 12 different search strings in which the relevant keywords were combined with the Boolean operators *AND* or *OR*. By running the search strings in MAXQDA, the reviewers were directed to articles containing the pre-entered keywords. The keywords and search strings used in MAXQDA are provided in appendix B (Table B.2 and B.3). The technical aspects of MAXQDA and the software-aided screening procedure were discussed between the two reviewers (KP and EW). The two reviewers independently assessed the titles and abstracts of the retrieved references. The applicability of each reference was determined by the reviewers, using the eligibility criteria. The reviewers manually labeled the abstracts with one of the following codes in MAXQDA: *include, questionable,* or *exclude*. The reviewers used the code '*include'* when the abstract met the eligibility criteria described above, and '*exclude'* when this was not the case. The code '*questionable'* was used if the reviewer was uncertain whether or not the abstract met the eligibility criteria. After all references were coded, MAXQDA presented a structured overview in an Excel database. The reviewers analyzed the screening results; all discrepancies were discussed and re-assessed. Abstracts coded *'questionable'* were discussed by the two reviewers, and consensus was reached to either include or exclude the abstracts for full-text review. In case of persistent disagreement, a third reviewer (RG) was consulted to assess the abstracts where discrepancies existed. The result would then be discussed by the three reviewers, and a final decision would be made based on the majority.

2.5. Final selection

For the final selection, articles underwent full-text review. The two reviewers independently examined the full-texts. Articles containing definitions of oral frailty or terms similar to oral frailty used to describe the oral health of older adults were selected for data extraction.

2.6. Data extraction and charting

Data from the selected articles were extracted and tabulated. The table format was based on the areas of interest. These include the selected references, by listing the authors' names, publication year, country, design, and the study's aim. Secondly, articles containing definitions of oral frailty, by summarizing the authors' names, publication year, and the definitions, were listed. Finally, the definitions of terms similar to oral frailty were also tabulated by summarizing the authors' names, publication year, and the definitions.

2.7. Data analysis and synthesis of results

To determine whether the definitions of oral frailty are well formulated on a conceptual level, we developed an instrument based on the work of Podsakoff et al. (2016) and Wacker (2004). All ten aspects of Podsakoff et al. and seven of Wacker's eight aspects were used to develop this guide. Wacker's eighth rule, *"Statistical tests for content validity must be performed after the terms are formally defined"*, was omitted since the guide evaluates conceptual definitions separately, not in relation to their operationalization in the literature.

We converged 17 of these 18 original aspects into a 12-item instrument that addresses three methodological aspects, three linguistic aspects, and six content-related aspects. We called this instrument *'Guide for Assessing Conceptual Definitions'*. The three methodological aspects were assessed according to the following items: 1. methodology, 2. dimensionality, and 3. logical fallacy. The three linguistic aspects were analyzed according to the following items: 4. parsimony, 5. familiarity, and 6. ambiguity. The six content-related aspects were analyzed using the following items: 7. essentiality, 8. measurable attributes, 9. differentiability, 10. consistency, 11. antecedents and consequences, and 12. exemplary expressions. A more elaborate description per item is provided in appendix B (Table B.4).

When items 1, 2, and 4–10 are answered 'yes' and items 3, 11, and 12 are answered 'no', the definition meets the criteria for a 'good' conceptual definition (Table A.1). To assess the conceptual consistency of the oral frailty definitions (item 10, Consistency), a separate qualitative analysis was conducted. In this analysis, the characteristics of oral frailty mentioned in the definitions are categorized. This allows for an analysis of how many characteristics are mentioned in each definition and into how many categories these characteristics can be divided. In this way, the degree of similarity (consistency) between the various definitions of oral frailty becomes evident. The definition assessment using the 'Guide for Assessing Conceptual Definitions' was conducted by three researchers KP, EW, and RG. Preceding the definition assessment, these researchers studied the theoretical approach of Podsakoff(Podsakoff et al., 2016) and Wacker(Wacker, 2004) regarding conceptual definitions, discussed how the 'Guide for Assessing Conceptual Definitions' is used, and how each criterion should be interpreted. The assessment was then conducted independently and subsequently discussed. All discrepancies were assessed, and a fourth researcher (FL) was consulted in case of disagreement. The inter-rater reliability was determined by calculating an intraclass correlation coefficient two-way mixed effects model using an absolute agreement definition(Koo and Li, 2016) in IBM SPSS Statistical package version 27 (SPSS Inc, Chicago, IL).

3. Results

3.1. Selection of sources of evidence

The search resulted in a total of 2,778 records (Fig. 1). After removing duplicates, 1,528 records were identified and screened by title

