TRANSLATION AND VALIDATION OF THE ADAPTED SELF-REPORTED ORAL HEALTH QUESTIONNAIRE (SROH) FOR PERIODONTITIS SCREENING AMONG MALAYSIAN ADULTS

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TRANSLATION AND VALIDATION OF THE ADAPTED SELF-REPORTED ORAL HEALTH QUESTIONNAIRE (SROH) FOR PERIODONTITIS SCREENING AMONG MALAYSIAN ADULTS

ABSTRACT

Background: Periodontitis is a globally prevalent disease, yet an instrument for large-scale screening remains elusive. Self-reported questionnaires hold promise as rapid, accessible, and non-invasive screening tools for disease surveillance. **Aim:** To translate the adapted Self-reported Oral Health Questionnaire (SROH) and to evaluate its validity and reliability as a screening tool for periodontitis among Malaysian adults. **Methods:** The study was conducted in two parts. First, the adapted SROH was translated into Malay by independent experts using forward-backward translation process. Then, the validity and reliability of the translated adapted SROH (M-SROH) were evaluated. Content validity was established through review by six experts, while the face validity was assessed by self-administering the questionnaire to 10 participants from the target population. Concurrent validity and internal consistency were tested in a pilot study of 90 participants from the Primary Care Unit at the Faculty of Dentistry, Universiti Malaya. The concurrent validity of the M-SROH, including sensitivity, specificity, positive predictive value, negative predictive values, and the area under the receiver operating characteristics curve (AUROCC), was determined against a full mouth periodontal examination. The internal consistency of the questionnaire was assessed using Cronbach's alpha value. **Results:** Both content and face validation were deemed acceptable, with item-level and scale-level indices exceeding the cut-off of 0.83. The M-SROH demonstrated excellent concurrent validity, with a sensitivity of 100%, specificity of 85.7%, positive predictive value of 91.7%, negative predictive value of 100%, and an

AUROCC of 0.994. The internal consistency was moderate with Cronbach's alpha value of 0.64. **Conclusion:** M-SROH demonstrates promising potential as a non-invasive and cost-effective screening tool for periodontitis among Malaysian adults.

Keywords: self-reported, periodontitis, screening, questionnaire, translation, validation

PENTERJEMAHAN DAN PENGESAHAN SOAL SELIDIK LAPORAN KENDIRI KESIHATAN MULUT (SROH) UNTUK SARINGAN PENYAKIT GUSI DALAM KALANGAN ORANG DEWASA DI MALAYSIA

ABSTRAK

Latar Belakang: Penyakit periodontitis merupakan penyakit yang lazim di seluruh dunia, namun alat untuk saringan berskala besar masih belum wujud. Soal selidik laporan kendiri menunjukkan potensi sebagai alat saringan yang cepat, mudah dicapai, dan tidak invasif untuk pengawasan penyakit. **Objektif:** Menterjemahkan Soal Selidik Laporan Kendiri Kesihatan Mulut (SROH) yang telah diadaptasi dan menilai kesahan dan kebolehpercayaan sebagai alat saringan untuk periodontitis dalam kalangan orang dewasa di Malaysia. **Kaedah:** Kajian ini dijalankan dalam dua bahagian. Pertama, soal selidik SROH yang diadaptasi diterjemahkan kepada Bahasa Melayu oleh pakar bahasa menggunakan proses terjemahan hadapan-belakang. Seterusnya, kesahan dan kebolehpercayaan SROH yang telah diterjemahkan (M-SROH) dinilai. Kesahan kandungan dinilai oleh enam orang pakar, manakala kesahan muka dinilai oleh 10 peserta daripada kumpulan sasaran. Kesahan serentak dan ketekalan dalaman diuji dalam kajian rintis yang melibatkan 90 peserta daripada Bahagian Rawatan Utama di Fakulti Pergigian, Universiti Malaya. Kesahan serentak M-SROH, termasuk sensitiviti, spesifisiti, nilai ramalan positif, nilai ramalan negatif, dan kawasan di bawah lengkung ciri operasi penerima (AUROCC), ditentukan berdasarkan pemeriksaan periodontium seluruh mulut. Ketekalan dalaman soal selidik dinilai menggunakan nilai alfa Cronbach. **Keputusan:** Kesahan kandungan dan muka didapati boleh diterima, dengan indeks peringkat item dan peringkat skala melebihi nilai ambang 0.83. Soal selidik M-SROH menunjukkan kesahan serentak yang cemerlang, dengan sensitiviti 100%, spesifisiti 85.7%, nilai ramalan positif

91.7%, nilai ramalan negatif 100%, dan AUROCC 0.994. Ketekalan dalaman adalah sederhana dengan nilai alfa Cronbach 0.64. **Kesimpulan:** M-SROH menunjukkan potensi yang baik sebagai alat saringan yang tidak invasif dan kos efektif untuk periodontitis dalam kalangan orang dewasa Malaysia.

Kata Kunci: laporan kendiri, periodontitis, saringan, soal selidik, terjemahan, pengesahan

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To my dear wife and family, thank you for your love, understanding, and for providing me with the space and support I needed to dedicate myself to my studies and research. Your encouragement and sacrifices were essential to my effort.

Finally, to the One to whom I owe everything and who has made all this possible, my Lord and Saviour, Jesus Christ. You have sustained me, answered my prayers and guided my steps. Your grace is sufficient for me and Your strength is made perfect in my weakness. All glory, honour, thanks and praise be unto You.

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LIST OF SYMBOLS AND ABBREVIATIONS

AAP	American Academy of Periodontology
AUC	Area under the curve
AUROCC	Area under the Receiver Operating Characteristics curve
BPE	Basic Periodontal Examination
CAL	Clinical attachment loss
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
CRP	C-reactive protein
CVD	Cardiovascular disease
CVI	Content validity index
EFA	Exploratory factor analysis
FVI	Face validity index
GR	Gingival recession
ICC	Intraclass correlation coefficient
IHME	Institute for Health Metrics and Evaluation
IHSR	Institute for Health Systems Research
IL-1β	Interleukin-1 beta
IL-6	Interleukin-6
ITBM	Institute of Translation & Books
M-SROH	Malay-translated adapted Self-reported Oral Health Questionnaire
MMP-8	Matrix metalloproteinase-8
MMP-9	Matrix metalloproteinase-9
MYR	Malaysian Ringgit
NCDs	Non-communicable diseases
NOHSA	National Oral Health Survey of Adults

NOHSS	National Oral Health Survey of Schoolchildren
NPV	Negative predictive value
OHP	Oral Health Programme
PPD	Probing pocket depth
PPV	Positive predictive value
ROC	Receiver Operating Characteristics
SD	Standard deviation
SDI	Socio-demographic index
SROH	Self-reported Oral Health Questionnaire
T2DM	Type 2 diabetes mellitus
UM	Universiti Malaya
USD	United States Dollar

LIST OF APPENDICES

CHAPTER 1 : GENERAL INTRODUCTION

1.1 Background

Periodontitis is a complex, chronic condition that affects the supporting structures of teeth (periodontium). It is marked by bacterial dysbiosis, dysregulated chronic inflammation, heightened oxidative stress and host-mediated tissue destruction (Bai et al., 2005; Bartold & Van Dyke, 2013; Page et al., 1997). Periodontitis occurs in susceptible individuals and if left untreated, leads to irreversible damage of the periodontium (i.e., gingiva, supporting alveolar bone, periodontal ligament and cementum) and eventually, tooth loss (Pihlstrom et al., 2005). This in turn can affect oral function and reduce one's quality of life (Schierz et al., 2021). In addition, severe periodontitis may impact systemic health, being associated with various non-communicable diseases, such as diabetes mellitus, rheumatoid arthritis, and cardiovascular disease (D'Aiuto et al., 2018; de Molon et al., 2019; Van Dyke et al., 2021). As a modifiable risk factor, periodontitis may influence the onset and progression of these diseases.

According to the Global Burden of Disease Study 2021 (Institute for Health Metrics and Evaluation [IHME], 2021), periodontitis is the seventh most widespread condition in the world. It affects around 62% of the global adult population (Trindade et al., 2023). In Malaysia, 38.2% of the adult population suffer from periodontitis (Oral Health Programme [OHP], 2023). The average cost for one year of periodontal treatment in public specialist periodontal clinics was estimated at MYR 2,820 per patient in 2012 (Mohd Dom et al., 2014). A more recent study by Anuwar et al. (2024) indicated that the burden on the national economy for non-surgical periodontal treatment during the initial year of management in specialist clinics across Malaysia amounted to MYR 8,283 per patient, totalling MYR 696 million, with estimates ranging from MYR 471 million to

MYR 922 million (Anuwar et al., 2024) These high treatment costs coupled with widespread prevalence place a significant burden not only on national and global economies (Botelho et al., 2022; Mohd Dom et al., 2016). Thus, periodontitis represents a significant public health challenge despite being a largely preventable, easily diagnosable, and effectively manageable condition.

Given its status as a public health challenge, it is crucial to screen for periodontitis. However, the disease has subtle symptoms that only become evident after severe destruction has occurred. Accordingly, the disease often progresses without causing significant discomfort in the oral cavity, allowing it to worsen unnoticed (Loesche & Grossman, 2001). In Malaysia, the prevalence of periodontal disease (including gingivitis) is alarmingly high, affecting 94.5% of adults aged 15 and older (OHP, 2023). Furthermore, the National Health and Morbidity Survey 2019 revealed that 69.5% of Malaysians with recent oral health problems did not seek dental treatment. The main reasons cited included not feeling sufficiently ill, work commitments, and self-medication (Institute for Health Systems Research [IHSR], 2020). The combination of low oral health awareness and the silent nature of periodontal disease, highlights the urgent need for an effective population-wide screening tool for this disease.

1.2 Problem statement

The full mouth periodontal examination is considered the gold standard in order to establish a periodontal diagnosis. However, it is both time consuming and labour intensive. To overcome this, periodontal screening methods have been developed. In Malaysia, the Basic Periodontal Examination (BPE) is the most widely taught and used (British Society of Periodontology [BSP], 2019). Nevertheless, this tool still requires substantial time, equipment, and trained personnel (Dietrich et al., 2019). This makes it

less than ideal for population-level screening. Therefore, it would be beneficial to develop and implement quicker, more accessible, and resource-effective screening methods for use in a broader, non-clinical setting, such as the workplace, institutions of learning and areas with limited access to dental healthcare services.

To address the need for a simple, non-invasive, and cost-effective periodontitis screening tool in Malaysia, the use of self-reported questionnaires is a promising strategy. In Malaysia, a self-assessment tool called MyGusi (Rani et al., 2020) was previously adapted from a Japanese questionnaire (Yamamoto et al., 2009) and demonstrated a positive correlation with patients' BPE scores. However, MyGusi has not been validated against the gold standard, which is periodontal diagnosis determined by a full mouth periodontal examination. On the other hand, there is the Self-reported Oral Health questionnaire (SROH) which was developed in the United States, has been widely used and validated across several countries as an alternative cost-effective population-based surveillance measure for periodontal disease (Eke et al., 2013; Iwasaki et al., 2021; Slade, 2007). This tool consists of eight questions selected for their statistical merit in predicting periodontitis (Eke & Genco, 2007). The SROH has been adapted into various languages and validated against diagnosis established by full mouth periodontal examination, showing substantial utility for periodontitis screening with acceptable levels of sensitivity and specificity (Carra et al., 2018; Deng et al., 2021b; Verhulst et al., 2019).

The World Workshop 2017 Classification for Periodontal and Peri-implant Diseases and Conditions has introduced a new classification of periodontal diseases that is applicable in clinical practice, research, and epidemiologic surveillance (Caton et al., 2018; Tonetti et al., 2018; Trombelli et al., 2018). To date few studies have evaluated the feasibility of the SROH or its individual questions in detecting periodontitis based on this

new classification (Deng et al., 2021b; Iwasaki et al., 2021). Given its potential use locally, an ongoing study in Universiti Malaya is adapting and validating the SROH in English (Appendix D) for use in Malaysia. To reach a broader Malaysian population and enhance accessibility, it must be translated into the Malay language, ensuring its linguistic and cultural appropriateness. Accordingly, in this study, the adapted SROH was translated and validated before being used to screen periodontitis among Malaysian adults.

1.3 Rationale of the study

The use of a self-reported questionnaire such as the SROH has the potential to foster awareness, facilitate prevention and improve early detection of periodontitis outside the conventional dental setting. This approach can be incorporated into health screenings conducted in various environments (i.e., schools and workplace) and can be administered by non-dental personnel. Moreover, this would also benefit underserved or rural communities with limited access to oral healthcare services. On one hand, this allows the target population to self-assess their oral health status and empower individuals to take a more active role in managing their periodontal health. On the other, it provides public health practitioners with a relatively simple and cost-effective means of identifying high-risk individuals as candidates for targeted intervention. A translated adapted SROH for periodontitis screening in Malaysia may help bridge the gap between monitoring prevalence and detection, enabling a larger population to assess their periodontal health and seek appropriate dental care.

The cost for management of periodontitis is influenced by both its severity and chronic nature. Patients with periodontitis, especially those suffering from severe forms, may require complex periodontal treatment. Furthermore, patients remain susceptible to relapse and require lifelong supportive care. The latest cost estimates for just the first line

of treatment amounted to MYR 8,863 per patient per year. Despite the low treatment-seeking rate, with only 0.7% of patients with periodontitis receiving periodontal care in Malaysia, the economic burden is substantial at MYR 696 million (Anuwar et al., 2024). Improving the management of periodontitis could lead to better oral health outcomes and reduced healthcare costs in Malaysia.

To date, the SROH has not been translated and validated for periodontitis screening in the Malaysian population, highlighting the need to evaluate the potential use of this tool for screening within our local population. To the best of our knowledge, this will be the first study to translate and validate the SROH for the Malaysian population. Besides its potential use as screening tool, the findings from this study could provide valuable insights for public health policy, encouraging more effective, data-driven approaches to oral health in Malaysia.

1.4 Research Questions

This study was conducted to address the following research questions:

i. Can the adapted SROH be translated and validated for periodontitis screening in the Malaysian context?
ii. What are the validity and reliability of the translated adapted SROH when applied in a sample of the Malaysian adult population?

1.5 Aim

The study aimed to translate and validate the adapted Self-reported Oral Health questionnaire (SROH) as a screening tool for periodontitis screening among Malaysian adults.

1.6 Objectives

The objectives of this study are:

i. To translate the adapted SROH tool for periodontitis screening into the Malay language to facilitate its use in Malaysia.

ii. To assess the validity and reliability of the Malay-translated adapted SROH (M-SROH) as a periodontitis screening tool among the adult population in Malaysia.