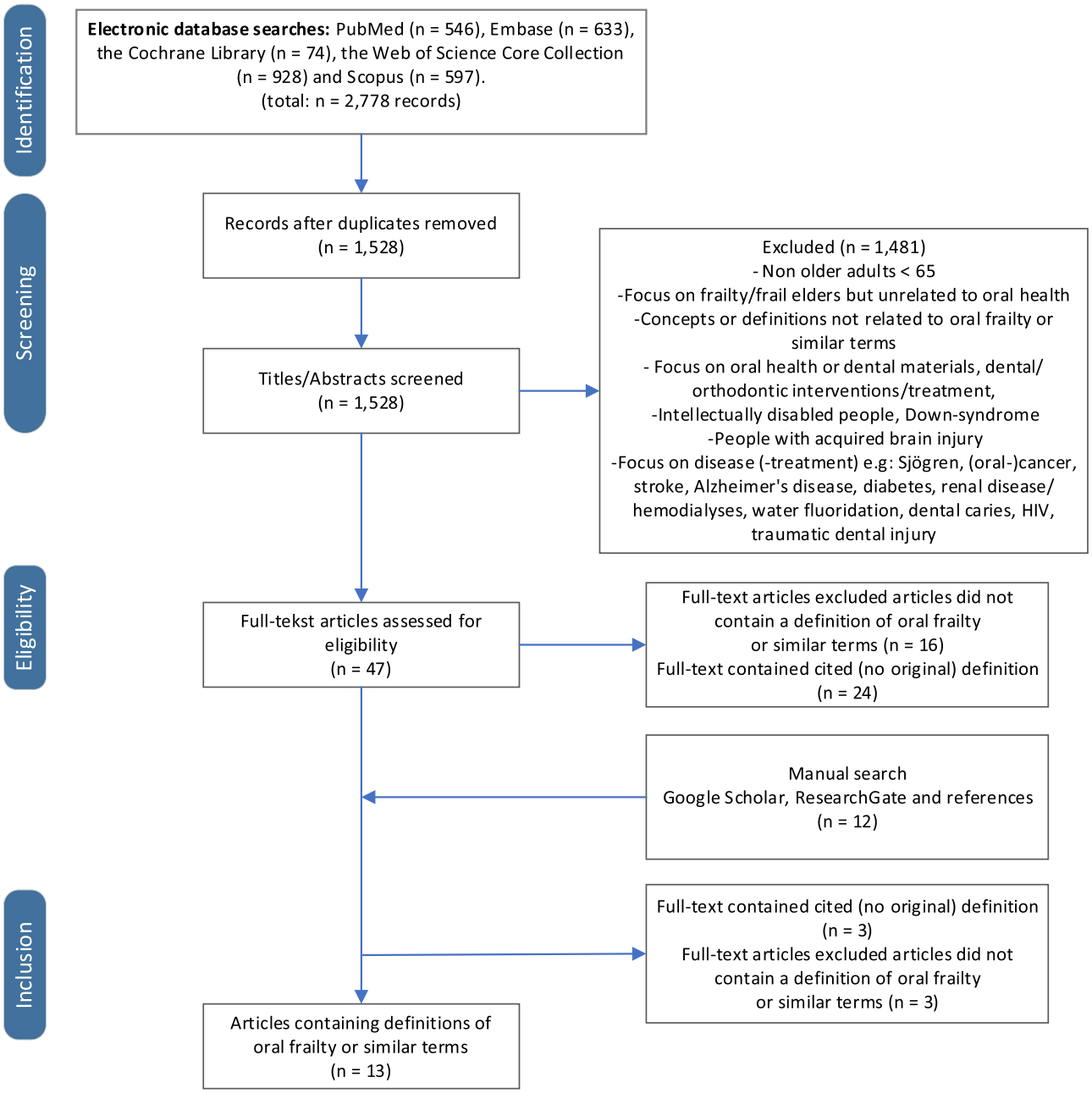

Fig. 1. Search strategy and selection of literature on oral frailty definitions.

and abstract. The initial screening resulted in the exclusion of 1,481 records. Forty-seven articles were eligible for full-text review. Of these articles, 16 did not contain a definition of oral frailty or similar terms, and 24 articles referred to a definition that originally appeared in an already included article. A manual search via web browsing generated 12 articles. Three full-text articles contained cited definitions of already included articles, and three did not contain a definition of oral frailty or similar terms. Hence, in total, 13 articles were included for data extraction and charting.

3.2. Characteristics of sources of evidence and results of individual sources of evidence

Eleven of the 13 included studies were published in the last five years. The majority of the studies (n = 9; 69%) were conducted in Japan, one (8%) in Mexico, one (8%) in Switzerland, and two (15%) in the United States of America. The studies consisted of three cross-sectional studies, two cohort studies, two prospective longitudinal studies, two position papers, one review article, one editorial, and two studies without a reported study design (Table B.5). Of the 13 studies, seven definitions of oral frailty, and 10 definitions of terms similar to oral frailty were mentioned (Table A.2 and A.3).

3.3. Synthesis of results

The definition assessment was conducted by three researchers: KP, EW, and RG. The inter-rater reliability was examined using an intraclass correlation coefficient (ICC). We calculated an ICC of 93% with a 95% confidence interval of 0.91 - 0.96; this indicates a 'good' to 'excellent' inter-rater reliability. The seven extracted definitions of oral frailty (Hihara et al., 2019; Ichikawa et al., 2018; Iwasaki et al., 2020; Minakuchi et al., 2018; Morley, 2020; Naruishi, 2018; Tanaka et al., 2018) (Table A.2) were assessed on three methodological aspects, three linguistic aspects, and six content-related aspects, using the *'Guide for Assessing Conceptual Definitions'* (Table A.1).

3.3.1. Methodological criteria 1–3

None of the studies described the techniques and methodology (item 1) used to define the concept, nor the dimensionality (item 2) of the definition. Four of the seven definitions (57%) met the logical fallacy criterion (item 3).

3.3.2. Linguistic criteria 4–6

The criterion of parsimony (item 4) was met by five of the seven definitions (71%). All definitions contained terminology assumed to be known by field professionals (item 5). Three of the seven definitions contained ambiguous, vague, or ill-defined expressions, leaving four (57%) that met the criterion of 'ambiguity' (item 6).

3.3.3. Content-related criteria 7–12

Four of the seven definitions lacked a description of the necessary characteristics to get to the essence of the concept. Three definitions (43%) were found to meet the criterion of 'essentiality' (item 7). All definitions contained measurable attributes (item 8). When the definitions of oral frailty were compared to the definitions of the similar concepts presented in Table A.3, we found that all definitions of oral frailty contained the same or equivalent terms and attributes used to define the concepts of 'oral health[a]', 'deterioration of oral function', 'oral hypofunction[a]' and 'oral hypofunction[b]'. The definitions of oral frailty were not clearly different from those of the similar concepts (item 9). To examine conceptual consistency (item 10), an additional analysis was necessary. This analysis involved breaking down the definitions into their characteristics (Table A.5). We found a lack of conceptual consistency between the seven definitions of oral frailty. In total, 28 different characteristics of oral frailty were mentioned in the seven definitions. These characteristics can be grouped into 12 overarching themes. Terms related to 1) oral muscle weakness, eating, and swallowing disorders were mentioned in six of the seven definitions (86%). Terms related to 2) occlusion and the number of teeth were mentioned in five of the seven definitions (71%). Terms related to 3) oral function and 4) tongue movement were mentioned in three of the seven definitions (43%). Terms related to 5) choking, 6) age-related oral health decline, and 7) poor oral health were mentioned in two of the seven definitions (29%). Terms related to 8) dry mouth, 9) oral hygiene, 10) oral motor skill, 11) decreased interest in oral health, and 12) physical/mental decline were mentioned in one of the seven definitions (14%). The analysis corresponding to item 10 is presented in appendix A (Table A.5). The criterion of 'antecedents and consequences' (item 11) was met by four of the seven definitions (57%). In three of the seven articles, oral frailty was solely defined utilizing examples. Three of the seven definitions (42%) met the criterion 'exemplary expressions' (item 12). Ultimately, none of the seven definitions met all 12 criteria. Therefore, according to our *'Guide for Assessing Conceptual Definitions'*, none of these definitions can be considered a 'good' conceptual definition. The complete overview is presented in Table A.4, and a more detailed critical examination of the seven definitions is presented in appendix B (Table B.6).

4. Discussion

The aim of this scoping review was firstly to search the gerodontology literature for definitions of oral frailty and terms similar to oral frailty; secondly, to analyze and assess their conceptual characteristics; and thirdly, to propose a new conceptual definition of oral frailty that meets the criteria of a good conceptual definition.

In the 1,528 articles that remained after removing duplicates from 2,778 articles, we identified 13 articles(Castrejon-Perez & Borges-Yanez, 2014; Glick et al., 2017; Hasegawa et al., 2020; Hihara et al., 2019; Ichikawa et al., 2018; Iwasaki et al., 2020; Iwasaki et al., 2018; Meng & Gilbert, 2007; Minakuchi et al., 2018; Minakuchi et al., 2016; Morley, 2020; Naruishi, 2018; Tanaka et al., 2018) that collectively included seven definitions of oral frailty and ten definitions of terms similar to oral frailty. After analyzing the seven definitions of oral frailty, it was apparent that they differed considerably from one another. As hypothesized, we found a lack of conceptual consistency. The seven definitions described oral frailty with different numbers and combinations of the (28) characteristics mentioned. This involved the use of both abstract and concrete (measurable) terms. Eventually, this results in definitions with different meanings. This suggests there is no consensus in the scientific community regarding the term oral frailty, which is problematic because conceptual inconsistency will likely lead to confusion among researchers and field professionals. Without consensus, the different definitions will each be seen as the actual definition, and a stream of studies will be conducted around one or several of them.

The first aspect of the *'Guide for Assessing Conceptual Definitions'* assesses whether the authors provided information on the methodology used to develop the conceptual definitions. Given the aim of the seven studies, it becomes clear that the authors did not primarily set out to develop a conceptual definition. It is, therefore, not surprising that no author describes the methods used to develop their definition. However, it is conceivable that readers may adopt these definitions as conceptual definitions without questioning the methodology and conceptual correctness. As a result, the scientific discussion and focus quickly moves away from the theoretical essence and concentrates on measuring oral frailty.

The second aspect of the guide reviews the linguistic characteristics (i.e., is the definition meticulously articulated to capture the phenomenon's essence through language?). According to our assessment, word redundancy and vague language, symbols, and poor formulations are used in three of the seven definitions. From a linguistic point of view, the definitions presented by Minakuchi et al. (2016), Hihara et al. (2019), and Iwasaki et al. (2020) lack quality. We considered that the formulation of these definitions did not contribute to a better understanding of the concept of oral frailty and that the wording unnecessarily broadened and complicated the definition.

The third aspect of the guide addresses content-related criteria. Our results suggest that the definitions presented by Ichikawa et al. (2018), Tanaka et al. (2018), Naruishi (2018), Morley (2020), and Minakuchi et al. (2018) are subject to criticism. The analysis showed that definitions are generally expressed in terms of examples, antecedents, and consequences. Some are even formulated as an operational definition since they express oral frailty in measurable terms(Wacker, 2004). We found that these definitions neither accurately captured the essence of oral frailty nor uncovered its unique characteristics, and therefore, are considered not sufficiently specific. As hypothesized, we found that the current definitions of oral frailty do not meet the criteria for good conceptual definitions.

As mentioned in the results, the definitions of oral frailty, oral

health[a], deterioration of oral function, oral hypofunction[a], and oral hypofunction[b] are expressed using several common characteristics and are, therefore, hardly distinguishable. This raises the question of whether these definitions actually describe different concepts or whether they are different terms for the same concept. Podsakoff et al. (2016) noted that this might obscure the pattern of findings in the literature and result in the development of multiple or conflicting measures of the concept and impede theoretical progress. If oral frailty and similar concepts are theoretically indistinguishable, perhaps current clinical measurements are not able to distinguish them either. As hypothesized, we found proliferation in the current definitions of oral frailty and similar terms.

4.1. Limitations

Although we considered a scoping review to be an appropriate study design, a specific methodology for assessing conceptual definitions is nonexistent. We were also unable to find an instrument to assess conceptual definitions, as a validated instrument could not be identified. We therefore developed a new instrument, which was constructed based on the solid theory of Podsakoff et al.(Podsakoff et al., 2016) and Wacker (Wacker, 2004). As indicated in the method section, we combined the work of these two authors and converted it from questions and rules into a twelve-item assessment instrument. It should be mentioned that the work of both Podsakoff and Wacker originates in operations management and business administration, which entailed reformulation to fit the medical context. As a result of our pioneering work in this field, this study's results were obtained using an assessment instrument that has not been validated nor scrutinized by the scientific community. Validating this instrument is important as it can be used more frequently in medical scientific research for the development and assessment of conceptual definitions. Such validation should include face and content validation. In this way, the relevance of the items and the completeness of the instrument can be examined, but also whether the instrument is reliable and actually able to discriminate good from bad conceptual definitions.

4.2. Recommendations: conceptualizing oral frailty

Since all seven definitions of oral frailty did not meet the criteria of a good conceptual definition, we inferred the characteristics of oral frailty from the seven identified definitions and used these to construct a new definition of oral frailty. We also verified that this new definition met the criteria of a good conceptual definition. As indicated earlier, we extracted a combination of 28 abstract and concrete characteristics from the identified definitions of oral frailty(Hihara et al., 2019; Ichikawa et al., 2018; Iwasaki et al., 2020; Minakuchi et al., 2018; Morley, 2020; Naruishi, 2018; Tanaka et al., 2018) and organized them into 12 themes. These 12 themes (Table A.5) can be divided into two categories. Seven of the 12 themes (1, 2, 3, 4, 5, 8, and 10) relate to the decline of oral function, oral health, hard dental tissues, and soft oral tissues, which can be conceptualized as orofacial function-related decline (category 1). Five of the 12 themes (6, 7, 9, 11, and 12) relate to age-related cognitive and physical decline, which can be conceptualized as age-related decline (category 2). Based on the studies regarding oral frailty, the knowledge, and the definitions that emerged from them, we suggest that orofacial function-related decline and age-related decline represent the fundamental and essential characteristics of oral frailty.