1.7 Conceptual framework

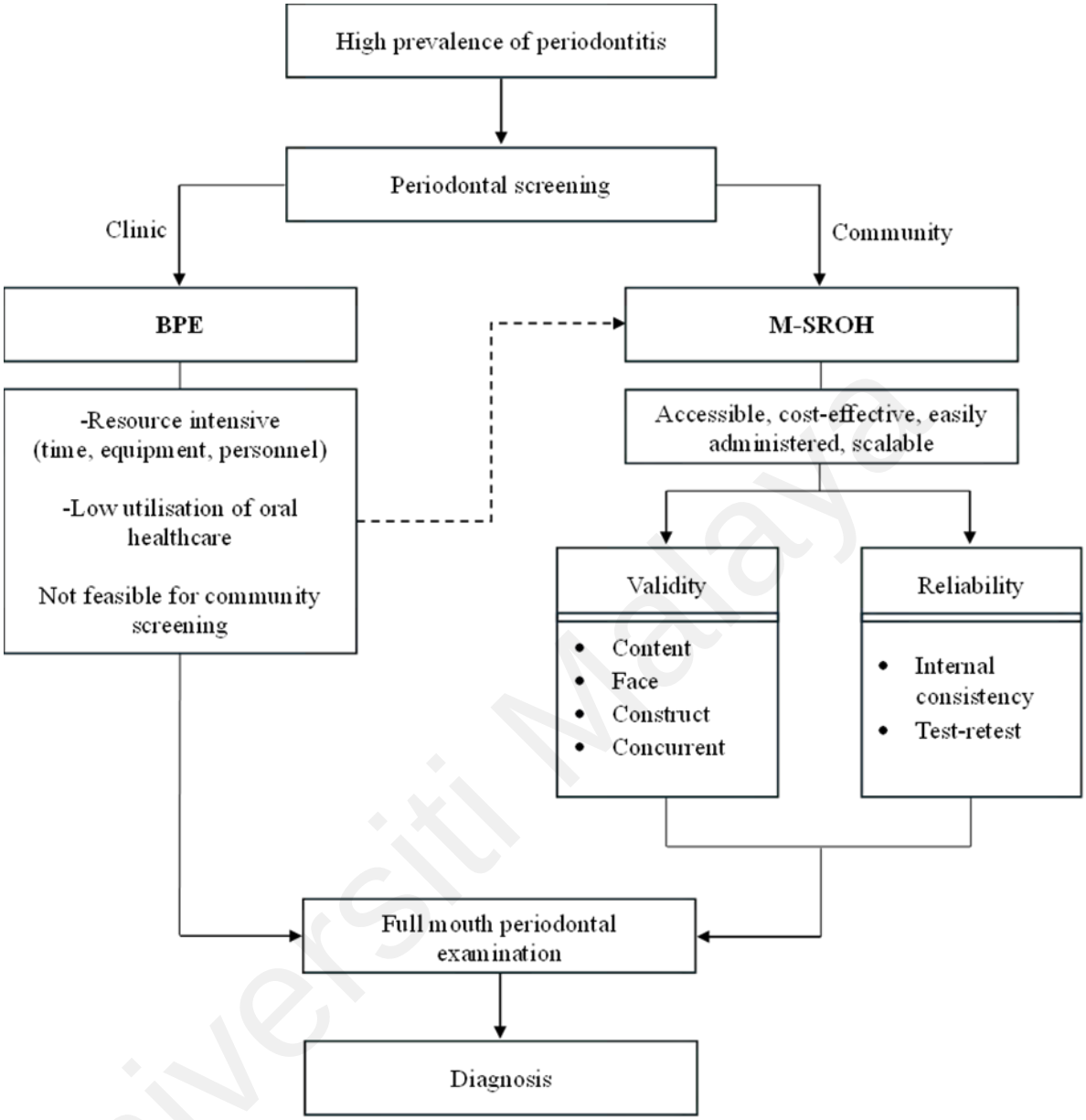

Figure 1.1: Conceptual framework of Translation and Validation of the Adapted SROH for Periodontitis Screening among Malaysian Adults

CHAPTER 2 : LITERATURE REVIEW

2.1 Periodontal disease

Periodontal disease is a multifactorial chronic inflammatory oral condition (Hajishengallis, 2022; Kinane et al., 2017). The initial stage of periodontal disease is gingivitis, a reversible inflammation of the gingiva caused by dental biofilm. In susceptible patients, gingivitis can progress to periodontitis if left untreated. The progression of periodontitis is driven by a combination of microbial dysbiosis and the host's immune response (Slots, 2017). Periodontal pathogens and their byproducts activate the innate and adaptive immunity to contain the infection, but inadvertently lead to the destruction of periodontal tissues (Cekici et al., 2014). This exaggerated inflammatory immune response results in the destruction of the tooth-supporting structures, including the gingiva, cementum, periodontal ligament, and alveolar bone, ultimately leading to the loosening and eventual loss of teeth (Pihlstrom et al., 2005).

While genetics significantly influences how our immune system responds to the initiating microbiota, environmental and lifestyle factors like smoking, hyperglycaemia, obesity, poor diet, and stress act as important modulators (Kinane et al., 2006; Tonetti et al., 2011). Nonetheless, the most crucial modifiable risk factor is oral hygiene, and removing the dental biofilm can prevent the chronic, unresolved inflammation that is characteristic of periodontitis (Axelsson et al., 2004; Chapple et al., 2015).

2.2 Clinical Burden of Periodontitis

According to the Global Burden of Disease 2019 Study, periodontitis affects approximately 18% of the global population, impacting over one billion people (IHME, 2021). Severe periodontitis ranked as the sixth most widespread condition out of 291 diseases and injuries, affecting up to 11% of the world population (Frencken et al., 2017;

Marcenes et al., 2013). The highest age-standardised prevalence rate of severe periodontitis was observed in sub-Saharan Africa (19,577 per 100, 000 persons), while the lowest rate was found in Southeast Asia, East Asia, and Oceania (10,060 per 100,000 persons). This illustrates the inverse correlation between the burden of severe periodontitis and the Socio-demographic Index (SDI), a composite indicator of income, education, and fertility (Chen et al., 2021). Periodontitis disproportionately affects vulnerable population groups and is a driver of social inequality (Jepsen et al., 2017; Jin et al., 2011).

Locally, the National Oral Health Survey for Adults 2020 (NOHSA 2020) reported that 94.5% of adults had some form of periodontal disease. Of them, 23.7% and 14.5% suffered from moderate and severe periodontitis, respectively (OHP, 2023). Even more concerning, the National Oral Health Survey of Schoolchildren 2017 (NOHSS 2017) indicated that nearly all schoolchildren in Malaysia had some form of periodontal disease (Oral Health Division, 2017). Overall, reports indicate increasing trends of severe periodontitis in various parts of the world (Kassebaum et al., 2014). Population growth, ageing and increased tooth retention were found to be among the factors contributing to the increased number of cases of severe periodontitis over the past three decades from 1990 to 2019 (Chen et al., 2021).

2.3 Periodontitis and Systemic Diseases

Periodontitis has been epidemiologically associated with various systemic diseases including cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), and rheumatoid arthritis (Genco & Sanz, 2020). However, it is important to ascertain whether the relationship between periodontitis and comorbid conditions is simply of a correlative nature or whether it also arises from causal interactions. With regards to the latter,

systemic inflammation may play a key role. Periodontal pathogens trigger the immune system to release pro-inflammatory mediators that enter systemic circulation. Patients with periodontitis have higher levels of interleukin-1 beta (IL-1β), interleukin-6 (IL-6), C-reactive protein (CRP), fibrinogen and neutrophils compared to those without periodontitis (Schenkein et al., 2020). Elevated CRP levels have been associated with an increased risk of CVD (Badimon et al., 2018). Elevated levels of proinflammatory mediators may also contribute to insulin resistance by activating intracellular pathways, such as nuclear factor-kappa B, eventually leading to worsening glycaemic control (Genco et al., 2020; Santos Tunes et al., 2010).

Conversely, interventional studies have demonstrated that treating periodontitis reduces systemic inflammation and surrogate markers of comorbid diseases. For instance, a study by Bajaj et al. (2018) in liver cirrhosis patients, periodontal therapy improved dysbiosis, endotoxemia and inflammatory mediators (e.g., IL-1β, IL-6) (Bajaj et al., 2018). Additionally, periodontal treatment was shown to enhance endothelial function (Tonetti et al., 2007) and reduce levels of CRP and tumour necrosis factor alpha (Iwamoto et al., 2003). Moreover, a recent systematic review found evidence that subgingival periodontal instrumentation in diabetic periodontitis patients led to improved glycaemic control, reducing glycated haemoglobin levels by 0.5% over 12 months (Simpson et al., 2022).

Likewise, these non-communicable diseases (NCDs) also have a significant impact on periodontitis. Patients with T2DM are three times more likely to develop periodontitis compared to those without T2DM patients (Löe, 1993). T2DM may influence periodontitis initiation and progression by inducing a hyperinflammatory

response, impairing bone repair processes, and producing advanced glycation end products (Chee et al., 2013; Stumvoll et al., 2005).

Another potential mechanism linking periodontitis to other diseases is the dissemination of periodontal pathogens to other parts of the body. Periodontal pathogens can enter the bloodstream and travel to other organs. For example, *Porphyromonas gingivalis*, has been found in atherosclerotic plaques of CVD and in brains of Alzheimer's disease patients (Dominy et al., 2019; Mougeot et al., 2017). These bacteria may contribute to disease development by promoting inflammation and oxidative stress. However, the relationship between bacterial colonisation and disease onset remains unclear. It is uncertain whether bacterial colonisation of healthy tissues precedes the development of disease, or if diseased tissues form first, enabling subsequent colonisation. Furthermore, the longevity of bacteria within tissues and the specific roles of different bacterial species in the progression of systemic diseases are not well understood.

The mechanisms linking periodontitis to other diseases are multifactorial, bidirectional and involve various pathways, including systemic inflammation, immune dysregulation, oxidative stress, and dysbiosis. The existence of this pathogenic synergy and shared risk factors emphasises the importance of preventive and early detection measures to address these interconnected health issues.

2.4 The Impact of Periodontitis

In early stage, periodontitis often exhibits mild and non-specific symptoms such as gingival bleeding and halitosis, which are frequently ignored by patients. Many individuals disregard these symptoms and do not seek professional care until the disease

has progressed to more severe stages (Jin, 2015). As the disease advances, more severe symptoms become apparent, including tooth hypermobility and migration, orofacial pain, and gingival recession. Individuals with severe periodontitis are at risk for extensive tooth loss, which can lead to loss of aesthetics, as well as masticatory and speech dysfunction. They have trouble chewing, pronouncing words and feel embarrassed, affecting their nutrition, quality of life, and self-esteem (Locker & Quiñonez, 2009; Ng & Leung, 2006). Changes in dietary habits, such as increased intake of starch and fats and reduced consumption of fresh fruits and vegetables, may contribute to the development and progression of chronic NCDs (Tonetti & Kornman, 2013).

A systematic review found a significant association between periodontitis and oral health-related quality of life (OHRQoL), with greater detrimental effects correlated with increasing disease severity and extent (Buset et al., 2016). Several studies using Oral Health Impact Profile (OHIP) instruments have linked periodontitis parameters, such as periodontal pocket probing depth, clinical attachment loss, tooth loss and gingival recession, to domains of functional limitation, physical pain, physical disability, psychological discomfort, psychological disability, handicap, and social disability (Acharya et al., 2009; Al Habashneh et al., 2012; Bianco et al., 2010; de Pinho et al., 2012; Durham et al., 2013; Jansson et al., 2014; Ng & Leung, 2006; Palma et al., 2013). These findings indicate that the impact of periodontitis on an individual's quality of life extends beyond the clinical manifestations of the disease, highlighting the need for a more comprehensive approach to understanding and addressing the burden of this condition.

Given the significant clinical burden of periodontitis, managing this disease has substantial financial implications. The economic impact of periodontitis is considerable, accounting for a significant proportion of the global cost of oral diseases, which was

estimated to be USD 442 billion in 2010 (Listl et al., 2015). The global cost of productivity loss due to severe periodontitis has been estimated to be USD 54 billion per year.

In Malaysia, the estimated expenditure required to treat all cases of periodontitis in 2012 was approximately MYR 32.5 billion, which would have accounted for 3.83% of the 2012 National Gross Domestic Product, comparable to other NCDs (Mohd Dom et al., 2016). In 2020, the national economic burden of non-surgical periodontal treatment during the first year of management in specialist clinics across Malaysia amounted to MYR 696 million despite the low utilisation rate among individuals with periodontitis (Anuwar et al., 2024). Timely diagnosis and treatment of periodontitis are crucial to reduce the burden of the disease and its associated costs. Early diagnosis can help prevent the progression of the disease, minimise the need for costly treatments, and improve overall oral health outcomes for individuals and populations.

2.5 The Importance of Early Diagnosis

There is a growing recognition among experts worldwide of the benefits associated with improving periodontal health. The impact of good periodontal health reaches beyond the oral cavity, extending to overall health, personal well-being, and the economy. Moreover, there exists a strong consensus that periodontitis can be effectively prevented, readily diagnosed and is highly manageable through appropriate treatment strategies (Tonetti et al., 2017).

The existence of common risk factors between NCDs and periodontitis supports the implementation of the Common Risk Factor Approach (CRFA) to integrate prevention strategies for both diseases (Puzhankara & Janakiram, 2021; Sheiham & Watt, 2000). For

example, the Malaysian Clinical Practice Guidelines for Management of T2DM (6th edition) include recommendations for screening and treatment of periodontal disease. A public health approach that integrates preventive and screening measures for both NCDs and periodontitis holds promise in improving overall health outcomes while also decreasing healthcare costs. Effective screening methods can help identify cases of periodontitis, leading to better prevention efforts, decreased clinical burden, and reduced economic implications associated with the disease.

2.6 Current Screening Methods

The Basic Periodontal Examination (BPE) is a clinical screening tool commonly used to identify periodontal disease. It provides guidance to clinicians on the necessary extent of examination and treatment needed (BSP, 2019). The World Workshop 2017 Classification for Periodontal and Peri-implant Diseases and Conditions has been integrated with the BPE system to streamline workflow in clinical practice (Dietrich et al., 2019). Although the BPE is quicker and simpler than a full mouth periodontal examination, it still requires periodontal probing, time, a trained dental professional, specialised instruments, and adequate lighting. Consequently, significant resources are still necessary to perform the BPE on a single patient. Furthermore, access to these resources may be limited in certain regions, particularly in remote areas with restricted access to oral health care services (Gardiner et al., 2020; Md Bohari et al., 2019).

In Malaysia, screening is hampered by low utilisation of oral healthcare services. More than two-thirds of patients only visit the dentist when there is a perceived treatment need (IHSR, 2020). Despite this, patient attendance at government dental clinics is increasing. As of 2019, over 80% of the population prefers to seek treatment at government facilities, representing a 40% increase from 2015 (IHSR, 2020). It is

becoming increasingly challenging to screen patients while providing treatment within an increasingly restricted time frame. Thus, there is a pressing need to identify more efficient, population-wide detection methods that are quick to administer, accessible, and cost-effective.

For these reasons, a questionnaire-based approach can be employed to exclude healthy individuals from having to undergo clinical examinations. This approach is especially relevant to resource-limited settings where the use of clinical screening may not be practical. In order to assess the feasibility of self-reported methods for periodontitis screening, the Centers for Disease Control and Prevention (CDC) in partnership with the American Academy of Periodontology (AAP), developed the Self-reported Oral Health questionnaire (SROH) (Eke & Genco, 2007). This 8-item tool was designed to facilitate the surveillance of periodontitis in the population at large.

2.7 Self-Reported Oral Health Questionnaire (SROH)

The SROH comprises eight self-reported oral health questions selected for their correlation with and ability to predict periodontitis. These questions assess patients' perception of their periodontal health, disease symptoms, treatment history, and oral hygiene practice. The feasibility of these self-reported oral health measures was first assessed among 456 adults in the United States using the CDC-AAP definition of periodontitis as reference standard. When responses towards all eight questions were combined with tooth loss, risk factors and demographic variables, a model with an area under the receiver operating characteristic curve (AUROCC) of 0.94, sensitivity of 56% and specificity of 87% was obtained (Eke & Dye, 2009)

Besides the United States (Eke et al., 2013), the SROH has undergone thorough validation in various local and national populations across several countries including Australia (Slade, 2007), France (Carra et al., 2018), Brazil (Reiniger et al., 2020), Spain (Montero et al., 2020) and Hong Kong (Deng et al., 2021b). This questionnaire, as a screening tool for periodontitis, has demonstrated an acceptable level of accuracy when benchmarked against a full mouth periodontal examination.

In the United States, a combination of the eight SROH questions and demographic factors among a nationally representative sample produced a model that demonstrated relatively high accuracy, with a sensitivity of 85%, specificity of 58%, and AUROCC score of 0.81 (Eke et al., 2013). Similarly, in a study conducted in France, combining SROH information with demographics resulted in a sensitivity rate of 78.9%, specificity rate of 74.8%, and AUROCC value of 0.82 (Carra et al., 2018). Researchers from various countries had to translate, adapt, and validate the SROH to ensure semantic, experiential and conceptual equivalence. Besides the inherent biases and confounding factors, differences in outcome can be partly attributed to the unique cultural, socioeconomic characteristics of each study population (Blicher et al., 2005).

In another study conducted in the Netherlands, it was found that using the SROH alone had similar predictive ability as a model that combined questionnaire responses with biomarkers from oral rinse samples (AUROCC of 88%, sensitivity of 78%, and specificity of 84%) (Verhulst et al., 2019). However, this could have been due to the evaluation of total matrix metalloproteinase-8 (MMP-8) instead of active MMP-8, which has been proven to have a correlation with periodontitis severity and treatment progress. Studies have shown that increased levels of active MMP-8, but not total or latent MMP-8, can distinguish periodontitis from gingivitis, and precede periodontal attachment loss

(Alassiri et al., 2018; Kiili et al., 2002; Sorsa et al., 2006). The combination of potential oral-fluid biomarkers with the SROH for periodontitis screening should be further explored in upcoming studies.

With future studies to test its external validity in larger and more diverse community-based populations, the SROH could indeed become a globally useful screening tool. The questionnaire has demonstrated its potential usefulness for identifying individuals with periodontitis in non-clinical and medical settings, allowing for early referral with acceptable levels of sensitivity and specificity (Eke et al., 2013).

Currently, a study has adapted and validated the SROH for use in Malaysia. However, the adapted SROH was not translated into the local language, Malay. Therefore, it becomes imperative to translate and validate the adapted SROH to ensure its implement ability and accessibility in the wider Malaysian population. Given the high prevalence of periodontal disease in Malaysia, by translating and validating the SROH for the Malaysian context, the tool can be more effectively utilised as a non-invasive, cost-effective screening method for periodontitis. Moreover, it will enable earlier identification of individuals with the disease, facilitating timely referral and intervention, and ultimately contributing to improved oral health outcomes and reduced disease burden in Malaysia.

2.8 Questionnaire Translation

Malaysia is a diverse country with a rich blend of ethnicities and cultures. The Malay language serves as the national language and lingua franca, used extensively in government setting and as the primary means of communication among the different ethnic communities. The population includes Malays, Chinese, Indians, as well as indigenous groups like the Orang Asli in Peninsular Malaysia and natives of Sabah and

Sarawak. Since gaining independence in 1957, Malaysian schools have taught Malay to all students. Given the importance of Malay language in Malaysia, it is essential to translate and adapt this tool to effectively apply it as a screening tool for periodontitis among Malaysian adults. This translation and adaptation process must consider the distinctive cultural factors and common language prevalent within the local population to ensure the tool's relevance, acceptability, and effectiveness in the Malaysian context.