Consequently, we propose the following conceptual definition: *Oral frailty is the age-related functional decline of orofacial structures.* Our definition of oral frailty is expressed as a unidimensional concept and is defined at an abstract level. It is formulated in terms familiar to gerodontology and related disciplines, free of measurable attributes, antecedents, consequences, hypotheses, and examples. The use of specific and concise wording in this definition differentiates oral frailty from similar concepts, such as oral health, deterioration of oral function, and hypofunction. Our definition is consistent with the other definitions of oral frailty we identified in this scoping review because it contains the conceptualization of their mentioned characteristics. The method through which we arrived at this new definition was performed in a reproducible manner and is accurately described in this scoping review.

Although the functional decline of orofacial structures typically manifests itself at an older age, it does not necessarily imply a causal relationship with aging. For this reason, the term "age-related" was adopted in our definition. Furthermore, as described earlier, a good conceptual definition should not contain hypotheses(Bunge, 1967); it serves as a basis for testing new hypotheses(Wacker, 2004). Therefore, our definition does not include potential causes and consequences of functional decline of orofacial structures (e.g., dry mouth, eating, speaking, swallowing disorders, and reduced quality of life). A logical next step is to examine the adequacy of current operational definitions of oral frailty and develop a new operational definition, if necessary.

5. Conclusions

This scoping review aimed to identify existing definitions of oral frailty in gerodontology literature and analyzed whether oral frailty definitions are well formulated on a conceptual level. According to our analysis, the current definitions of oral frailty cannot be considered 'good' conceptual definitions. Therefore, we proposed a new conceptual definition: *Oral frailty is the age-related functional decline of orofacial structures.*

Declaration of Competing Interest

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Author contributions: KP.: study design, literature search, software-aided screening and selection development, instrument development, data extraction, data analysis and assessment, and manuscript preparation. EW: screening and selection, data extraction, analysis and assessment of the data, critical revision of the manuscript, and approval of the final version of the manuscript. LS: literature search, search description in the methods section, critical revision of the manuscript, and approval of the final version of the manuscript. GA: critical revision of the manuscript and approval of the final version of the manuscript. RG: study design, oral frailty analysis and conceptualization, critical revision and editing of the manuscript, and approval of the final version of the manuscript. FL: study design, oral frailty analysis and conceptualization, critical revision and editing of the manuscript, and approval of the final version of the manuscript.

Appendix A

See Appendix Tables A.1–A.5.

Table A.1
Guide for assessing conceptual definitions

Methodological criteria			
1.	Methodology	Are the techniques used to develop the conceptual definition described in the paper?	**Yes**/No
2.	Dimensionality	Is the dimensionality of the concept definition specified?	**Yes**/No
3.	Logical fallacy	Are new hypotheses introduced in the definition?	Yes/**No**
Linguistic criteria			
4.	Parsimony	Is the definition described using as few terms as possible to capture the essence of the concept?	**Yes**/No
5.	Familiarity	Is the definition expressed using terms and ideas assumed to be known by field professionals?	**Yes**/No
6.	Ambiguity	Is the definition free from ambiguous, vague, or ill-defined terms/expressions?	**Yes**/No
Content-related criteria			
7.	Essentiality	Does the definition describe the essential characteristics of the phenomenon?	**Yes**/No
8.	Measurable attributes	Is the definition free from measurable attributes?	**Yes**/No
9.	Differentiability	Does the definition clearly delineate the concept from other seemingly similar concepts?	**Yes**/No
10.	Consistency	Is the definition as similar as possible between studies?	**Yes**/No
11.	Antecedents/consequences	Is the definition solely expressed by reference to its antecedents or consequences?	Yes/**No**
12.	Exemplary expressions	Is the definition solely expressed in terms of examples?	Yes/**No**

Note: Definitions are considered 'good' conceptual definition when items 1, 2, and 4–10 are answered 'yes' and items 3, 11 and 12 are answered 'no'.

Table A.2
Definitions of oral frailty

Authors	*Year*	*Concept*	*Definition*
Hihara et al.	2019	Oral frailty	Oral frailty refers to a mild decline in oral function, with symptoms such as the decline in tongue action, spilling foods, and slight choking.
Ichikawa et al.	2018	Oral frailty	For evaluating oral frailty, occlusal force and moisture of oral mucosa was measured.
Iwasaki et al.	2020	Oral frailty	Oral Frailty presents a series of phenomena and processes characterized by vulnerability in oral health status due to age-related changes in different oral health conditions (number of teeth, oral hygiene, oral functions, etc.) accompanied by a decreased interest in oral health and physical and mental reserve capacity → deterioration in eating function → physical and mental disorders.*
Minakuchi et al.	2018	Oral frailty	Decreased oral function is referred to as "oral frailty"; namely, "oral frailty" here means frailty that manifests only in the oral cavity with signs or symptoms specified as decreased articulation, slight choking or spillage while eating, and an increased number of unchewable foods.
Morley	2020	Oral frailty	"Oral frailty" can be defined as difficulty in chewing associated with age related changes in swallowing (presbyphagia).
Naruishi	2018	Oral frailty	"Oral frailty" was defined as poor oral conditions, such as unclosed mouth, impaired movements of the tongue, and loss of posterior occlusion.
Tanaka et al.	2018	Oral frailty	We defined oral frailty status as poor status in three or more of the six targeting measures. These six measures included the following: (i) the number of natural teeth, (ii) chewing ability, (iii) articulatory oral motor skill for "ta," (iv) tongue pressure, (v) subjective difficulty in swallowing.

* This definition is initially written in Japanese and is presented in the 2019 Japan Dental Association manual for oral frailty in dental clinics(JapanDentalAssociation, 2019).