The translation process ensures that the measure maintains its conceptual integrity across various settings, allowing it to be reliably utilised to explore the same area of interest in different contexts. (Beaton et al., 2000). The need for cross-cultural adaptation depends on the origin of the measure (language and culture) and its planned prospective use (Beaton et al., 2000; Guillemin et al., 1993). No cross-cultural adaptation is necessary when the measure is utilised in a similar language and cultural environment. However, for a population with a different culture and language, cross-cultural adaptation is essential (Beaton et al., 2000). Guidelines for the cross-cultural adaptation process have been published by Guillemin et al. (1993) and Beaton et al. (2000). This process comprises of five main stages namely forward translation, synthesis of the translations, back translation, expert committee review, and pre-testing.

2.8.1 Forward translation

The forward translation process involves translating the original language into the target language. It is recommended to have at least two independent forward translations to identify any ambiguous wording in the original. It is preferable for these translators to work in their native language, in order to better capture the nuances of the target language. One of the translators should be aware of the concepts the questionnaire intends to measure, so as to provide a translation that closely mirrors the original instrument.

Conversely, the second translator should not be aware of the questionnaire's purpose, in order to discern any subtle differences within the original (Beaton et al., 2000).

2.8.2 Synthesis of the translations

The second step of the translation process is the synthesis of the translated versions to produce a common translation. This stage is conducted to achieve consensus among all the forward translators. Any discrepancies between the two translations can be discussed and resolved by the original translators, or through the involvement of an impartial, bilingual translator who did not participate in the preceding translations. The purpose of this synthesis stage is to consolidate the forward translations into a single, harmonised version that accurately captures the conceptual and linguistic equivalence of the original measure. This approach helps to minimise potential ambiguities or inconsistencies that may arise during the initial translation process. The resulting synthesised translation serves as the foundation for the subsequent back-translation and expert committee review stages (Beaton et al., 2000).

2.8.3 Back translation

The third step of the process if back-translation. This involves translating the target language version back into the original language, working from the forward-translated version. The purpose of this step is to is ensure that the initial translation reflects the same item content as the original. It is recommended to have at least two back translations performed by independent translators, preferably translating into their mother tongue. This helps to identify any inconsistencies or conceptual errors that may have been introduced during the forward translation process. To avoid bias, the back-translators should ideally be unaware of the intended concepts measured by the questionnaire. This ensures that the back-translations are done objectively, without preconceptions about the

underlying constructs. The back-translation stage is a crucial quality control measure, allowing the researchers to compare the back-translated versions to the original questionnaire and identify any discrepancies or issues that need to be addressed in the final adapted version (Beaton et al., 2000).

2.8.4 Expert committee review

The fourth step of the questionnaire translation process is expert committee review. The role of this committee is to ensure cross-cultural equivalence between the original and target language versions of the questionnaire. The expert committee review involves achieving the following types of equivalence (Beaton et al., 2000):

- Semantic equivalence ensures that the meaning of words in the original and target languages is similar.
- Idiomatic equivalence ensures that expressions used in both languages are comparable.
- Experiential equivalence ensures that the target culture shares similar experiences to those in the original.
- Conceptual equivalence ensures that the conceptual meaning of terms aligns between the languages.

The expert committee typically comprises of individuals familiar with the construct of interest (in this case, periodontitis), a methodologist, the forward and backward translators, if possible, the developers of the original questionnaire. This diverse team reviews and consolidates all the translated versions to derive a pre-final version of the adapted questionnaire. By involving this expert committee, the researchers can ensure that the translation and adaptation process has been thorough and that the final

version of the questionnaire maintains conceptual and linguistic equivalence with the original (Beaton et al., 2000).

2.8.5 Pre-testing

Pre-testing is crucial step in the translation and adaptation process, aimed at understanding how subjects interpret the items in the measure. A sample of 30 - 40 participants is recommended. Following the administration of the translated questionnaire, participants are invited to provide explanations regarding their interpretations of each questionnaire item and the associated response options.. This can be done verbally by an interviewer or via an open-ended question. The distribution of the responses is analysed to identify any missing items and ensure that the translated items have preserved their original meaning. This approach allows the investigator to ensure that the translated items are clear and unambiguous, thereby eliminating any potential confusion regarding the translated questionnaire. This process may be repeated a few times to finalise the definitive translated version of the questionnaire. This process is designed to ensure content and face validity between the original and the target versions of a measure. However, it is important to note that the derived target measure may not retain the psychometric properties as the original measure. Therefore, further validity and reliability testing is often required to evaluate the psychometric properties of the target version. This includes testing the questionnaire's sensitivity, specificity, and reliability, as well as its ability to distinguish between different levels of the construct being measured (Beaton et al., 2000).

2.9 Questionnaire Validation

The quantifiable characteristics of a test that denote its statistical strength or weakness are known as its psychometric properties.. They provide information about a

test's adequacy, relevance, and usefulness, and are associated with the data collected to determine how well the test evaluates the construct of interest. Validity and reliability are fundamental psychometric properties. Validity refers to a measure's ability to accurately assess what it is intended to measure, whereas reliability refers to its ability to yield consistent results. Validation is the process used to determine the validity and reliability of a measure among the intended participants (Tsang et al., 2017).

It is important to note that a measure that demonstrates excellent reliability and validity within one population may not necessarily exhibit the same characteristics when applied to a different sample. In the context of research, it is critical to evaluate the psychometric properties of the instruments used to ensure the accuracy and dependability of the findings. The validation process involves assessing various aspects of a measure, such as its content validity, construct validity, and criterion-related validity, as well as its internal consistency and test-retest reliability (Tsang et al., 2017). By thoroughly evaluating the psychometric properties of a measure, researchers can ensure that the data collected using that instrument is valid, reliable, and suitable for drawing meaningful conclusions.

2.9.1 Validity

It is important to note that reliability does not necessarily equate to validity. A reliable measure produces consistent results, but it may not be accurate (valid). For instance, a bathroom scale that consistently shows you are five kilogrammes lighter than your actual weight is reliable (consistent) but not valid (accurate). The validity of a measure refers to its ability to accurately capture the intended construct, regardless of its reliability. The main forms of validity assessment are content validity, face validity, criterion validity, and construct validity.

a. Content validation

Content validation is a process that evaluates the extent to which a measure comprehensively includes all necessary items to represent the construct being measured. Content validation consists of six steps: (i) preparation of the content validation form; (ii) selection of a review panel of experts; (iii) conduct of the content validation; (iv) review of domain and items; (v) provision of a score on each item; and (vi) calculation of the content validity index (CVI) (Yusoff, 2019a).

i. Preparation of the content validation form

The content validation form should begin with an introductory section outlining the purpose of the validation and the domain being assessed. This is then followed by instructions guiding the experts in evaluating each item using a specified rating scale. One example is a 4-point Likert scale, where experts rate each item based on its relevance to the construct being measures. The scale ranges from 1 (the item is not relevant), to 4 (the item is highly relevant) (Yusoff, 2019a).

By providing a clear rating scale, the experts can systematically evaluate each item and provide their assessment of the item's relevance. This structured approach helps to ensure consistency in the experts' ratings and facilitates the calculation of the CVI for each item and the overall measure. The content validation form should also include space for the experts to provide qualitative feedback and suggestions for improving or clarifying the items, if needed. This feedback can be valuable in refining the measure and enhancing its content.

ii. Selection of a review panel of experts

Individuals selected to serve on the expert review panel should be chosen based on their relevant expertise in the study topic (Yusoff, 2019a). The recommended number of experts and the implications for the acceptable cut-off score of the CVI should be used as a reference point in this process (Table 2.1) (Yusoff, 2019a). This approach is especially important to provide a comprehensive and robust evaluation of the questionnaire, ensuring its relevance, clarity, and effectiveness in measuring the intended constructs. By involving a panel of experts with appropriate knowledge and experience, the content validation process can more accurately assess whether the measure includes all the necessary items and adequately represents the construct being measured.

Table 2.1: The number of experts and the acceptable cut-off score of CVI

Number of experts	Acceptable CVI values	Source
Two experts	At least 0.80	(Davis, 1992)
Three experts	Should be 1	(Polit & Beck, 2006; Polit et al., 2007)
At least six experts	At least 0.83	(Polit & Beck, 2006; Polit et al., 2007)
Six to eight experts	At least 0.83	(Lynn, 1986)
At least nine experts	At least 0.78	(Lynn, 1986)

iii. Conduct of the content validation

The content validation process can be conducted either through a face-to-face approach or remotely, depending on the practical considerations and constraints of the study. A face-to-face approach may be preferable as it allows for direct interaction and discussion among the expert panel members. This can facilitate a more comprehensive evaluation of the questionnaire items. Nevertheless, a remote approach may be chosen to balance cost and logistical constraints associated with convening all the experts physically. In such cases, it is crucial to implement a systematic follow-up mechanism to guarantee a high response rate and timely feedback from the experts within a prescribed timeframe (Yusoff, 2019a).

This follow-up process may involve regular email reminders, virtual meetings, or other communication strategies to ensure the experts provide their feedback in a timely manner. By maintaining a high level of engagement and responsiveness, the researchers can maximise the quality and completeness of the content validation process, even when conducted remotely. Regardless of the approach chosen, the goal is to obtain a robust and comprehensive evaluation of the questionnaire from the expert panel, ensuring the relevance, clarity, and effectiveness of the measure in assessing the intended constructs.

iv. Review of domain and items

After distributing the content validation forms, the experts are tasked with critically assessing the domain and its associated items. They should be encouraged to offer written comments and suggestions to enhance the relevance of the items to the targeted domain. All feedback received from the experts should be carefully considered and used to refine both the domain and its constituent items. This iterative process ensures a thorough and comprehensive content validation, where experts' input is used to improve the measure and ensure it comprehensively represents the construct being assessed (Yusoff, 2019a). The inputs also facilitates the researchers in making necessary adjustments to the wording, clarity, and relevance of the questionnaire items. This helps to optimise the content validity of the measure, increasing confidence that it accurately captures the intended construct.

v. Provision of a score on each item

During the content validation process, the experts independently review and score each item related to the domain using the 4-point Likert scale. Upon completing their evaluations, the experts submit their scored responses to the researcher. This ensures that all items have been thoroughly assessed and scored by the panel of experts (Yusoff,

2019a). The researchers then compile and analyse the scores provided by the experts to calculate the CVI for each item and for the overall measure . This statistical analysis helps to determine the extent to which the items and the measures as a whole are deemed relevant and representative of the construct being assessed. This process maintains objectivity and rigour by minimising potential biases and ensures that the final assessment of the measure's content validity is based on the collective expertise and judgements of the review panel (Yusoff, 2019a).

vi. Calculation of the content validity index (CVI)

The CVI comprises two components namely the Item-level CVI (I-CVI) and the Scale-level CVI (S-CVI). The I-CVI represents the proportion of experts who rated an item as quite relevant (score 3) and highly relevant (score 4) out of the total number of experts. As for the S-CVI, it represents the overall content validity of the entire measure. Two methods are commonly used to calculate the S-CVI, the average of the I-CVI scores across all items (S-CVI/Ave), and the proportion of items that achieved a rating of 3 and 4 by all experts (S-CVI/UA) (Davis, 1992; Polit & Beck, 2006; Polit et al., 2007). The detailed definitions and formulas for these CVI indices are provided in Table 2.2. Items attaining a CVI value of 0.80 or higher should be retained in the questionnaire (Yusoff et al., 2021).

Table 2.2: Definition and formula for content validation indices

Indices	Definition	Formula
Content Validation Indices		
I-CVI (Item-level Content Validity Index)	The sum of points for each item (relevance score of 3 or 4 divided by the number of experts)	I-CVI = (sum of points item) / (number of experts)
S-CVI/Ave (Scale-level Content Validity Index based on the average method)	The average of the I-CVI scores for all items on the scale or the average of proportion relevance judged by the experts. The proportion relevance is the average of relevance rating by the individual expert.	S-CVI/Ave = (sum of I-CVI scores) / (number of items)
		S-CVI/Ave = (sum of proportion relevance rating) / (number of experts)
S-CVI / UA (Scale-level Content Validity Index based on the universal agreement method	The proportion of items on the scale that achieve a relevance scale of 3 or 4 by all experts. Universal agreement (UA) is given as '1' when the item achieved 100% agreement among the experts. If not, the UA score is given as '0'	S-CVI/UA = (sum of UA scores) / (number of items)

b. Face validation (Pre-testing)

Face validity is closely linked to content validity, it concerns the degree to which the participants judge the measure's items to be clear and comprehensible (Tsang et al., 2017). The face validation process involves the following procedures: (i) preparation of the face validation form; (ii) selection of a panel of participants; (iii) conduct of the face validation; (iv) review of items for clarity and comprehensibility; (v) provision of scores for each item based on the rating scale for clarity and comprehensibility; and (vi) calculation of the face validity index (FVI) (Yusoff, 2019b).

i. Preparation of the face validation form

To conduct the face validation response form should be developed to provide clear guidelines and instructions to participants. This ensures uniform comprehension of the task and the domain being evaluated (Yusoff, 2019b). The response form should include detailed guidance on how the participants should evaluate the questionnaire items. A common approach is to use a 4-point Likert scale, where participants rate each item based

on its clarity and comprehensibility. The scale ranges from not clear or comprehensible (score 1) to very clear and comprehensible (score 4) (Yusoff, 2019b).

The face validation response form should also include space for the participants to provide written comments and suggestions for improving the clarity and comprehensibility of the items. This qualitative feedback can be valuable in refining the measure and enhancing its face validity. The use of a well-designed response form ensures that the face validation process is conducted in a consistent and meaningful manner, allowing the researchers to gather valuable insights from the target population.

ii. Selection of a panel of participants

The selection of participants for face validation process should be based on the target user group of the questionnaire. The recommended number of participants and the implications for the acceptable cut-off score for the FVI are summarised in Table 2.3 (Yusoff, 2019b). The size and composition of the respondent panel should be carefully considered to ensure the face validation process is thorough and the resulting FVI is a reliable indicator of the measure's acceptability and usability within the target population.

Table 2.3: The number of participants and the acceptable cut-off score of FVI

Number of participants	Acceptable FVI values	Method	Source
30 medical students	At least 0.80	Face-to-face survey	(Hadie et al., 2017)
30 paramedics	At least 0.83	Face-to-face survey	(Ozair et al., 2017)
30 parents of pre-school children	At least 0.80	Face-to-face survey	(Lau et al., 2017)
30 parents of pre-school children	At least 0.80	Face-to-face survey	(Lau et al., 2018)
10 users of medical apps	At least 0.83	Online survey	(Mohamad Marzuki et al., 2018)
32 medical students	At least 0.80	Online survey	(Andrew Chin et al., 2018)
32 medical students	At least 0.80	Online survey	(Mahadi et al., 2018)

iii. Conduct of the face validation

As with the content validation process, the face validation can be conducted either through an in-person or online approach, depending on the practical considerations and constraints of the study. The goal is to obtain a robust and comprehensive evaluation of the questionnaire from the target population, ensuring the clarity, comprehensibility, and relevance of the measure from the end-user's perspective.

iv. Review of items for clarity and comprehensibility

During the face validation process, participants should be instructed to examine each questionnaire item carefully before assigning a score based on the provided rating scale. They should also be encouraged to offer written feedback to improve the clarity and comprehensibility of the items. All comments and feedback provided by the participants should be reviewed thoroughly by the researchers. The aim is to use this input to refine and improve the items, addressing any issues or ambiguities identified during face validation process (Yusoff, 2019b). The combination of numerical ratings and qualitative feedback from the participants provides a comprehensive assessment of the measure's face validity, guiding the researchers in finalising the questionnaire for use in the target context.

v. Provision of scores for each item based on the clarity and comprehensibility rating scale

During the face validation process, participants should carefully read and evaluate each questionnaire item. Participants. They should then score the items using specified rating scale. After completing the assessments, the participants should submit their scored responses to the researcher. This ensures that all items have been thoroughly evaluated and rated by the panel of participants (Yusoff, 2019b). The researchers can then use the

FVI, along with the qualitative feedback from the participants, to refine and finalise the questionnaire, ensuring it is well-suited for use in the intended context.

vi. Calculation of the face validity index (FVI)

Calculating the FVI involves two components namely Item-level FVI (I-FVI) and Scale-level FVI (S-FVI). For the S-FVI, there are two approaches which is average I-FVI scores (S-FVI/Ave) and the proportion of items rated 3 or 4 (S-FVI/UA). The specific definitions and formulas for these FVI indices are outlined in Table 2.4. This analysis, based on input from the participants, is essential for a complete assessment of the face validity of the questionnaire (Ozair et al., 2017). It helps to identify which items are clear, comprehensible, and relevant to the target population. Questions that achieve a score of 0.80 or above should be retained in the questionnaire (Yusoff et al., 2021).

Table 2.4: Definition and formula for face validation indices

Indices	Definition	Formula
Content Validation Indices		
I-FVI (Item-level Face Validity Index)	The sum of points for each item (relevance score of 3 or 4 divided by the number of reviewers)	I-FVI = (sum of points item) / (number of reviewers)
S-FVI/Ave (Scale-level Face Validity Index based on the average method)	The average of the I-CVI scores for all items on the scale or the average of proportion relevance judged by the reviewers. The proportion relevance is the average of relevance rating by the individual reviewer.	S-FVI/Ave = (sum of I-CVI scores) / (number of items)
		S-FVI/Ave = (sum of proportion relevance rating) / (number of reviewers)
S-FVI / UA (Scale-level Face Validity Index based on the universal agreement method	The proportion of items on the scale that achieve a relevance scale of 3 or 4 by all reviewers. Universal agreement (UA) is given as '1' when the item achieved 100% agreement among the reviewers. If not, the UA score is given as '0'	S-FVI/UA = (sum of UA scores) / (number of items)

The main difference between content validation and face validation is the timing of the review process. Content validation is conducted during the initial development of the instrument, while face validation is done after the instrument has been constructed. Both content and face validation are subjectively measured and not amenable to formal

statistical testing. They emphasise the comprehensive coverage and item relevance based on the construct measured.

While content and face validation are distinct processes, they are both crucial in establishing the overall validity of the instrument. By combining these subjective assessments, researchers can have confidence that the measure not only covers the necessary content but is also perceived as relevant and understandable by the intended participants. The complementary nature of content and face validation helps to enhance the overall quality and acceptability of the measure, ensuring it is fit for purpose in the target context.

c. Criterion validation

Criterion validation refers to the assessment of a measure against a recognised "gold standard" or criterion. This process involves correlating the measure the measure being validated with the established reference standard. Criterion validation can be conducted in two forms, concurrent validation and predictive validation. In concurrent validation, the comparison is made simultaneously whereas predictive validation evaluates the measure's ability to forecast or predict a future event or outcome. A desirable correlation coefficient for this process is ≥ 0.7, indicating a strong positive correlation between the measure and the criterion (McDonald, 2005).

A high correlation coefficient suggests that the measure being validated is accurately capturing the same construct as the gold standard reference. This provides evidence that the measure is a valid and reliable assessment tool, as it aligns with a widely recognised and accepted standard. Criterion validation is an important step in the overall validation process, as it helps to establish the external validity of the measure. By demonstrating the

measure's ability to correlate with a known standard, researchers can have greater confidence in the measure's ability to accurately assess the intended construct. The specific gold standard measure used for criterion validation will depend on the context and the construct being measured. Identifying an appropriate criterion is a crucial part of the validation process (McDonald, 2005).

d. Construct validation

Construct validation involves evaluating a measure's ability to accurately assess the intended construct. Several approaches exist for assessing construct validity, including known-group validation, convergent validation, and discriminative validation (Fayers & Machin, 2007). Known-group validation relies on the premise that certain subject groups are expected to score differently on the measure. A valid measure should demonstrate statistically significant differences between these known groups, making it a form of sensitivity assessment. Sensitivity refers to a measure's ability to detect differences between groups, distinct from responsiveness, which reflects a measure's capacity to detect changes within individuals over time. Highly sensitive instruments are typically also highly responsive (Fayers & Machin, 2007).

Convergent and discriminant validation are assessed through correlation. Convergent validity is established when the target measure is strongly correlated with a measure of similar or related constructs. A high correlation indicates convergent validity. Discriminant validation is demonstrated when the target measure is uncorrelated with a measure of a very different construct. Low or no correlation indicates discriminant validity.

For a measure to be effectively utilised within clinical practice and research, it must demonstrate sound psychometric properties, including both validity and reliability. This ensures the measure is accurately capturing the intended construct and producing consistent, dependable results. By thoroughly evaluating the construct validity of a measure through known-group, convergent, and discriminant approaches, researchers can have confidence in the measure's ability to assess the intended construct and its suitability for the target population and context.

2.9.2 Reliability

The reliability and consistency of a measure can be evaluated through two key approaches; internal consistency and test-retest reliability.

a. Internal consistency

Internal consistency is the extent to which the items within a measure are inter-correlated and consistent in measuring the same underlying construct. This is often estimated using Cronbach's alpha ($\alpha Cronbach$) value, which is calculated from a single administration of the measure (Cronbach, 1951). Cronbach's alpha values range from 0 (zero) to 1 (one), with 0 indicating no internal consistency (none of the items are inter-correlated) and 1 indicating perfect internal consistency (all items are inter-correlated). The Cronbach alpha values have been described as excellent (0.93 – 0.94), strong (0.91 – 0.93), reliable (0.84 – 0.90), robust (0.81), fairly high (0.76 – 0.95), high (0.73 – 0.95), good (0.71 – 0.91), relatively high (0.70 – 0.77), slightly low (0.68), reasonable (0.67 –0.87), adequate (0.64 – 0.85), moderate (0.61 – 0.65), satisfactory (0.58 – 0.97), acceptable (0.45 – 0.98), sufficient (0.45 – 0.96), not satisfactory (0.4 – 0.55) and low (0.11) (Taber, 2018).

However, an adequate level of internal consistency is typically considered to be a Cronbach's alpha value of more than 0.70 (Nunnally & Bernstein, 1994). If the alpha value is lower, items with weak correlations to the total score should be revised or discarded. Conversely, an alpha value of 0.90 or higher may necessitate the elimination of repetitive questions to ensure the measure is concise and effectively measures the intended construct (Tsang et al., 2017). It is important to note that Cronbach's alpha value is related to the length of the measure, as it tends to increase with the number of items (Streiner, 2003).

b. Test-retest reliability

Test-retest reliability is the extent to which the subjects' responses to the measure's items remain consistent across repeated administrations of the measure. It reflects the stability of the measure over time. Test-retest reliability refers to the consistency of participants' responses when the is administered repeatedly at two different time points. The duration between the two time points should be sufficient to minimise the impact of memory, but not so long that changes may occur in the construct being measured. There is no universally accepted interval between the two administrations, but the typical test-retest period is between 10 and 14 days (Keszei et al., 2010). This duration allows for a balance between minimising memory effects and avoiding potential changes in the construct.

Statistical analyses of test-retest reliability are based on the initial and subsequent administrations of the measure at two distinct time points. Reliability coefficients range between 0 (no reliability) and 1.0 (perfect reliability). For applications involving the evaluation of individual participants, a reliability coefficient of 0.9 or higher is recommended. The high threshold ensures that the measure can reliably assess individual differences and changes over time. Conversely, in studies aimed at discriminating

between groups, the reliability coefficient should exceed 0.70 (Nunnally & Bernstein, 1994). This lower threshold is acceptable for group-level comparisons, as individual differences are less critical in such contexts. By establishing test-retest reliability, researchers can have confidence that the measure is producing stable and consistent results over time, which is crucial for its effective use in research and clinical practice.

2.10 Summary of Literature

Periodontitis is a major public health concern in Malaysia, affecting 38.2% of the adult population (OHP, 2023). Despite being highly preventable, easily diagnosed, and effectively managed, most cases of periodontitis remain untreated. This condition is a leading cause of tooth loss, edentulism, and poor quality of life. There is an urgent need to implement more rapid, accessible, and cost-effective detection methods to address this public health issue.

The self-report method has the potential to improve early detection of periodontitis outside traditional dental settings. Currently, the SROH has been adapted for use as screening tool for periodontitis in Malaysia. However, maintaining it in its original language, English, may limit its potential for widespread use as a nation-wide screening tool in Malaysia, where Malay is the country's first language. Thus, translating and validating the adapted SROH may help bridge the gap between monitoring prevalence and detecting disease. This tool would enable a larger population to assess their periodontal health and seek appropriate dental care, ultimately leading to improved oral health outcomes in Malaysia.

The translated and validated adapted SROH can also be used by healthcare professionals from different fields to effectively screen for periodontitis, fostering multidisciplinary collaboration. Additionally, this questionnaire could be integrated with suitable biomarkers to potentially evaluate risk even before signs or symptoms manifest. This study aims to translate and validate the adapted SROH for periodontitis screening in the Malaysian context. To the best of my knowledge, this will be the first study to translate and validate the adapted SROH for the Malaysian population.

CHAPTER 3 : TRANSLATING AND VALIDATING THE ADAPTED SELF-REPORTED ORAL HEALTH QUESTIONNAIRE (SROH) AS A SCREENING TOOL FOR PERIODONTITIS IN MALAYSIA

3.1 Introduction

Periodontitis is a chronic, multifactorial inflammatory disease characterised by the presence of dysbiotic plaque biofilms and progressive deterioration of the tooth-supporting structures (Papapanou et al., 2018). When left untreated, periodontitis can result in progressive tooth mobility, functional impairment and, ultimately, tooth loss (Slots, 2017). Periodontitis is highly prevalent and constitutes a major public health issue. According to the Global Burden of Disease Study 2019, the age-standardised prevalence of severe periodontitis was 10.59%, equating to 1.1 billion affected individuals globally (Chen et al., 2021). Similarly, the National Oral Health Survey of Adults (NOHSA) 2020 in Malaysia found that 38.2% of dentate individuals aged 15 years and above had periodontitis (OHP, 2023). In its early stages, periodontitis is often silent and insidious, but as it progresses, it can negatively impact oral health-related quality of life (Buset et al., 2016). Such adverse outcomes may include impaired speech and communication, pain, psychological discomfort, and difficulty with chewing (Ferreira et al., 2017). Despite the low oral healthcare utilisation rate, with only 0.7% of patients with periodontitis receiving periodontal care in Malaysia, the economic burden is substantial, estimated at MYR 696 million (≈USD 166 million) (Anuwar et al., 2024). Moreover, recent evidence has indicated that periodontitis is related to several systemic diseases, such as diabetes mellitus and cardiovascular diseases (Genco & Sanz, 2020). The importance of diagnosing and treating periodontitis cannot be overstated. The combination of these factors, along with low oral health awareness and the silent nature of periodontal disease, highlights the urgent need for an effective population-wide screening tool for this disease. Furthermore, there is a strong consensus that periodontitis

can be effectively prevented, readily diagnosed, and managed through appropriate treatment strategies (Tonetti et al., 2017).

Despite significant advancements in the field of periodontology, the methods for detecting and diagnosing periodontitis have remained relatively unchanged. Periodontal diagnosis continues to be predominantly based on clinical assessment of the periodontal tissues through various measurements, as well as radiographic analysis of alveolar bone loss. Currently practiced screening methods, such as the Basic Periodontal Examination (BPE) (BSP, 2019), are largely confined to clinical settings. They necessitate periodontal probing, time, trained dental personnel, specialised instruments, and are relatively invasive. This limits the accessibility of screening in underserved and remote areas with restricted access to oral healthcare services. Furthermore, this is compounded by the fact that most Malaysians underutilise healthcare services. The National Health and Morbidity Survey 2019 revealed that 69.5.% of Malaysians with recent oral health problems did not seek dental treatment (IHSR, 2020).

Another promising screening approach is point-of-care testing utilising salivary biomarkers. A systematic review of salivary biomarkers in periodontitis research found good discriminative capability for interleukin-1 beta (IL-1β), interleukin-6 (IL-6), matrix metalloproteinase-8 (MMP-8) and (matrix metalloproteinase-9) MMP-9 (Arias-Bujanda et al., 2020). Furthermore, saliva collection is a straightforward procedure that can be carried out by non-dental personnel, eliminating the need for specialised equipment (Giannobile et al., 2009). Recently, a commercial testing kit based on active MMP-8 was developed and patented (Sorsa et al., 2020). However, it demonstrated poor sensitivity (33.2%) for periodontitis when tested in a sample of 408 patients. The authors attributed this to the kit's detection limit of 10 ng/ml, as 75% of test results fell below this threshold

(Deng et al., 2021a). In another study, an MMP-9 test kit attained a sensitivity and specificity of 0.92 and 0.85 respectively but only when combined with demographic information such as age, gender, smoking and obesity (Kim et al., 2020). Although promising, point-of-care testing in the periodontal field remains at an early stage, offering significant room for improvement.

Self-reported assessment is an efficient and accepted method of evaluating a range of medical conditions, including cancer, cardiovascular disease (Newell et al., 1999), and juvenile rheumatoid arthritis (Wright et al., 1994). A key advantage is the straightforward, non-invasive, and cost-effective manner in which data can be gathered from individuals. This also renders it an effective screening tool, as surveys can reach much broader audiences than clinical examinations. Furthermore, this approach can raise awareness regarding periodontal disease and serve as a motivational factor for promoting good oral hygiene practices. Nonetheless, self-report is currently not widely used for periodontal disease screening. The Self-reported Oral Health Questionnaire (SROH), developed by the Centers for Disease Control and Prevention (CDC) and the American Academy of Periodontology (AAP), comprises eight self-reported oral health questions for predicting the prevalence of periodontitis in the United States (Eke & Genco, 2007). When evaluated in a sample of 456 adults, a model combining responses to these questions with tooth loss, risk factors, and demographic variables achieved an excellent area under the receiver operating characteristics curve (AUROCC) of 0.94, with sensitivity of 56%, and specificity of 87% for detecting periodontitis according to the CDC-AAP definition (Eke & Dye, 2009).

A subsequent study by the same research team further validated the usefulness of these survey questions among a nationally representative sample of American adults aged

30 years and older who participated in the National Health and Nutrition Examination Survey from 2009 to 2010 (Eke et al., 2013). The similar model demonstrated an AUROCC of 0.81, with sensitivity of 84.7% and specificity of 57.6%. Additionally, the SROH has been translated and validated in various countries with acceptable levels of accuracy (Carra et al., 2018; Deng et al., 2021b; Iwasaki et al., 2021; Verhulst et al., 2019). This accumulated evidence appears to support the utility of the SROH for periodontitis screening beyond the conventional dental setting.

An ongoing study is currently adapting and validating the SROH for use in the Malaysian context. To enhance accessibility and reach a wider Malaysian population, the instrument should be translated into the Malay language, ensuring its linguistic and cultural appropriateness. This would enable a larger segment of the Malaysian populace to assess their periodontal health and seek appropriate dental care, ultimately leading to improved oral health outcomes nationwide. To the researchers' knowledge, this represents the first effort to translate and validate the SROH for the Malaysian population. Therefore, the primary aim of this study is to translate the adapted SROH tool for periodontitis screening into the Malay language to facilitate its use in Malaysia. The secondary aim is to assess the validity and reliability of the Malay-translated adapted SROH (M-SROH) tool for periodontitis screening for Malaysian adults by evaluating its content validity, face validity, construct validity, concurrent validity (including sensitivity, specificity, positive predictive value, negative predictive value, area under the receiver operating characteristics curve), and internal consistency.

3.2 Methodology

3.2.1 Study design and Ethical Consideration

This study employed a cross-sectional design, conducted at the Faculty of Dentistry, Universiti Malaya, between November 2023 and April 2024. It consisted of two main components, as depicted in Figure 3.1.

i. Translation of the adapted English SROH into the Malay language (Beaton et al., 2000); and
ii. Validation of the Malay-translated version (M-SROH) of the adapted SROH, as described by (Tsang et al., 2017).

This study is part of a larger project titled "Evaluation of Metallothioneins and Matrix Metalloproteinases Biomarkers as Diagnosis Biomarkers for Periodontitis" and has received ethical approval (DF RD2013/0064) from the Faculty of Dentistry Medical Ethics Committee (FDMEC) at Universiti Malaya (Appendix A). An extension of ethics approval for the current study has been obtained [DF RD2013/0064/2333/23105 (P)] (Appendix B). The study was conducted in accordance with the Declaration of Helsinki.