Table A.3
Definitions of terms similar to oral frailty

Authors	*Year*	*Concept*	*Definition*
Castrejon-Perez and Borges-Yanez	2014	Oral health[a]	Oral health refers to a cluster of conditions related to the mouth and teeth, the most common of which are dental caries. It also includes periodontal diseases, xerostomia, presbyphagia, dysphagia and oral cancer, among others.
Glick et al.	2017	Oral health[b]	Oral health is multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex.
Hasegawa et al.	2020	Oral hypofunction[a]	Oral hypofunction is a dental disease in which oral function is multiply decreased due to not only aging but also various factors such as other diseases and disorders.
Iwasaki et al.	2018	Functional dentition	A dentition status that provides adequate oral function, such as mastication, is referred to as functional dentition.
Meng and Gilbert	2007	Oral health and OHRQoL	Oral health and OHRQoL comprises of five domains: (i) oral disease/tissue damage connotes disorders at the organic level; (ii) oral pain/discomfort refers to painful or uncomfortable experiences or symptoms as a response to oral disease/tissue damage; (iii) oral functional limitation refers to the compromised physiological or psychological function caused by oral disease/tissue damage, or oral pain/discomfort; (iv) oral disadvantage is a more socially involved dimension and (v) self-rated oral health is the global assessment of oral health.
Minakuchi et al.	2016	Deterioration of oral function	Deterioration of oral function was expressed from seven oral symptoms: oral uncleanness, oral dryness, decline in occlusal force, decline in motor function of tongue and lips, decline in tongue pressure, decline in chewing function and decline in swallowing function.
Minakuchi et al.	2018	Oral hypofunction[b]	Oral hypofunction is defined as the state when more than 3 (or more) of the 7 oral function measures meet the diagnostic criteria. Additionally, we selected 7 conditions (poor oral hygiene, oral dryness, reduced occlusal force, decreased tongue- lip motor function, decreased tongue pressure, decreased masticatory function, and deterioration of swallowing function) for making a diagnosis of oral hypofunction and established initial thresholds to be used as diagnostic criteria for these conditions.
Tanaka et al.	2018	Oral non-frailty Oral prefrail	We defined oral non-frailty as no poor status in the six targeted measures and oral prefrail status as poor status in 1 or 2 measures. These six measures included the following: (i) the number of natural teeth, (ii) chewing ability, (iii) articulatory oral motor skill for "ta," (iv) tongue pressure, (v) subjective difficulty in eating tough foods, and (vi) subjective difficulty in swallowing.

Note: Similar terms in different articles are marked with letters in superscript e.g.: [a, b], OHRQoL stands for Oral Health-Related Quality of Life.

Table A.4
Conceptual definition assessment

Methodological criteria	Hihara 2019	Ichikawa 2018	Iwasaki 2020	Minakuchi 2018	Morley 2020	Naruishi 2018	Tanaka 2018	% criterion met
1. Methodology	X	X	X	X	X	X	X	0
2. Dimensionality	X	X	X	X	X	X	X	0
3. Logical fallacy	✓	X	✓	✓	X	X	✓	57
Linguistic criteria								
4. Parsimony	✓	✓	X	X	✓	✓	✓	71
5. Familiarity	✓	✓	✓	✓	✓	✓	✓	100
6. Ambiguity	X	✓	X	X	✓	✓	✓	57
Content-related criteria								
7. Essentiality	✓	X	✓	✓	X	X	X	43
8. Measurable attributes	X	X	X	X	X	X	X	0
9. Differentiability	X	X	X	X	X	X	X	0
10. Consistency	X	X	X	X	X	X	X	0
11. Antecedents and/or consequences	✓	✓	✓	X	X	X	✓	57
12. Exemplary expressions	✓	X	✓	X	✓	X	X	42
% in which the definition meets the criteria for a good conceptual definition	50	33	42	25	33	25	42	
Considered a 'good' conceptual definition:	~~yes~~/no	~~yes~~/no	~~yes~~/no	~~yes~~/no	~~yes~~/no	~~yes~~/no	~~yes~~/no	

Table A.5
Characteristics and conceptual consistency analysis

	Hihara T. et al., 2019	Ichikawa T. et al., 2018	Iwasaki M. et al., 2020	Minakuchi S. et al., 2018	Morley J.E., 2020	Naruishi K., 2018	Tanaka T. et al., 2018	*% consistency/ aspect*
1. Eating/ swallowing/ weak oral muscles	spilling foods		deterioration in eating function	spillage while eating/ increased number of unchewable foods	difficulty in chewing changes in swallowing	unclosed mouth	chewing ability/ subjective difficulty in swallowing	6/7 - **86%**
2. Occlusion/ Number of teeth		occlusal force	number of teeth	decreased articulation		loss of posterior occlusion	the number of natural teeth	5/7 - **71%**
3. Oral function decline	oral function decline		decline of oral functions	oral function decline				3/7 - **43%**
4. Impaired tongue movement	tongue action					impaired movements of the tongue	tongue pressure	3/7 - **43%**
5. Choking	slight choking			slight choking				2/7 - **29%**
6. Age related oral health decline			age-related		age related			2/7 - **29%**
7. Poor oral health/oral condition			vulnerability in oral health status			poor oral conditions		2/7 - **29%**
8. Dry mouth		moisture of oral mucosa						1/7 - **14%**
9. Oral hygiene			oral hygiene					1/7 - **14%**
10. Oral motorskill							articulatory oral motor skill for "ta"	1/7 - **14%**
11. Decreased interest in oral health			decreased interest in oral health					1/7 - **14%**
12. physical and mental decline			physical and mental reserve capacity /physical and mental disorders					1/7 - **14%**
N characteristics per definition	**4**	**2**	**9**	**5**	**3**	**6**	**5**	***Total N characteristics:* 28**

Appendix B

See Tables B.1–B.6.