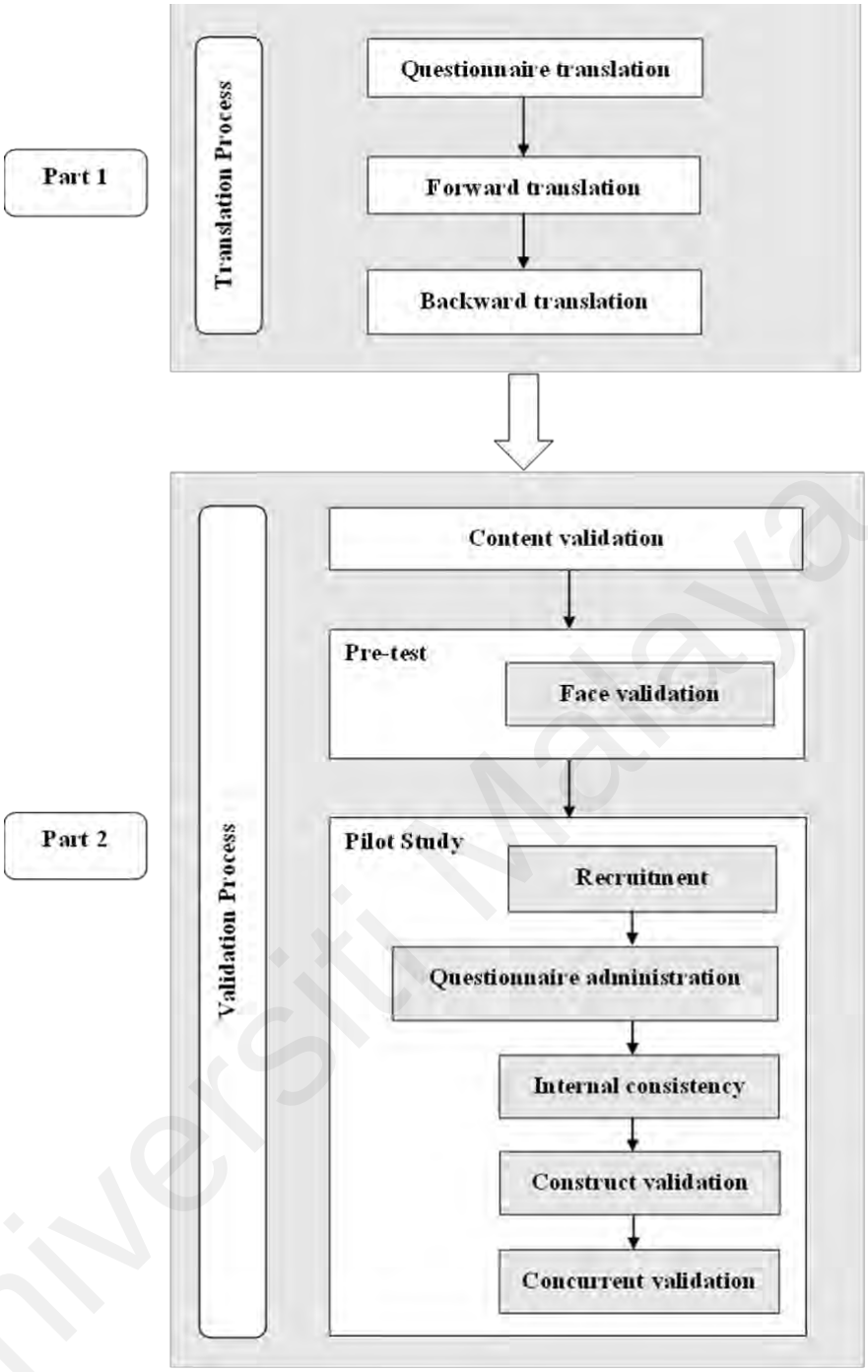

Figure 3.1: Research framework

3.2.2 Part 1: Translation of the adapted SROH

The original CDC/AAP SROH (Appendix C) has been adapted into a nine-item questionnaire for the local context in an ongoing study in Malaysia (Appendix D). It consists of the initial 8-item CDC/ AAP questionnaire with the addition of one item on gingival bleeding (question 3). This was based on a validation study of the SROH in Japan which found the question on bleeding gums to significantly improve the tool's ability to

predict periodontitis (Iwasaki et al., 2021). Moreover, gingival bleeding is an early clinical manifestation of periodontal disease and a key indicator of current periodontal inflammation as well as the development and progression of periodontitis (Lang et al., 2009). Conversely, the continuous absence of gingival bleeding has been reported as an indicator of periodontal health and stability (Lang et al., 1990). Another modification was the addition of an intraoral radiograph to question 6 (Have you ever been told by a dentist that the bone holding your teeth is lost?). This was added to improve the clarity of the question and aid respondent comprehension.

3.2.2.1 Forward translation

The initial translation of the adapted SROH from English to Malay was conducted by two independent translators (F1 and F2) who are proficient in both Malay and English. F1 was a certified translator from the Malaysian Institute of Translation & Books (ITBM), while F2 was a subject matter expert in dental public health. A committee of experts was formed to resolve any discrepancies through a consensus-building process. This committee involved a dental public health specialist, a periodontist, and the translators themselves. The translation was carried out with meticulous attention to detail to ensure that the intended meaning of the source questionnaire was preserved. The translated questionnaire from both translators was compiled into a single version.

3.2.2.2 Backward translation

The forward translated adapted SROH in Malay was then independently translated back into English to verify that the translation accurately reflects the same item content as the original version. This back-translation was conducted by two independent translators who had no access to nor prior knowledge of the source questionnaire. The first was a different certified professional from the ITBM (B1), while the second translator (B2) was a subject

matter expert in periodontology. The translations from both translators were compiled and discrepancies were discussed and resolved through a consensus-building process.

3.2.2.3 Finalised translation

The final step of the translation process involved a thorough comparison of both the forward and backward translations by a committee of experts to ensure semantic, experiential, and conceptual equivalence. This committee consisted of a periodontist, a dental public health specialist and the translators themselves. The rigorous process ensured that the translation accurately conveyed the intended meaning and content of the original questionnaire. Through a consensus-building process all translational discrepancies were resolved, resulting in a finalised translation of the Malay-translated adapted SROH (M-SROH).

3.2.3 Part 2: Validation of the translated SROH

The M-SROH underwent a comprehensive validation process, which included content validation, face validation, and concurrent validation which include assessment of specificity, specificity, positive predictive value, negative predictive value, and area under the curve.

3.2.3.1 Content validation

A non-face-to-face approach was implemented for the content validation. Six experts from the disciplines of periodontology (three experts) and dental public health (three experts) were involved in the content validity of the M-SROH. Given the panel size of six experts, the acceptable CVI value should be at least 0.83 (Polit & Beck, 2006; Polit et al., 2007). The experts independently reviewed and scored each item related to the domain using the 4-point Likert scale (Table 3.1).

Additionally, they were encouraged to offer written comments to enhance the relevance of the items to the targeted domain (Yusoff, 2019a). This feedback was used to refine the items and to ensure the accuracy of the intended construct of periodontitis screening. Upon completing their evaluation, the experts submitted their scored responses to the primary investigator (JL).

Table 3.1: Score for assessment of item relevance

Score	Relevance
1	not relevant
2	somewhat relevant
3	quite relevant
4	highly relevant

Subsequently, the primary researcher calculated the I-CVI and S-CVI. The detailed definitions and formulas for these CVI indices are provided in Table 3.2. Items that achieve a CVI value of 0.80 or higher were retained in the questionnaire (Yusoff et al., 2021).

Table 3.2: Definition and formula for content validation indices

Indices	Definition	Formula
Content Validation Indices		
I-CVI (Item-level Content Validity Index)	The sum of points for each item (relevance score of 3 or 4 divided by the number of experts)	I-CVI = (sum of points item) / (number of experts)
S-CVI/Ave (Scale-level Content Validity Index based on the average method)	The average of the I-CVI scores for all items on the scale or the average of proportion relevance judged by the experts. The proportion relevance is the average of relevance rating by the individual expert.	S-CVI/Ave = (sum of I-CVI scores) / (number of items)
		S-CVI/Ave = (sum of proportion relevance rating) / (number of experts)
S-CVI / UA (Scale-level Content Validity Index based on the universal agreement method	The proportion of items on the scale that achieve a relevance scale of 3 or 4 by all experts. Universal agreement (UA) is given as '1' when the item achieved 100% agreement among the experts. If not, the UA score is given as '0'	S-CVI/UA = (sum of UA scores) / (number of items)

3.2.3.2 Face validation

The participants for the face validation were selected from the target group, which included members of the public. To meet the criteria for an acceptable cut-off score of 0.83, a minimum of 10 participants participated to ensure a thorough face validation process (Mohamad Marzuki et al., 2018; Yusoff, 2019b). Participants were instructed to carefully examine each item before assigning a score using 4-point Likert scale (Table 3.3). They were also encouraged to provide written feedback to improve the clarity and comprehensibility of the items.

Table 3.3: Score for assessment of item clarity and comprehensibility

Score	Clarity and Comprehension
1	not clear and not understandable
2	somewhat clear and understandable
3	clear and understandable
4	very clear and understandable

After completing their assessments, the participants submitted their scored responses to the researcher, ensuring all items had been evaluated (Yusoff, 2019b). The researchers then reviewed the comments to enhance the items (Yusoff, 2019b). Then, the I-FVI and S-FVI were calculated by the researcher. The specific definitions and formulas are outlined in Table 3.4. Items that achieved a score of 0.80 or above were retained in the questionnaire (Yusoff et al., 2021).

Table 3.4: Definition and formula for face validation indices

Indices	Definition	Formula
Face Validation Indices		
I-FVI (Item-level Face Validity Index)	The sum of points for each item (relevance score of 3 or 4 divided by the number of reviewers)	I-FVI = (sum of points item) / (number of reviewers)
S-FVI/Ave (Scale-level Face Validity Index based on the average method)	The average of the I-CVI scores for all items on the scale or the average of proportion relevance judged by the reviewers. The proportion relevance is the average of relevance rating by the individual reviewer.	S-FVI/Ave = (sum of I-CVI scores) / (number of items)
		S-FVI/Ave = (sum of proportion relevance rating) / (number of reviewers)
S-FVI / UA (Scale-level Face Validity Index based on the universal agreement method	The proportion of items on the scale that achieve a relevance scale of 3 or 4 by all reviewers. Universal agreement (UA) is given as '1' when the item achieved 100% agreement among the reviewers. If not, the UA score is given as '0'	S-FVI/UA = (sum of UA scores) / (number of items)

3.2.3.3 Pilot study

Following the completion of content and face validity assessments, a pilot study was conducted among Malaysian adults seeking dental care at the Primary Care Unit (*Bahagian Rawatan Utama)* at the Faculty of Dentistry, Universiti Malaya. Prospective participants were approached and invited to take part in the study. This pilot study aimed to assess the utility of the instrument, to evaluate its accuracy in gathering the intended information, and establish its concurrent validity and reliability in terms of internal consistency..

a. Participants' recruitment

Participants were selected using convenience sampling and consecutively screened for eligibility based on to the inclusion and exclusion criteria outlined in Table 3.5. A written consent was obtained from each subject before participating in this study.

Table 3.5: The eligibility criteria

Inclusion criteria	Exclusion criteria
• **Age 18 years and above** • **Malaysian citizen** • **Presence of ≥ 20 permanent teeth**	• Illiterate • Not fluent in Malay

b. Sample size determination

The sample size for the validation of the M-SROH was determined based on established guidelines and empirical evidence. According to the standard recommendation, the sample size should be 10 participants per questionnaire item (Nunnally & Bernstein, 1994). As the M-SROH comprises of nine items, the minimum required sample size is 90 participants. Thus, a sample size of 90 participants was chosen, as it was deemed to balance statistical rigor with research efficiency.

c. Questionnaire administration

Physical self-administered questionnaires, were provided to 90 eligible participants who completed the questionnaire and submitted them to the principal investigator on the spot. The questionnaire consisted of Sections A and B (as outlined in Table 3.6)

Table 3.6: Sections of the M-SROH

Sections	Descriptions
Section A	This section includes six items related to the respondent's sociodemographic background (age, gender, education, smoking status, diabetes status, diabetes medication status).
Section B	It comprises the nine close-ended questions of the M-SROH

d. Establishment of Validity and Reliability

The data analysis plan for the M-SROH validation involved a two-step approach. First, descriptive analyses, such as mean (standard deviation), were calculated to provide preliminary insights into the distribution of responses for each item (Mohamad Adam, 2022). This followed by a comprehensive evaluation of the questionnaire's reliability and validity.

To assess internal consistency, Cronbach's alpha was calculated to determine the extent to which the items within the M-SROH were inter-correlated and consistently measured the underlying construct of periodontitis. Construct validity was evaluated by conducting exploratory factor analysis (EFA) to determine the measure's ability to accurately assess the intended construct. Finally, concurrent validity was examined by correlating the M-SROH with a recognised gold standard measure, full mouth periodontal examination.

i. Internal consistency

Internal consistency of the M-SROH was determined using Cronbach's alpha value, based on the performance scores of the M-SROH administration. The corrected item-total correlation was used to assess the association of each individual item in relation to all nine items in the questionnaire. A cut-off score of 0.3 or higher is considered as an acceptable correlation for this study (Nunnally & Bernstein, 1994). Items with a corrected

item-total correlation below the 0.3 threshold were examined for potential removal or revision.

ii. Construct validation

EFA was performed to evaluate the construct validity of the questionnaire. Factor loadings, which indicate the strength of the relationship between each item and the underlying construct, were examined to guide item retention decisions. Factor loadings between 0.3 and 0.4 are generally deemed acceptable. However, items with slightly lower loadings may be kept if they contribute meaningfully to the questionnaire, as long as the overall model fit and reliability are satisfactory (Yusoff et al., 2021).

iii. Concurrent validation

A subset of 18 participants who completed the M-SROH were willing to undergo a full mouth periodontal examination. These 18 participants were classified according to case definitions for periodontal health (H), gingivitis (G) and periodontitis (PD) from the 2017 Classification of Periodontal and Peri-implant Diseases and Conditions (Caton et al., 2018). The findings from the full mouth periodontal examination of these 18 patients were then concurrently validated against their M-SROH scores.

- **Calibration exercise**

Prior to the oral examination, a pre-study calibration was conducted for the assessment of probing pocket depth (PPD) and gingival recession (GR). The calibration involved two participants who were not part of the main study. The primary investigator (JL) and the calibrated clinician (HJY) made measurements 30 minutes apart. Intra- and inter-rater reliability were assessed using the Intraclass Correlation Coefficient (ICC) with a two-

way mixed and absolute agreement model. The ICC values were >0.8 for all parameters studied, indicating excellent reliability.

- **Oral health examination**

The clinical examinations were conducted by the primary investigator (JL) while maintaining blindness to the questionnaire responses. The sulcus/pockets of all teeth (except third molars) were probed with a recommended probing force of 25 g using a UNC-15 color-coded periodontal probe. The GR, PPD, clinical attachment loss (CAL) and, bleeding on probing were measured at six sites per tooth (mesio-buccal, mid-buccal, disto-buccal, mesio-lingual/mesio-palatal, mid-lingual/mid-palatal and disto-lingual/disto-palatal) and recorded in a standardised data collection form.

Based on the clinical characteristics, the subjects were categorised into three groups: periodontal health (H), gingivitis (G) and periodontitis (PD). The case definitions for these three groups are based on the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions (Caton et al., 2018):

- Periodontal health (H): <10% bleeding sites and PPD ≤3mm (Chapple et al., 2018)
- Gingivitis (G): ≥10% bleeding sites and PPD ≤3mm (Trombelli et al., 2018)
- Periodontitis (PD): Interdental CAL is detectable at ≥ 2 non-adjacent teeth OR/AND buccal or oral CAL detectable at PPD ≥ 3 mm at ≥ 2 teeth not attributed to non-periodontitis related causes (Tonetti et al., 2018) AND bleeding sites ≥4 mm or any PPD ≥5 mm, which indicates unstable disease status (Dietrich et al., 2019).

- **Data Analyses and Score Calculation**

The data analysis was performed using SPSS Statistical software version 26 (IBM) and involved several steps to evaluate the predictive performance of the 9-item M-SROH against clinically classified periodontitis. First, the correlation between respective self-reported questionnaire items and the periodontal classification was assessed using the chi-squared test. Similar to the original study (Eke et al., 2013), items from the SROH with more than two outcome possibilities were dichotomised, and all responses were coded with either 0 (No or Don't know) or 1 (Yes), while missing and refused items were coded as 99 and excluded from analysis.

A prediction model was then developed by performing multivariable binary logistic regression analysis, and contingency tables were used for cross-tabulation and to calculate sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV).

The regression coefficients (B coefficients) obtained from the regression analysis were used to assign weightage scores to each questionnaire item, which were then used to calculate the weighted scores of each participant using the following formula:

$B_{X1} + B_{X2} + \ldots B_{Xn} = Y$

B - regression coefficient specific to each item X – only items that were scored positively by the participant are included Y - total score

The totalled scores of each participant were used to generate a Receiver Operating Characteristics (ROC) curve with the corresponding area under the curve (AUC). ROC and AUC are part of an analysis method to assess the overall diagnostic accuracy of a test by including all the decision threshold from test results that employ continuous or ordinal predictors (Mandrekar, 2010). The AUC is expressed as a value from 0 to 1, where the value 1 indicates a perfectly accurate test. A value of 0.5 means the model does not discriminate better than 'random' (i.e., flipping a coin) (Metz, 1978). Additional analysis determined the optimal predicted probability cut-off score. This predicted probability represented the value with the highest sum of sensitivity and specificity across the ROC curve. This score provided the best predictive value to identify individuals with periodontitis. P-values <0.05 were considered as statistically significant.

3.3 Results

3.3.1 Translation

Following forward and backward translation, an overview of the initial Malay translated adapted SROH (M-SROH) is presented in Table 3.7.

Table 3.7: Overview of the translation of the adapted SROH (M-SROH)

Item	English adapted SROH	Translated adapted SROH (M-SROH)
Q1	Do you think you might have gum disease?	Adakah anda rasa anda mungkin mempunyai penyakit gusi?
Q2	Overall, how would you rate the health of your gums?	Secara keseluruhan, bagaimana anda menilai kesihatan gusi anda?
Q3	During the past three months, have you had bleeding gums?	Dalam tempoh tiga bulan yang lalu, adakah anda mengalami gusi berdarah?
Q4	Have you ever had treatment for gum disease such as scaling and root planing, sometimes called deep "cleaning"?	Pernahkah anda menjalani rawatan untuk penyakit gusi seperti penskaleran (cuci gigi) dan pembersihan akar, juga dipanggil pembersihan mendalam?
Q5	Have you ever had any teeth become loose on their own, without an injury?	Pernahkah anda mendapati gigi goyang dengan sendiri, tanpa sebarang kecederaan?
Q6	Have you ever been told by a dentist that the bone holding your teeth is lost?	Pernahkah anda diberitahu oleh doktor gigi bahawa tulang yang memegang gigi anda telah susut?
Q7	During the past 3 months, have you noticed a tooth that doesn't look right (e.g., shaky, tilted, drifted etc.)?	Dalam tempoh 3 bulan yang lalu, adakah anda menyedari ada gigi yang kelihatan ganjil (contohnya, gigi menjadi goyang, condong, beralih kedudukan dan lain-lain)?
Q8	Aside from brushing your teeth with a toothbrush, in the last seven days, how many days did you use dental floss or any other device to clean between your teeth?	Selain memberus dengan berus gigi, dalam tempoh tujuh hari yang lalu, berapa hari anda menggunakan flos gigi atau alat lain untuk membersihkan celah-celah di antara gigi anda?
Q9	Aside from brushing your teeth with a toothbrush, in the last seven days, how many days did you use mouthwash or other dental rinse product that you used to treat dental diseases or dental problems?	Selain memberus dengan berus gigi, dalam tempoh tujuh hari yang lalu, berapa hari anda menggunakan ubat kumur atau produk kumuran pergigian yang lain untuk merawat penyakit atau masalah pergigian?

3.3.2 Content Validity

The findings from the content validation process indicate that all nine items on the M-SROH were marked as relevant by the six expert reviewers (Table 3.8). The individual I-CVI scores ranged from 0.83 to 1.00. Eight of the items achieved a perfect I-CVI of 1.00, demonstrating complete agreement among the experts. At the overall scale level, the S-CVI/Ave was 0.98, while the S-CVI/UA was 0.89. Both of these values indicate acceptable content validity as they exceed recommended threshold of 0.83. A summary of the revisions made to the M-SROH following content validation is outlined in Appendix E.

Table 3.8: Relevance ratings on the item scale and the calculation of CVI indices for the M-SROH

INDICES	SCORE
S-CVI /Ave	0.98
S-CVI /UA	0.89
Proportion of relevance ratings	0.98

Cut-off: >0.83

3.3.3 Face Validity

The clarity and comprehensibility ratings on the item scale by 10 reviewers for the M-SROH is presented in Table 3.9. The I-FVI scores ranging from 0.90 to 1.00, indicating complete agreement among the reviewers that these items were very clear and comprehensible. One item had a score of 0.90, still well above the acceptable threshold. At the overall scale level, the S-FVI/Ave was 0.99, and the S-FVI/UA was 0.89. These values exceed the minimum acceptable cut-off score of 0.83 for the face validity index. Therefore, the content of the M-SROH can be deemed valid. No further revisions to the M-SROH were deemed necessary.

Table 3.9: The clarity and comprehensibility ratings on item scale and the calculation of FVI indices for the M-SROH.

INDICES	SCORE
S-FVI /Ave	0.99
S-FVI /UA	0.89
Proportion of clarity and comprehensibility ratings	0.99

Cut off: >0.83

3.3.4 Sociodemographic Profile of Participants in the Pilot Study

The sociodemographic characteristics of the 90 participants are presented in Table 3.10. The participants' aged ranged from 20 to 67 years, with a mean age of 41.29 years. The majority were women (62.2%). In terms of education, 78.9% had completed tertiary education, 18.9% had completed secondary school, and 2.2% had completed primary school. Regarding smoking habits, four participants (4.4%) were active smokers, and eight (8.9%) were past smokers. Only 10 participants reported being diabetic, and all were on medication, indicating a degree of glycaemic control. Of the 90 participants, 18 consented to undergo a full mouth periodontal examination. These participants were classified based on the 2017 Classification of Periodontal and Peri-implant Diseases and Conditions (Caton et al., 2018), which categorised them into health, gingivitis, and the four stages of periodontitis (i.e., stages I, II, III, IV) (Tonetti et al., 2018).

Table 3.10: Sociodemographic characteristics of the participants (n = 90)

Demographic Characteristics	Mean (SD)	n	%
Age (years) (n = 90)	41.29 ± 13.29		
18 – 39		44	48.9
40 – 59		39	43.3
>60		7	7.8
Gender			
Male		34	37.8
Female		56	62.2
Education Level (n = 90)			
Primary School		2	2.2
Secondary School		17	18.9
Diploma/College		28	31.1
Undergraduate degree		33	36.7
Postgraduate degree		10	11.1
Smoking (n = 90)			
Non-smoker		78	86.7
Past smoker		8	8.9
Current smoker		4	4.4
Diabetes (n = 90)			
Yes		10	11.1
No		80	88.9
Use of hypoglycaemic (n = 90)			
Yes		10	11.1
No		80	88.9
Periodontal Status (n = 18)			
Health		3	16.7
Gingivitis		4	22.2
Stage I		5	27.8
Stage II		3	16.7
Stage III		3	16.7
Stage IV		0	0

3.3.5 Response Distribution of the Pilot Study (All participants)

The response distribution of the M-SROH is presented in Table 3.11. All participants answered all items, resulting in a 100% response rate. Additionally, the proportion of participants who answered 'Don't know' for any items was low ranging from 2.2% to 31.1%. Regarding self-reported oral health, about half of the participants (51.1%) believed that they did not suffer from periodontal disease. Most participants valued their periodontal health as satisfactory (27.8%), good (33.3%), very good (14.4%), and excellent (4.4%). The proportion of participants who had undergone some form of gum treatment (53.3%) was slightly higher than those who had not (43.3%). Furthermore, the use of interdental cleaning aids was markedly low, with only 31.2% using them 5 - 7 days a week.

Table 3.11: Response distribution (All participants) (n = 90)

Item	Question	n	%
1.	**Adakah anda berpendapat anda menghidapi penyakit gusi?**		
	Ya	16	17.8
	Tidak	46	51.1
	Tidak tahu	28	31.1
	Enggan menjawab	0	0
2.	**Secara keseluruhan, bagaimana anda menilai kesihatan gusi anda?**		
	Cemerlang	4	4.4
	Sangat baik	13	14.4
	Baik	30	33.3
	Memuaskan	25	27.8
	Tidak baik	11	12.2
	Tidak tahu	7	7.8
	Enggan menjawab	0	0
3.	**Dalam tempoh tiga bulan yang lalu, adakah anda mengalami gusi berdarah?**		
	Tidak pernah	33	36.7
	Sangat jarang	18	20.0
	Jarang	28	31.1
	Agak kerap	7	7.8
	Selalu	4	4.4
	Enggan menjawab	0	0
4.	**Pernahkah anda menjalani rawatan untuk penyakit gusi seperti penskaleran (cuci gigi) dan pembersihan permukaan akar?**		
	Ya	48	53.3
	Tidak	39	43.3
	Tidak tahu	3	3.3
	Enggan menjawab	0	0

Item	Question	n	%
5.	**Pernahkah anda mendapati gigi goyang dengan sendiri, tanpa sebarang kecederaan?**		
	Ya	26	28.9
	Tidak	62	68.9
	Tidak tahu	2	2.2
	Enggan menjawab	0	0
6.	**Pernahkah anda diberitahu oleh doktor gigi bahawa tulang sekeliling gigi anda telah susut?**		
	Ya	18	20.0
	Tidak	56	62.2
	Tidak tahu	16	17.8
	Enggan menjawab	0	0
7.	**Dalam tempoh 3 bulan yang lalu, adakah anda menyedari terdapat keganjilan pada keadaan gigi anda (contohnya: gigi menjadi goyang, condong, beralih kedudukan dan lain-lain)?**		
	Ya	19	21.1
	Tidak	61	67.8
	Tidak tahu	10	11.1
	Enggan menjawab	0	0
8.	**Selain memberus dengan berus gigi, dalam tempoh seminggu yang lalu, berapa hari anda menggunakan flos gigi atau alat lain untuk membersihkan celah-celah gigi anda?**		
	Tidak pernah	21	23.3
	Sangat jarang	27	30.0
	Jarang	14	15.6
	Agak kerap	14	15.6
	Selalu	14	15.6
	Enggan menjawab	0	0
9.	**Selain memberus dengan berus gigi, dalam tempoh seminggu yang lalu, berapa hari anda menggunakan ubat kumur atau produk kumuran pergigian untuk merawat penyakit atau masalah pergigian?**		
	Tidak pernah	29	32.2
	Sangat jarang	27	30.0
	Jarang	18	20.0
	Agak kerap	8	8.9
	Selalu	8	8.9
	Enggan menjawab	0	0

3.3.6 Reliability Assessment (Internal Consistency)

The internal consistency of M-SROH is presented in Table 3.12. The Cronbach's alpha value was 0.64, indicating moderate internal consistency. The corrected item-total correlation analysis revealed that most items had correlations of more than 0.3, except for Q4, Q8, and Q9, which had correlation of 0.26, 0.24 and 0.09, respectively. Q9 had a particularly low correlation, suggesting it should be eliminated. However, removing Q9 only marginally improved the Cronbach's alpha value to 0.66. Considering the importance of preserving the originality of the English adapted SROH, the decision was made to retain item Q9.

Table 3.12: Internal consistency of the M-SROH

Item	Internal consistency	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	0.64	0.43	0.59
Q2		0.36	0.61
Q3		0.37	0.60
Q4		0.29	0.63
Q5		0.43	0.59
Q6		0.34	0.61
Q7		0.37	0.60
Q8		0.24	0.64
Q9		0.09	0.66

3.3.7 Construct Validity

The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.609, and Bartlett's test of sphericity was statistically significant ($p<0.001$), suggesting the data were appropriate for factor analysis (Table 3.13). All items exhibited factor loading exceeding 0.3, except for items eight (0.254) and nine (0.032). However, upon further deliberation, these two items were retained, as their exclusion would only marginally enhance the internal consistency of the M-SROH.

Table 3.13: Exploratory factor analysis of the M-SROH

Items	Questions	Factor loading
1	Adakah anda rasa anda mungkin mempunyai penyakit gusi?	0.704
2	Secara keseluruhan, bagaimana anda menilai kesihatan gusi anda?	0.556
3	Dalam tempoh tiga bulan yang lalu, adakah anda mengalami gusi berdarah?	0.548
4	Pernahkah anda menjalani rawatan untuk penyakit gusi seperti penskaleran (cuci gigi) dan pembersihan akar, juga dipanggil pembersihan mendalam?	0.484
5	Pernahkah anda mendapati gigi goyang dengan sendiri, tanpa sebarang kecederaan?	0.627
6	Pernahkah anda diberitahu oleh doktor gigi bahawa tulang yang memegang gigi anda telah susut?	0.656
7	Dalam tempoh 3 bulan yang lalu, adakah anda menyedari ada gigi yang kelihatan ganjil (contohnya, gigi menjadi goyang, condong, beralih kedudukan dan lain-lain)?	0.542
8	Selain memberus dengan berus gigi, dalam tempoh tujuh hari yang lalu, berapa hari anda menggunakan flos gigi atau alat lain untuk membersihkan celah-celah di antara gigi anda?	0.254
9	Selain memberus dengan berus gigi, dalam tempoh tujuh hari yang lalu, berapa hari anda menggunakan ubat kumur atau produk kumuran pergigian yang lain untuk merawat penyakit atau masalah pergigian?	0.032

Kaiser-Meyer-Olkin: 0.609; Bartletts's test: <0.001

3.3.8 Concurrent Validity

3.3.8.1 Response Distribution of the Pilot Study and Items Association with Periodontal Disease (Full Mouth Periodontal Examination)

The response distribution according to the participants' periodontal status is presented in Table 3.14. Among those who had periodontal examination (n = 18), only a minority (27.8%) believed that they suffered from periodontal disease. The majority of participants perceived their periodontal health as satisfactory (27.8%), good (22.2%), very good (16.7%), and excellent (5.6%). Regarding symptoms, two-thirds of participants reported bleeding gums. Other symptoms included experiencing tooth mobility (38.9%), bone loss around teeth (16.7%), and the feeling that their teeth did not look right (27.8%). In terms of treatment, less than half (44.4%) of participants received periodontal treatment. Additionally, less than half of them had never used any interdental cleaning aid (38.9) nor dental rinse products (38.9%). Responses to self-reported question items 1 and 5 were significantly associated with periodontal status, regardless of the severity category used.

Table 3.14: Response distribution (Participants who underwent full mouth periodontal examination) (n = 18)

Item	Question	Periodontal Status						Total
		H	G	I	II	III	IV	
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
1.	**Adakah anda berpendapat anda menghidapi penyakit gusi?***							
	Ya	0	1 (5.6)	1 (5.6)	0	3 (16.7)	0	5 (27.8)
	Tidak	3 (16.7)	2 (11.1)	1 (5.6)	3 (16.7)	0	0	9 (50.0)
	Tidak tahu	0	1 (5.6)	3 (16.7)	0	0	0	4 (22.2)
	Enggan menjawab	0	0	0	0	0	0	0
2.	**Secara keseluruhan, bagaimana anda menilai kesihatan gusi anda?**							
	Cemerlang	1 (5.6)	0	0	0	0	0	1 (5.6)
	Sangat baik	1 (5.6)	1 (5.6)	0	1 (5.6)	0	0	3 (16.7)
	Baik	1 (5.6)	1 (5.6)	1 (5.6)	1 (5.6)	0	0	4 (22.2)
	Memuaskan	0	1 (5.6)	2 (11.1)	1 (5.6)	1 (5.6)	0	5 (27.8)
	Tidak baik	0	1 (5.6)	1 (5.6)	0	1 (5.6)	0	3 (16.7)
	Tidak tahu	0	0	1 (5.6)	0	1 (5.6)	0	2 (11.1)
	Enggan menjawab	0	0	0	0	0	0	0
3.	**Dalam tempoh tiga bulan yang lalu, adakah anda mengalami gusi berdarah?**							
	Tidak pernah	2 (11.1)	1 (5.6)	0	3 (16.7)	1 (5.6)	0	7 (38.9)
	Sangat jarang	1 (5.6)	1 (5.6)	1 (5.6)	0	0	0	3 (16.7)
	Jarang	0	2 (11.2)	2 (11.2)	0	0	0	4 (22.2)
	Agak kerap	0	0	2 (11.2)	0	1 (5.6)	0	3 (16.7)
	Selalu	0	0	0	0	1 (5.6)	0	1 (5.6)
	Enggan menjawab	0	0	0	0	0	0	0
4.	**Pernahkah anda menjalani rawatan untuk penyakit gusi seperti penskaleran (cuci gigi) dan pembersihan permukaan akar?**							
	Ya	2 (11.1)	3 (16.7)	1 (5.6)	0	2 (11.1)	0	8 (44.4)
	Tidak	1 (5.6)	1 (5.6)	3 (16.7)	3 (16.7)	1 (5.6)	0	9 (50.0)
	Tidak tahu	0	0	1 (5.6)	0	0	0	1 (5.6)
	Enggan menjawab	0	0	0	0	0	0	0
5.	**Pernahkah anda mendapati gigi goyang dengan sendiri, tanpa sebarang kecederaan?***							
	Ya	0	1 (5.6)	1 (5.6)	2 (11.1)	3 (16.7)	0	7 (38.9)
	Tidak	3 (16.7)	3 (16.7)	4 (22.2)	1 (5.6)	0	0	11 (61.1)
	Tidak tahu	0	0	0	0	0	0	0
	Enggan menjawab	0	0	0	0	0	0	0

Item	Question	Periodontal Status						Total
		H	G	I	II	III	IV	
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
6.	**Pernahkah anda diberitahu oleh doktor gigi bahawa tulang sekeliling gigi anda telah susut?**							
	Ya	0	0	1 (5.6)	0	2 (11.1)	0	3 (16.7)
	Tidak	3 (16.7)	4 (22.2)	2 (11.1)	2 (11.1)	1 (5.6)	0	12 (66.7)
	Tidak tahu	0	0	2 (11.1)	1 (5.6)	0	0	3 (16.7)
	Enggan menjawab	0	0	0	0	0	0	0
7.	**Dalam tempoh 3 bulan yang lalu, adakah anda menyedari terdapat keganjilan pada keadaan gigi anda (contohnya: gigi menjadi goyang, condong, beralih kedudukan dan lain-lain)?**							
	Ya	1 (5.6)	1 (5.6)	1 (5.6)	0	2 (11.1)	0	5 (27.8)
	Tidak	2 (11.1)	3 (16.7)	2 (11.1)	2 (11.1)	1 (5.6)	0	10 (55.6)
	Tidak tahu	0	0	2 (11.1)	1 (5.6)	0	0	3 (16.7)
	Enggan menjawab	0	0	0	0	0	0	0
8.	**Selain memberus dengan berus gigi, dalam tempoh seminggu yang lalu, berapa hari anda menggunakan flos gigi atau alat lain untuk membersihkan celah-celah gigi anda?**							
	Tidak pernah	0	1 (5.6)	3 (16.7)	0	3 (16.7)	0	7 (38.9)
	Sangat jarang	0	2 (11.1)	1 (5.6)	3 (16.7)	0	0	6 (33.3)
	Jarang	0	0	1 (5.6)	0	0	0	1 (5.6)
	Agak kerap	1 (5.6)	1 (5.6)	0	0	0	0	2 (11.1)
	Selalu	2 (11.1)	0	0	0	0	0	2 (11.1)
	Enggan menjawab	0	0	0	0	0	0	0
9.	**Selain memberus dengan berus gigi, dalam tempoh seminggu yang lalu, berapa hari anda menggunakan ubat kumur atau produk kumuran pergigian untuk merawat penyakit atau masalah pergigian?**							
	Tidak pernah	3 (16.7)	0	2 (11.1)	1 (5.6)	1 (5.6)	0	7 (38.9)
	Sangat jarang	0	2 (11.1)	1 (5.6)	2 (11.1)	2 (11.1)	0	7 (38.9)
	Jarang	0	2 (11.1)	1 (5.6)	0	0	0	3 (16.7)
	Agak kerap	0	0	1 (5.6)	0	0	0	1 (5.6)
	Selalu	0	0	0	0	0	0	0
	Enggan menjawab	0	0	0	0	0	0	0

***p<0.05 chi-squared test for the association between periodontal classification (no periodontitis and 4 stages of periodontitis) and responses to questions.**

3.3.8.2 Weighting of Screening Questions

To predict periodontitis, weighting scores should be assigned to each item in the M-SROH. The weighting scores were calculated using the coefficients from the logistic regression model (Table 3.15). The resulting distribution of weighting scores ranged from -38.898 to 39.031.