Table B.1
Search strategy for all databases

Search	PubMed Query – April 30, 2021	Items found
#4	#1 AND #2 AND #3	546
#3	"Classification"[MeSH] OR "concept"[tiab] OR "means"[tiab] OR "meaning*"[tiab] OR "defin*"[tiab] OR "framework*"[tiab] OR "theor*"[tiab] OR "model*"[tiab] OR "classif*"[tiab] OR "characteristic*"[tiab] OR "position"[tiab] OR "determined"[tiab]	8,383,782
#2	"Aged"[MeSH] OR "aged, 80 and over"[MeSH] OR "Frail Elderly"[MeSH] OR "Geriatrics"[MeSH] OR "Geriatric Dentistry"[MeSH] OR "Dental Care for Aged"[MeSH] OR "elder*"[tiab] OR "eldest"[tiab] OR "frail*"[tiab] OR "geriatri*"[tiab] OR "old age*"[tiab] OR "oldest old*"[tiab] OR "senior*"[tiab] OR "senium"[tiab] OR "very old*"[tiab] OR "septuagenarian*"[tiab] OR "octagenarian*"[tiab] OR "octogenarian*"[tiab] OR "nonagenarian*"[tiab] OR "centarian*"[tiab] OR "centenarian*"[tiab] OR "supercentenarian*"[tiab] OR "older people"[tiab] OR "older subject*"[tiab] OR "older patient*"[tiab] OR "older age*"[tiab] OR "older adult*"[tiab] OR "older man"[tiab] OR "older men"[tiab] OR "older male*"[tiab] OR "older woman"[tiab] OR "older women"[tiab] OR "older female*"[tiab] OR "older population*"[tiab] OR "older person*"[tiab]	3,466,309
#1	"oral frailty"[tiab] OR (("Oral Health"[MeSH] OR "Oral Health"[tiab] OR "oral function*"[tiab]) AND ("frailty"[tiab] OR "decline"[tiab] OR "deteriorat*"[tiab] OR "decreas*"[tiab] OR "reduction"[tiab] OR "reduced"[tiab] OR "hypofunction*"[tiab]))	4,935
Search	Embase.com (Elsevier) Query – April 30, 2021	Items found
#4	#1 AND #2 AND #3	633
#3	'classification'/exp OR 'conceptual framework'/exp OR 'concept formation'/exp OR concept*:ab,ti,kw OR means:ab,ti,kw OR meaning*:ab,ti,kw OR defin*:ab,ti,kw OR framework*:ab,ti,kw OR theor*:ab,ti,kw OR model*:ab,ti,kw OR classif*:ab,ti,kw OR characteristic*:ab,ti,kw OR position:ab,ti,kw OR determined:ab,ti,kw	11,886,393
#2	'aged'/exp OR 'geriatrics'/exp OR 'elderly care'/exp OR elder*:ab,ti,kw OR eldest:ab,ti,kw OR frail*:ab,ti,kw OR geriatri*:ab,ti,kw OR 'old age*':ab,ti,kw OR 'oldest old*':ab,ti,kw OR senior*:ab,ti,kw OR senium:ab,ti,kw OR 'very old*':ab,ti,kw OR septuagenarian*:ab,ti,kw OR octagenarian*:ab,ti,kw OR octogenarian*:ab,ti,kw OR nonagenarian*:ab,ti,kw OR centarian*:ab,ti,kw OR centenarian*:ab,ti,kw OR supercentenarian*:ab,ti,kw OR 'older people':ab,ti,kw OR 'older subject*':ab,ti,kw OR 'older patient*':ab,ti,kw OR 'older age*':ab,ti,kw OR 'older adult*':ab,ti,kw OR 'older man':ab,ti,kw OR 'older men':ab,ti,kw OR 'older male*':ab,ti,kw OR 'older woman':ab,ti,kw OR 'older women':ab,ti,kw OR 'older female*':ab,ti,kw OR 'older population*':ab,ti,kw OR 'older person*':ab,ti,kw	3,618,009
#1	'oral frailty':ab,ti,kw OR (('oral health':ab,ti,kw OR 'oral function*':ab,ti,kw) AND (frailty:ab,ti,kw OR decline:ab,ti,kw OR deteriorat*:ab,ti,kw OR decreas*:ab,ti,kw OR reduction:ab,ti,kw OR reduced:ab,ti,kw OR hypofunction*:ab,ti,kw))	5,114
Search	Web of Science Core Collection (Clarivate) Query – April 30, 2021	Items found
#4	#1 AND #2 AND #3	928
#3	TS =(concept* OR meaning* OR defin* OR framework* OR theor* OR model* OR classif* OR characteristic* OR position OR determined)	18,756,330
#2	TS = (elder* OR eldest OR frail* OR geriatri* OR old age* OR oldest old* OR senior* OR senium OR "very old*" OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR "older people" OR "older subject*" OR "older patient*" OR "older age*" OR "older adult*" OR "older man" OR "older men" OR "older male*" OR "older woman" OR "older women" OR "older female*" OR "older population*" OR "older person*")	1,904,546
#1	TS = ("oral frailty" OR (("oral health" OR "oral function*") AND (frailty OR decline OR deteriorat* OR decreas* OR reduction OR reduced OR hypofunction*)))	6,085
Search	Scopus (Elsevier) Query – April 30, 2021	Items found
#4	#1 AND #2 AND #3	597
#3	TITLE-ABS-KEY (concept* OR meaning* OR defin* OR framework* OR theor* OR model* OR classif* OR characteristic* OR position OR determined)	30,044,542
#2	TITLE-ABS-KEY (elder* OR eldest OR frail* OR geriatri* OR old age* OR oldest old* OR senior* OR senium OR "very old*" OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR "older people" OR "older subject*" OR "older patient*" OR "older age*" OR "older adult*" OR "older man" OR "older men" OR "older male*" OR "older woman" OR "older women" OR "older female*" OR "older population*" OR "older person*")	2,304,467
#1	TITLE-ABS-KEY ("oral frailty" OR (("oral health" OR "oral function*") AND (frailty OR decline OR deteriorat* OR decreas* OR reduction OR reduced OR hypofunction*)))	5,735
Search	The Cochrane Library (Wiley) Query – April 30, 2021	Items found
#4	#1 AND #2 AND #3	74
#3	(concept* OR meaning* OR defin* OR framework* OR theor* OR model* OR classif* OR characteristic* OR position OR determined):ti,ab,kw	648,949
#2	(elder* OR eldest OR frail* OR geriatri* OR old NEXT age* OR oldest NEXT old* OR senior* OR senium OR ery NEXT old* OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR older NEXT people OR older NEXT subject* OR older NEXT patient* OR older NEXT age* OR older NEXT adult* OR older NEXT man OR older NEXT men OR older NEXT male* OR older NEXT woman OR older NEXT women OR older NEXT female* OR older NEXT population* OR older NEXT person*):ti,ab,kw	82,263
#1	("oral frailty" OR (("oral health" OR "oral function*") AND (frailty OR decline OR deteriorat* OR decreas* OR reduction OR reduced OR hypofunction*))):ti,ab,kw	1,260