Table 3.15: Logistic regression model for determining the weighting scores for screening items in M-SROH

Items	B Coefficients
Q1	21.068
Q2	21.068
Q3	-19.669
Q4	-38.898
Q5	1.211
Q6	37.013
Q7	-3.844
Q8	39.031
Q9	-25.722

3.3.8.3 Periodontal Screening Weighted Score

Parameter estimates using B coefficients (Table 3.14) from the logistic regression model were used to calculate the weighted score of each of the 18 participants (Table 3.16). Each of the calculated values were plotted against the Receiver Operating Characteristics (ROC) curve. The area under the ROC curve (AUROCC) for the complete sample was calculated across the range of predicted probabilities. The optimal cut-off score was found to be -6.36, which provided the best balance of sensitivity (100%) and specificity (85.71%). This score represents the threshold value from which the model classified an individual as having periodontitis.

Table 3.16: Periodontal screening weighted score

Subject	Positive Response	Weighted Score	Disease Classification	
			M-SROH	Full mouth Periodontal Examination
1	Q1, Q2, Q3, Q5, Q7, Q8, Q9	33.143	PD	PD
2	Q1, Q3, Q4, Q5, Q6, Q8, Q9	14.034	PD	PD
3	Q8, Q9	13.309	PD	PD
4	Q5, Q8, Q9	14.52	PD	PD
5	Q5, Q8, Q9	14.52	PD	PD
6	Q1, Q3, Q8, Q9	14.708	PD	PD
7	Q3, Q4, Q5, Q6, Q7, Q8	14.844	PD	PD
8	Q2, Q3, Q8, Q9	14.708	PD	PD
9	Q8, Q9	13.309	PD	PD
10	Q3, Q8, Q9	-6.36*	PD	PD
11	Q4, Q5, Q7, Q8, Q9	-28.222	NP	NP
12	Q1, Q2, Q3, Q4, Q9	-42.153	NP	NP
13	Q4, Q8, Q9	-25.589	NP	NP
14	Q3, Q8, Q9	-6.36*	PD	NP
15	Q4, Q9	-64.62	NP	NP
16	Q1, Q4, Q5, Q6, Q7, Q8, Q9	29.859	PD	PD
17	Q9	-25.722	NP	NP
18	Q4, Q7, Q9	-68.464	NP	NP

PD – Periodontitis; NP - No Periodontitis

3.3.8.4 Accuracy of M-SROH in Predicting Periodontitis

The distribution of periodontitis and no periodontitis as identified by M-SROH and the full mouth periodontal examination is presented in Table 3.17. The results indicate that the M-SROH has a sensitivity of 100%, indicating that the M-SROH correctly identifies all individuals with periodontitis. As for the specificity, the M-SROH achieved a specificity of 85.7%, indicating that it correctly identifies 85.7% of individuals without periodontitis as not having periodontitis. The positive predictive value (PPV) of the M-SROH is 91.7% and the negative predictive value (NPV) is 100%, demonstrating its outstanding accuracy in predicting periodontitis. The area under the curve (AUC) is 0.994

(95% CI: 0.968 to 1), indicating an excellent discriminatory ability of the M-SROH (Figure 3.1). Furthermore, Chi square statistic is significant (p = 0.001), suggesting a good fit of the model to the data.

Table 3.17: Accuracy of M-SROH in predicting individuals with periodontitis

	n = 18	Full Mouth Periodontal Examination		Total
		Periodontitis	No Periodontitis	
M-SROH	Periodontitis	11	1	12
	No Periodontitis	0	6	6
	Total	11	7	18

Performance measures:

- Sensitivity: 100%
- Specificity: 85.7%
- Positive Predictive Value (PPV): 91.7%
- Negative Predictive Value (NPV): 100%
- Area under the curve (AUC): 0.994 (95% CI: 0.968 to 1)

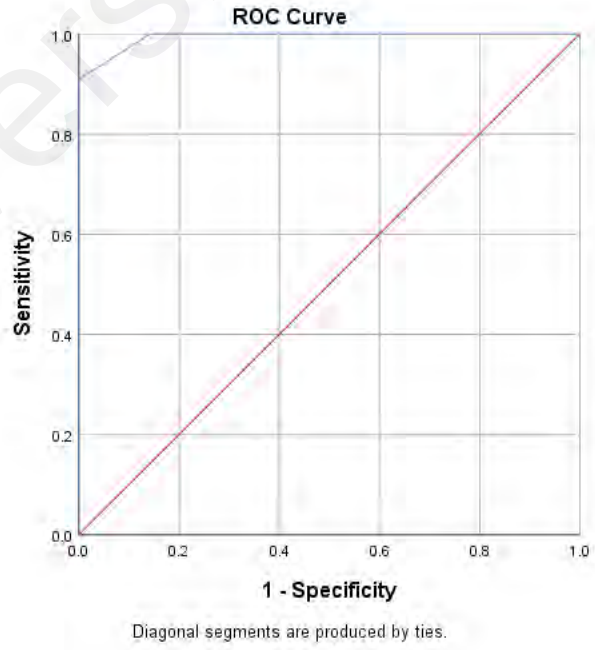

Figure 3.2: Receiver operating characteristic (ROC) curve for the M-SROH prediction model

3.3.9 Final Validated M-SROH

Following the validation and reliability analyses, the M-SROH was finalised as shown in Appendix F.

3.4 Discussion

3.4.1 Discussion of main findings

The results of this study provide valuable insights into the reliability and validity of the M-SROH for periodontitis screening among Malaysian adults. The 9-item adapted SROH was successfully translated for this purpose. The forward and backward translation of the questionnaire for use in the Malaysian context was performed according to the measures recommended for translation and cultural adaptation (Beaton et al., 2000; Tsang et al., 2017). A committee of dental specialists and translators reviewed and produced the finalised Malay translation of the adapted SROH.

Concerning the validity of M-SROH, the relevance of the items was evaluated and found to be an equivalent measure of the adapted English version with good content validity. Further evaluation among target respondents confirmed the clarity and comprehensibility of the M-SROH. All item- and scale-level indices exceeded the minimum cut-off value of 0.83. A pilot study in a convenient sample population achieved a 100% response rate, and no difficulties comprehending the questionnaire items were reported. The questionnaire demonstrated moderate internal consistency and accurate ability to detect periodontitis.

The multivariable prediction model in this pilot study, which incorporated all nine self-reported oral health questions, demonstrated robust performance in identifying cases of periodontitis (AUROCC = 0.994; sensitivity = 100%; and specificity = 85.7%). The screening accuracy of the M-SROH for periodontitis in this study appears to be better compared to similar models in previous studies in terms of AUROCC and sensitivity while specificity was either similar or better (Deng et al., 2021b; Eke & Dye, 2009; Eke et al., 2013; Iwasaki et al., 2021; Verhulst et al., 2019). The sensitivity and AUROCC of

the eight items in the original CDC-AAP studies ranged from 48% to 59.3% and 0.68 to 0.70 respectively (Eke & Dye, 2009; Eke et al., 2013). More recently, in Hong Kong the same model produced a sensitivity of 67.9% and an AUROCC of 0.8 (Deng et al., 2021b). In a sample population of Dutch patients, Verhulst et al. (2018) reported a sensitivity of 85% and AUROCC of 0.81 but a lower specificity of 63% (Verhulst et al., 2019). A study in a Japanese population by Iwasaki et al. (2021) which included the question on 'gum bleeding', achieved a sensitivity of 47.5% and an AUROCC of 0.64 (Iwasaki et al., 2021). The results reported by Verhulst et al. (2018) were the closest to those of the current study, possibly due to similarities in the study populations, which comprised adults seeking dental treatment (Verhulst et al., 2019). However, Deng et al. (2021) also recruited participants from a comparable demographic of patients seeking treatment at a dental hospital (Deng et al., 2021b). Additionally, Deng and colleagues were the only study to use the same case definitions as the current study which is the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions (Chapple et al., 2018; Tonetti et al., 2018; Trombelli et al., 2018). The limited number of patients included in the prediction model of the present study may also have contributed to its high accuracy. The disparity in performance is not surprising given the variability already observed among the previous validation studies of the SROH. Indeed, the heterogeneity in predictive performance may be attributed to various factors, such as differences in population characteristics, sample size, questionnaire items, case definitions, and periodontal examination procedures (Abbood et al., 2016).

In addition to the standard model of questionnaire items, these studies also examined hybrid predictive models. Combining questionnaire items with socio-demographic and other risk factors of periodontitis notably improved the accuracy of the questionnaire-only model. Factors such as smoking and age are associated with an

increase in the prevalence and severity of periodontitis (Billings et al., 2018; Genco & Borgnakke, 2013). Sensitivity values improved by 10-30 percentage points (Eke & Dye, 2009; Iwasaki et al., 2021) and AUROCC by up to 24 points (Eke & Dye, 2009). Another common finding in all the studies, was that the SROH was most accurate in predicting severe periodontitis as opposed to the milder disease categories, regardless of the case definition used (Carra et al., 2018; Deng et al., 2021b; Iwasaki et al., 2021; Montero et al., 2020; Reiniger et al., 2020). Understandably, early diagnosis of periodontitis is extremely challenging, as the more obvious symptoms that impact quality of life may not appear until the condition has progressed to more severe and advanced stages (Buset et al., 2016). Iwasaki et al. (2021) produced a model with 80.8% (sensitivity), 77.1% (specificity) and 0.88 (AUROCC) (Iwasaki et al., 2021) while Deng et al. (2021) reported a model with a sensitivity of 95.7% and a specificity of 89.0%, with an AUROCC of 0.95 for predicting severe periodontitis (Deng et al., 2021b). In order to evaluate these models, sufficiently large sample sizes with adequate distribution among different health and disease categories are required. While these models were beyond the scope of the present study, they nevertheless represent a promising direction to be explored in future research.

To analyse the data, as with previous studies, the items from the SROH with more than two outcome possibilities were dichotomised. All responses where coded with either 0 (negative for periodontitis) or 1 (positive for periodontitis) and missing and refused items were excluded from analysis. However, the studies differed in the way the response "don't know" was treated. It was coded as either 0 or as missing data (i.e. excluded from analysis), with none coding it as 1. The reasoning behind this decision was never explicitly stated but may potentially be due to the proportion of "don't know" responses. Studies in which this response was minimal (<10% of any given item), excluded it from analysis (Deng et al., 2021b; Eke & Dye, 2009; Eke et al., 2013) whereas studies with a

higher proportion of “don’t know” responses chose to include it by coding it as 0 along with “no” (Carra et al., 2018; Iwasaki et al., 2021).

The question with the most “don't know” responses was typically question 1, which asked, “do you think you have gum disease?”. In the study by Carra et al. (2018), up to 46.1% of the responses for this item (Q1) were “don’t know” (Carra et al., 2018). Excluding such a large proportion of the data would have led to a substantial loss of information. Similarly, in the current study, the “don’t know” response made up to 31.1% of responses for question 1. Having a significant number of “don’t know” response can provide valuable insights. This response captures patients who are uncertain about their periodontal health, which gives researchers a measure of the confidence level in the “yes” and “no” answers. On the other hand, being uncertain also indicates a lack of oral health awareness and utilisation of oral healthcare services, putting these participants at risk of developing periodontitis and other oral diseases (Tan et al., 2021).

As described earlier, the response “don’t know” was also coded as 0 in this study. The study findings revealed that patients with periodontitis constituted the overwhelming majority of those who responded with “don’t know”, especially for question 1. To further analyse the impact of “don’t know” responses, binary logistic regression analyses were performed comparing two models: (i) Model 1: Scoring ‘don’t know’ as positive for periodontitis (1) along with “yes” responses; and (ii) Model 2: Scoring “don’t know” as negative response (0) along with “no”.

Both models produced models with high screening accuracy: (i) Model 1: 90.9% sensitivity and 100% specificity; while (ii) Model 2: 100% sensitivity and 85.7% specificity. In the context of periodontitis screening, it is preferable to identify patients

without the disease as potentially diseased (false positive), rather than to miss those who are truly afflicted (false negative) (Monaghan et al., 2021). Thus, scoring "don't know" as a negative response (0) provided a more desirable model, with a greater false positive and a lower false negative rate.

The M-SROH demonstrated an overall internal consistency level of 0.64, indicating the items are moderately inter-correlated and relatively consistent in measuring a similar construct (Taber, 2018; van Griethuijsen et al., 2015). High values (≥ 0.9) may reflect unnecessary duplication or redundancy of the content across the items (Streiner, 2003). Previous validation studies of the SROH did not report any assessments of internal consistency. Eke et al. (2013) and Iwasaki et al. (2021) mentioned evaluating the inter-item correlation between pairs of self-reported questions but did not discuss the implications (Eke et al., 2013; Iwasaki et al., 2021). In this study, item 9 ('use of mouthwash') showed a very low corrected item-total correlation of 0.09 (Nunnally & Bernstein, 1994), suggesting its potential elimination. This finding was supported by exploratory factor analysis, where item 9 demonstrated a very poor correlation with periodontitis screening (factor loading: 0.032). However, removing this item only marginally improved the internal consistency value to 0.66. Furthermore, eliminating an item solely due to a low item correlation is not recommended (Taber, 2018), as this item should be retained pending further analysis of its predictive utility in future studies involving a larger sample size. Additionally, further analysis showed that removing item 9 resulted in a predictive model with 90.9% sensitivity and 100% specificity. This model is considered a less desirable model as it has a higher false negative rate compared to the model that included item 9.

3.4.2 Strength of study

To the best of my knowledge, this is the first study to translate the SROH into the Malay language and assess its psychometric properties. The translation process was conducted by strictly adhering to established guidelines and recommended best practices (Beaton et al., 2000)). Content and face validation were planned and carried out in an organised and systematic manner. The questionnaire was carefully reviewed, evaluated and adapted following input and feedback from a panel of experts and representatives of the target participants.

Full mouth periodontal examinations, which is considered the gold standard for diagnosing periodontitis were performed by a calibrated clinician. This study also defined periodontal status according to the case definitions established by the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions (Chapple et al., 2018; Tonetti et al., 2018; Trombelli et al., 2018). This classification is being widely used in clinical practice, research and epidemiologic surveillance. This will hopefully improve comparability and reduce heterogeneity and thereby, enhance external validity.

Moreover, this study was able to conduct a preliminary assessment of the predictive ability of the questionnaire items. The findings demonstrate the feasibility of using the M-SROH for periodontitis screening among Malaysian adults. A higher sensitivity is preferable as it reduces the likelihood of false negatives. Conversely, a lower specificity (higher false positive rate) is acceptable since there is minimal risk of harm to the patient along with the added benefit of increased awareness and primary prevention.

Additionally, this study explored the use of a weighted scoring method which may be used to differentiate between periodontitis and non-periodontitis cases. Further refinement and validation of this weighted scoring system is still required in a larger more representative population. As for the reliability of the M-SROH, this study evaluated the internal consistency of the M-SROH and appraise the corrected item-total correlation. The findings supported the addition of the question on bleeding (during the past three months, have you had bleeding gums?) which achieved the second highest corrected item-total correlation (0.37).