Table B.2
Tiab screening keywords

Definition and similar terms		Oral frailty and similar terms	Exclusion terms
Conceptual	Description	Oral frailty	Paediatric
Concept	Meaning	Oral health	Pediatric
Definition	Characterization	Oral function	Childhood
Defined	Characterized	Oral hypofunction	Children
Depiction	Clarification	Reduction in oral function	Schoolchildren
Depicted	Clarified	Deterioration of oral function	Child
Explanation	Signified	Oral health deterioration	Adolescent
Explained	Understand	Decreasing oral function	Adolescents
Expressed	Represent	Decline in oral function	
Description	Representation	Rapid oral health deterioration	
Described	Framework	ROHD	
Determined		Decline in oral health	
Term		Loss of oral function	
Terminology			
Delineate			

Note: software aided Tiab screening in MAXQDA. Each article is labeled (exclude, questionable or include).

Table B.3
Tiab screening search strings

	Definition and similar terms
1.	Oral frailty AND concept
2.	Oral function AND concept
3.	Oral functionality AND concept
4.	Oral health AND concept
5.	Oral health deterioration AND concept
6.	Oral hypofunction AND concept
7.	Oral motor AND concept
8.	Rapid Oral Health Deterioration
9.	Oral frailty OR oral function OR oral hypofunction OR reduction in oral function OR deterioration of oral function OR oral health deterioration OR decreasing oral function OR decline in oral function OR rapid oral health deterioration OR ROHD OR decline in oral health OR loss of oral function
10.	Conceptual OR concept OR definition OR defined OR depiction OR explanation OR explained OR expressed OR description OR described OR determined OR term OR terminology OR delineate OR meaning OR characterization OR characterized OR clarification OR clarified OR signified OR understand OR represent OR representation OR framework OR classification OR characteristics OR characteristic
11.	Paediatric OR pediatric OR childhood OR children OR schoolchildren OR child OR adolescent OR adolescents
12.	Oral health

Note: software-aided Tiab screening in MAXQDA. Each article is labeled (exclude, questionable or include)

Table B.4
Guide for assessing conceptual definitions: criteria explanation

Methodological aspects	1. Methodology* The criterion 'methodology' is met when procedures and techniques (e.g., expert interviews, literature search) used to develop the presented definition are described in the paper. 2. Dimensionality* The dimensionality should be described in the paper. In the case of multidimensionality, sub-dimensions must be explained. In this case, the definition is considered a good conceptual definition. 3. Logical fallacy‡ By defining a new concept, several new hypotheses emerge. Incorporating a new hypothesis in a conceptual definition can lead to circular reasoning and conflict with the general theory on the subject. For example, if 'B' is part of the definition of 'A', it is not possible to falsify the (new) hypothesis that 'A' leads to 'B' because 'B' is by definition embedded in 'A'. The criterion of 'logical fallacy' is met when the definition does not contain new hypotheses.
Linguistic aspects	4. Parsimony‡ The criterion of parsimony is met when the definition does not contain additional words and terms that are not instrumental in uncovering the concept's essence. 5. Familiarity* A good conceptual definition contains self-evident conceptions and terms that are known to field professionals. If this is the case, the definition meets the criterion of 'familiarity'. If terms have too many different meanings, it is difficult to interpret exactly what is being discussed. 6. Ambiguity*,‡ The third criterion, 'ambiguity', is met when the definition includes only unambiguous, clear, and well-defined terms.
Content-related aspects	7. Essentiality* A good conceptual definition should describe the nature and properties of the phenomenon and the entity to which they apply. The criterion of 'essentiality' is met when these characteristics are clearly stated. 8. Measurable attributes‡ Conceptual definitions are expressed at an abstract level; hence, measurable attributes should not be included. Definitions containing measurable attributes are called operational definitions. This criterion is met when the definition is free from measurable attributes. 9. Differentiability*,‡ A definition must distinguish the defined term from other similar terms. Overlap in definitions has a disruptive effect on the understanding of the concept. The criterion of 'differentiability' is met when the definition clearly delineates the concept from other seemingly similar concepts. 10. Consistency‡ The criterion 'consistency' is met when the same term's definitions coincide when compared with each other. This would otherwise indicate conceptual inconsistency in the academic field in which they occur. 11. Antecedents/consequences* While antecedents and consequences are illustrative in understanding the concept connected to related manifestations, a good conceptual definition should not solely be expressed in these terms. The eleventh criterion, 'antecedents/consequences', is met if this is the case. 12. Exemplary expressions* Concrete examples help understand a concept, but should not be the basis of the definition. If the definition is not only expressed by examples, the criterion 'exemplary expressions' is met.

Note:
* Podsakoff et al. (2016).
‡ Wacker (2004).

Table B.5
Characteristics of sources of evidence

Authors	*Year*	*Country*	*Design*	*Concept*	*Aim*
Castrejon-Perez and Borges-Yanez	2014	Mexico	Not mentioned	Oral health	To provide a comprehensive synthesis of the relationship between Frailty and oral health.
Glick et al.	2017	Switzerland	Not mentioned	Oral health	To develop a universally accepted definition of oral health, one that conveys that oral health is a fundamental human right and that facilitates the inclusion of oral health in all policies.
Hasegawa et al.	2020	Japan	Prospective longitudinal survey	Oral hypofunction	To examine the relationship between social withdrawal and oral function in independent older adults aged 65 years or older who live in the Tamba-Sasayama area.
Hihara et al.	2019	Japan	Cross-sectional study	Oral frailty	To investigate eating behaviour and subjective symptoms of oral frailty in elderly people and examine the association between the two.
Ichikawa et al.	2018	Japan	Cross-sectional study	Oral frailty	To investigate the relationship between oral frailty and physical frailty.
Iwasaki et al.	2020	Japan	Cross-sectional study	Oral frailty	To investigate the association between oral frailty and malnutrition among community-dwelling older adults.
Iwasaki et al.	2018	Japan	5-year prospective cohort study	Functional dentition	To investigate the possible longitudinal association of clinically measured dental status with frailty in community-dwelling older adults.
Meng and Gilbert	2007	USA	Prospective longitudinal study	Oral health and OHRQoL	To identify the longitudinal relationships between changes in satisfaction with chewing ability and changes in other dimensions of oral health, using the multidimensional conceptual model of oral health and OHRQoL as a theoretical guide.
Minakuchi et al.	2016	Japan	Position paper	Deterioration of oral function	To gather evidence up to this time and to propose tentative diagnostic criteria in order to develop appropriate arguments about this issue efficiently.
Minakuchi et al.	2018	Japan	Position paper	-Oral frailty -Decrease in oral function	To develop the hypothesis that oral frailty and oral hypofunction emerge during the process towards oral dysfunction among the various declines in ability. In addition, as a starting point for discussing this problem, present criteria for diagnosing oral hypofunction.
Morley	2020	USA	Editorial	Oral frailty	To emphasize the importance of screening for oral frailty with the EAT-10 questionnaire or the D-E-N-T-A-L questionnaire.
Naruishi	2018	Japan	Review article	Oral frailty	To focus on oral conditions of hospitalized elderly patients and to describe the effects of co-existing risk factors, such as oral frailty, on the geriatric condition.
Tanaka et al.	2018	Japan	Prospective cohort study	-Oral frailty -Oral non-frailty -Oral prefrail	To characterize oral status as a potential predictor for future physical weakening in Japanese community-dwelling elderly individuals by performing comprehensive oral examinations. Furthermore, to define accumulated poor oral status as "oral frailty", we determined the longitudinal impact of the baseline accumulation of poor oral status on future physical weakening and all-cause mortality.

Note: EAT-10 stands for Eating Assessment Tool – 10; D-E-N-T-A-L stands for Dysphagia / Dry mouth, Eating difficulty, No recent dental care, Tooth or mouth pain, Alterations or change in food selection and Lesions, sores or lumps in mouth.

Table B.6
Criticism of the oral frailty definitions

Hihara et al., 2019 *"Oral frailty refers to a mild decline in oral function, with symptoms such as the decline in tongue action, spilling foods, and slight choking".* It is unclear what "*mild decline in oral function*" exactly represents. The interpretation of a qualifier such as "*mild*" is imprecise and often used inconsistently. This suggests that a decline in oral function can also be moderate or severe. However, the difference between mild, moderate, and severe is unclear and not defined. From this perspective, "*mild*" is considered to be a vague qualifier.	%† 50
Ichikawa et al., 2018 *"For evaluating oral frailty, occlusal force and moisture of oral mucosa was measured".* At first glance, it is evident that this definition is not formulated at a conceptual level, as it does not describe what oral frailty is, but how it is measured. It should therefore be classified as an operational definition. Despite this, we included this definition in the analysis to discuss the notion that occlusal force and moisture of the oral mucosa are potentially measurable manifestations of oral frailty, but are not automatically essential characteristics of oral frailty.	33
Iwasaki et al., 2020 "*Oral Frailty presents a series of phenomena and processes characterized by vulnerability in oral health status due to age-related changes in different oral health conditions (number of teeth, oral hygiene, oral functions, etc.) accompanied by a decreased interest in oral health and physical and mental reserve capacity → deterioration in eating function → physical and mental disorders.*" This lengthy and broad definition incorporates several expressions in an effort to clarify the concept of oral frailty. These expressions include manifestations, characteristics, causes, examples, and coexisting factors. The use of arrow symbols in the last section is notable and raises questions about its meaning. It is unclear whether this refers to a temporal relationship, a simultaneous event, or a causal relationship. Arguably, readers are unable to interpret this properly just by reading the definition. It is also debatable whether the extensiveness of the definition and the use of arrows contributes to understanding the concept of oral frailty, or whether it unnecessarily broadens and complicates the concept.	42
Minakuchi et al., 2018 "Oral frailty means frailty that manifests only in the oral cavity with signs or symptoms specified as decreased articulation, slight choking or spillage while eating, and an increased number of unchewable foods". The term 'oral frailty' literally implies that the condition manifests itself in the oral cavity. The phrase "oral frailty means frailty that manifests only in the oral cavity" contributes little to comprehending oral frailty as a concept and is therefore considered superfluous. The phrase "an increased number of unchewable foods" should have been formulated differently. It is not the food itself that becomes unchewable, but the person's ability to chew food with a certain hardness gradually diminishes. This definition also present symptoms, including slight choking and spillage while eating. These manifestations are common in children under the age of 5 or children with feeding or swallowing disorders(Viviers et al., 2020), people with anatomical abnormalities such as lip/palate cleft(Kaczorowska et al., 2020) and, people with muscular degeneration disease, such as multiple sclerosis(Printza et al., 2020). Choking or spillage while eating also occurs in people with an intellectual disability and Down syndrome(Manduchi et al., 2020). In our view, definitions that predominantly propose these manifestations as fundamental characteristics of oral frailty do not contribute to an understanding of the essence of the concept of oral frailty. We, therefore, consider these definitions not to be sufficiently specific.	25
Morley, 2020 "Oral frailty can be defined as difficulty in chewing associated with age related changes in swallowing (presbyphagia)". It is important to discuss whether difficulty in chewing and changes in swallowing are fundamental characteristics of oral frailty or whether they are consequences or symptoms of oral frailty. By fundamental, we mean whether these characteristics do in fact represent the very essence of oral frailty. These characteristics are present in several other conditions.	33
Naruishi, 2018 "Oral frailty was defined as poor oral conditions, such as unclosed mouth, impaired movements of the tongue, and loss of posterior occlusion". Most of this definition consists of examples. When these are omitted, the definition reads, "Oral frailty was defined as poor oral conditions". We believe that this description does not capture the essence of the concept of oral frailty, nor does it uniquely characterize it, as several other oral conditions result in poor oral conditions.	25
Tanaka, 2018 "We defined oral frailty status as poor status in three or more of the six targeting measures. These six measures included the following: (i) the number of natural teeth, (ii) chewing ability, (iii) articulatory oral motor skill for "ta," (iv) tongue pressure, (v) subjective difficulty in eating tough foods, and (vi) subjective difficulty in swallowing". In this study, oral frailty is defined as a poor status in three or more of the six targeting measures. Although not mentioned by the authors, this definition should be regarded as an operational definition.	42

Note:
† % in which the criteria for a good conceptual definition are met.

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