3.4.3 Limitations of study

This study encountered several limitations that should be considered when interpreting the findings. Firstly, as a pilot study, the small sample size of patients who underwent full mouth periodontal examination, presents a limitation. This was primarily due to time constraints, as the data collection period was limited to one month. Additionally, not all participants were willing or available to undergo the examinations, further reducing the sample size. Furthermore, recruiting a representative sample across all stages of periodontitis severity proved difficult, as evidenced by the absence of stage IV periodontitis patients. This limited the possibility of assessing the predictive accuracy of individual questionnaire items and explore potential relationships between sociodemographic factors, risk factors (like smoking and diabetes), and the questionnaire's performance. It also prevented the evaluation of a model to predict severe periodontitis (Stage III and IV). Nevertheless, this was not the primary aim of the study, and the sample size was sufficient to demonstrate the potential validity of the M-SROH in detecting periodontitis regardless of stage.

Secondly, the inherent nature of symptom-based questionnaires poses a limitation. These tools rely on patients recognising and reporting their symptoms, which may be negligible or absent in the early stages of disease. Self-report tools tend to be more accurate in detecting advanced disease stages where clinical signs and symptoms are more pronounced. This inherent limitation may contribute to a lower predictive ability in milder cases of periodontitis (Stage I and II).

Thirdly, the sample population, comprising patients seeking treatment at an urban university-based dental clinic, may not be representative of the general Malaysian population. Given the low utilisation rate of oral healthcare services in Malaysia, with only 23.7% accessing such services and 61.6% visiting the dentist solely when treatment was needed, this group may represent a more diseased and symptomatic demographic (IHSR, 2020). Therefore, the generalisability of our findings to the broader Malaysian population requires further investigation.

Finally, while we found the M-SROH to have potential validity for predicting periodontitis in this study population, we did not assess its test-retest reliability. While acknowledging the importance of test-retest reliability in establishing the robustness of a screening tool, this study was designed as a preliminary investigation into the validity of the M-SROH. The primary focus was to determine if the translated questionnaire could effectively discriminate between individuals with and without periodontitis within the Malaysian population. Given the resource-intensive nature of conducting full-mouth periodontal examinations, which were necessary for establishing the validity of the questionnaire, repeating the self-report measure for test-retest reliability was not feasible within the limited timeframe and resources available for this initial study. However, we recognise that assessing test-retest reliability is crucial for determining the stability and

consistency of the M-SROH over time. Future research, building upon the promising findings of this study, should incorporate an evaluation of the test-retest reliability of the questionnaire. Addressing these limitations will further strengthen the validity and utility of the M-SROH, potentially paving the way for its wider implementation as a useful tool for periodontitis screening in Malaysia.

3.4.4 Implications of the study

The prevalence of periodontitis and periodontal diseases in Malaysia remains concerningly high, at 38.2% and 94.5% respectively (OHP, 2023). This underscores the urgent need for accessible and effective screening tools. While the Ministry of Health Malaysia has implemented BPE screening for new patients attending public dental clinics aged 15 and above, dental service utilization is low, with only 23.7% of Malaysians visiting a dentist annually (IHSR, 2020). Consequently, a large portion of the population remains beyond the reach of clinical screening. Additionally, the time constraints faced by dental professionals, who are expected to address patient concerns and provide a wide range of treatments, may hinder the effectiveness of comprehensive periodontal screening during routine visits.

The M-SROH presents a promising solution as a population-wide screening tool, given its validity and reliability. Its simplicity and ease of administration allow for application in settings where dental expertise and equipment are limited, such as rural areas. Medical practitioners can utilise the M-SROH to aid the implementation of the common risk factor approach, especially for patients with diabetes mellitus. Non-health personnel can also use the M-SROH in community-based approaches like workplace screenings. Dental professionals, in turn, can incorporate the M-SROH to complement their existing clinical examinations.

Furthermore, the M-SROH can play an educational role by empowering individuals to recognise potential periodontal disease symptoms, promoting early detection and intervention. Developing an online platform for self-assessment, guidance, and referral to dental professionals would further enhance the M-SROH's accessibility and impact. The M-SROH has the potential to significantly improve the detection and management of periodontal diseases in Malaysia, addressing the challenges posed by high prevalence, low dental service utilisation, and limitations of current screening methods.

3.4.5 Recommendations for future studies

This pilot study provides preliminary evidence for the validity of the M-SROH as a potential tool for periodontitis screening among Malaysian adults. However, further research is recommended to strengthen these findings and enhance the generalisability and applicability of the M-SROH.

To strengthen the M-SROH's validity and generalisability, future research should prioritise a validation study with a more representative sample of the general Malaysian population. This expanded scope will allow for a more robust assessment of the questionnaire's psychometric properties, ensuring its applicability across diverse demographic subgroups. Furthermore, a larger sample size will enable researchers to explore the relationship between questionnaire items, sociodemographic factors, and known risk factors for periodontitis. This comprehensive analysis will facilitate the development of a more refined and predictive model for periodontitis screening. This includes examining the correlation and individual contribution of each question, identifying the most predictive items for a more parsimonious model (the best fit with the fewest number of predictor variables), and evaluating the model’s accuracy in predicting

different levels of periodontal disease. Acceptable sensitivity and specificity values will allow for suitable cut-off scores to be derived to aid the differentiation between health, gingivitis, and stages of periodontitis severity.

Additionally, exploring the potential of combining the M-SROH with other point-of-care diagnostic methods, such as salivary biomarkers, could enhance screening accuracy. While the M-SROH captures an individual's subjective experience of oral health, incorporating objective biological markers captures a more comprehensive and nuanced aspect of periodontal disease status. Salivary biomarkers, in particular, offer a non-invasive and readily accessible means of detecting inflammatory mediators associated with periodontitis. For instance, a combination of IL-1β, IL-6 and MMP-8 reported a sensitivity and specificity range of 78%–94% and 77%–97%, respectively when comparing individuals with periodontitis to those with healthy gingiva (Ebersole et al., 2015; Ebersole et al., 2013). By combining M-SROH data with the analysis of such biomarkers, clinicians and researchers could potentially develop more precise models. This approach could lead to earlier detection of periodontitis, even in asymptomatic individuals, and facilitate more targeted interventions. The framework of the current classification allows for the introduction of validated biomarkers in the case definition system (Tonetti et al., 2018). It is anticipated that such diagnostic tests would enable a definition of the susceptibility of periodontitis progression, contributing to a better assessment of the grade of periodontitis in the individual patient. Although several biomarkers have shown good accuracy, these findings have yet to be translated into a viable and accessible point-of-care screening product.

To ensure the reliability of the M-SROH as a screening tool, future research should prioritise evaluating its test-retest reliability and internal consistency. Assessing test-

retest reliability would indicate the stability of the instrument's measurements over time. Additionally, internal consistency should be evaluated, as it may vary according to the characteristics of the sample (Streiner, 2003). Future studies should assess the reliability of the questionnaire when administered to a larger, more representative population. Conducting these assessments would provide a more comprehensive understanding of the reliability of the M-SROH and help strengthen its validity and credibility as a screening tool for periodontitis.

3.5 Conclusion

Within the limitation of the study, the following conclusions can be drawn:

i. The Malay adapted SROH is an equivalent translation of the adapted SROH that can effectively capture relevant information for identifying individuals at risk for periodontitis among Malaysian adults.
ii. It is a relevant and clear tool that is reliable and demonstrates potential validity for predicting periodontitis in this study population.

REFERENCES

Abbood, H. M., Hinz, J., Cherukara, G., & Macfarlane, T. V. (2016). Validity of Self-Reported Periodontal Disease: A Systematic Review and Meta-Analysis. *Journal of Periodontology*, *87*(12), 1474-1483. https://doi.org/https://doi.org/10.1902/jop.2016.160196

Acharya, S., Bhat, P. V., & Acharya, S. (2009). Factors affecting oral health-related quality of life among pregnant women. *International Journal of Dental Hygiene*, *7*(2), 102-107. https://doi.org/10.1111/j.1601-5037.2008.00351.x

Al Habashneh, R., Khader, Y. S., & Salameh, S. (2012). Use of the Arabic version of Oral Health Impact Profile-14 to evaluate the impact of periodontal disease on oral health-related quality of life among Jordanian adults. *Journal of Oral Science*, *54*(1), 113-120. https://doi.org/10.2334/josnusd.54.113

Alassiri, S., Parnanen, P., Rathnayake, N., Johannsen, G., Heikkinen, A. M., Lazzara, R., van der Schoor, P., van der Schoor, J. G., Tervahartiala, T., Gieselmann, D., & Sorsa, T. (2018). The Ability of Quantitative, Specific, and Sensitive Point-of-Care/Chair-Side Oral Fluid Immunotests for aMMP-8 to Detect Periodontal and Peri-Implant Diseases. *Disease Markers*, *2018*, 1306396. https://doi.org/10.1155/2018/1306396

Andrew Chin, R. W., Chua, Y. Y., Chu, M. N., Mahadi, N. F., Wong, M. S., Yusoff, M. S. B., & Lee, Y. Y. (2018). Investigating validity evidence of the Malay translation of the Copenhagen Burnout Inventory. *Journal of Taibah University Medical Sciences*, *13*(1), 1-9. https://doi.org/10.1016/j.jtumed.2017.06.003

Anuwar, A. H. K., Ng, C. W., Safii, S. H., Saub, R., & Ab-Murat, N. (2024). Modelling the national economic burden of non-surgical periodontal management in specialist clinics in Malaysia using a markov model. *BMC Oral Health*, *24*(1), 346. https://doi.org/10.1186/s12903-024-04094-z

Arias-Bujanda, N., Regueira-Iglesias, A., Balsa-Castro, C., Nibali, L., Donos, N., & Tomás, I. (2020). Accuracy of single molecular biomarkers in saliva for the diagnosis of periodontitis: A systematic review and meta-analysis. *Journal of Clinical Periodontology*, *47*(1), 2-18. https://doi.org/10.1111/jcpe.13202

Axelsson, P., Nyström, B., & Lindhe, J. (2004). The long-term effect of a plaque control program on tooth mortality, caries and periodontal disease in adults. Results after 30 years of maintenance. *Journal of Clinical Periodontology*, *31*(9), 749-757. https://doi.org/10.1111/j.1600-051X.2004.00563.x

Badimon, L., Peña, E., Arderiu, G., Padró, T., Slevin, M., Vilahur, G., & Chiva-Blanch, G. (2018). C-Reactive Protein in Atherothrombosis and Angiogenesis. *Frontiers in Immunology*, *9*, 430. https://doi.org/10.3389/fimmu.2018.00430

Bai, X.-c., Lu, D., Liu, A.-l., Zhang, Z.-m., Li, X.-m., Zou, Z.-p., Zeng, W.-s., Cheng, B.-l., & Luo, S.-q. (2005). Reactive Oxygen Species Stimulates Receptor Activator of NF-κB Ligand Expression in Osteoblast*. *Journal of Biological Chemistry*, *280*(17), 17497-17506. https://doi.org/https://doi.org/10.1074/jbc.M409332200

Bajaj, J. S., Matin, P., White, M. B., Fagan, A., Deeb, J. G., Acharya, C., Dalmet, S. S., Sikaroodi, M., Gillevet, P. M., & Sahingur, S. E. (2018). Periodontal therapy

favorably modulates the oral-gut-hepatic axis in cirrhosis. *American Journal of Physiology-Gastrointestinal and Liver Physiology*, *315*(5), G824-g837. https://doi.org/10.1152/ajpgi.00230.2018

Bartold, P. M., & Van Dyke, T. E. (2013). Periodontitis: a host-mediated disruption of microbial homeostasis. Unlearning learned concepts. *Periodontology 2000*, *62*(1), 203-217. https://doi.org/https://doi.org/10.1111/j.1600-0757.2012.00450.x

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine 25*(24), 3186-3191. https://doi.org/10.1097/00007632-200012150-00014

Bianco, V. C., Lopes, E. S., Borgato, M. H., Moura e Silva, P., & Marta, S. N. (2010). [The impact on life quality due to oral conditions in people fifty years or above]. *Ciência & Saúde Coletiva*, *15*(4), 2165-2172. https://doi.org/10.1590/s1413-81232010000400030 (O impacto das condições bucais na qualidade de vida de pessoas com cinquenta ou mais anos de vida.)

Billings, M., Holtfreter, B., Papapanou, P. N., Mitnik, G. L., Kocher, T., & Dye, B. A. (2018). Age-dependent distribution of periodontitis in two countries: Findings from NHANES 2009 to 2014 and SHIP-TREND 2008 to 2012. *Journal of Clinical Periodontology*, *45 Suppl 20*, S130-s148. https://doi.org/10.1111/jcpe.12944

Blicher, B., Joshipura, K., & Eke, P. (2005). Validation of self-reported periodontal disease: a systematic review. *Journal of Dental Research*, *84*(10), 881-890. https://doi.org/10.1177/154405910508401003

Botelho, J., Machado, V., Leira, Y., Proença, L., Chambrone, L., & Mendes, J. J. (2022). Economic burden of periodontitis in the United States and Europe: An updated estimation. *Journal of Periodontology*, *93*(3), 373-379. https://doi.org/10.1002/jper.21-0111

British Society of Periodontology. (2019). BPE Guidelines 2019. Retrieved 3 November 2023, from https://www.bsperio.org.uk/assets/downloads/BSP_BPE_Guidelines_2019.pdf

Buset, S. L., Walter, C., Friedmann, A., Weiger, R., Borgnakke, W. S., & Zitzmann, N. U. (2016). Are periodontal diseases really silent? A systematic review of their effect on quality of life. *Journal of Clinical Periodontology*, *43*(4), 333-344. https://doi.org/10.1111/jcpe.12517

Carra, M. C., Gueguen, A., Thomas, F., Pannier, B., Caligiuri, G., Steg, P. G., Zins, M., & Bouchard, P. (2018). Self-report assessment of severe periodontitis: Periodontal screening score development. *Journal of Clinical Periodontology*, *45*(7), 818-831. https://doi.org/10.1111/jcpe.12899

Caton, J. G., Armitage, G., Berglundh, T., Chapple, I. L. C., Jepsen, S., Kornman, K. S., Mealey, B. L., Papapanou, P. N., Sanz, M., & Tonetti, M. S. (2018). A new classification scheme for periodontal and peri-implant diseases and conditions – Introduction and key changes from the 1999 classification. *Journal of Periodontology*, *89*(S1), S1-S8. https://doi.org/https://doi.org/10.1002/JPER.18-0157

Cekici, A., Kantarci, A., Hasturk, H., & Van Dyke, T. E. (2014). Inflammatory and immune pathways in the pathogenesis of periodontal disease. *Periodontology 2000*, *64*(1), 57-80. https://doi.org/10.1111/prd.12002

Chapple, I. L., Van der Weijden, F., Doerfer, C., Herrera, D., Shapira, L., Polak, D., Madianos, P., Louropoulou, A., Machtei, E., Donos, N., Greenwell, H., Van Winkelhoff, A. J., Eren Kuru, B., Arweiler, N., Teughels, W., Aimetti, M., Molina, A., Montero, E., & Graziani, F. (2015). Primary prevention of periodontitis: managing gingivitis. *Journal of Clinical Periodontology*, *42 Suppl 16*, S71-76. https://doi.org/10.1111/jcpe.12366

Chapple, I. L. C., Mealey, B. L., Van Dyke, T. E., Bartold, P. M., Dommisch, H., Eickholz, P., Geisinger, M. L., Genco, R. J., Glogauer, M., Goldstein, M., Griffin, T. J., Holmstrup, P., Johnson, G. K., Kapila, Y., Lang, N. P., Meyle, J., Murakami, S., Plemons, J., Romito, G. A., . . . Yoshie, H. (2018). Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *Journal of Periodontology*, *89*(S1), S74-S84. https://doi.org/https://doi.org/10.1002/JPER.17-0719

Chee, B., Park, B., & Bartold, M. P. (2013). Periodontitis and type II diabetes: a two-way relationship. *JBI Evidence Implementation*, *11*(4), 317-329.

Chen, M. X., Zhong, Y. J., Dong, Q. Q., Wong, H. M., & Wen, Y. F. (2021). Global, regional, and national burden of severe periodontitis, 1990-2019: An analysis of the Global Burden of Disease Study 2019. *Journal of Clinical Periodontology*, *48*(9), 1165-1188. https://doi.org/10.1111/jcpe.13506

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297-334. https://doi.org/10.1007/BF02310555

D'Aiuto, F., Gkranias, N., Bhowruth, D., Khan, T., Orlandi, M., Suvan, J., Masi, S., Tsakos, G., Hurel, S., Hingorani, A. D., Donos, N., & Deanfield, J. E. (2018). Systemic effects of periodontitis treatment in patients with type 2 diabetes: a 12 month, single-centre, investigator-masked, randomised trial. *Lancet Diabetes & Endocrinology*, *6*(12), 954-965. https://doi.org/10.1016/s2213-8587(18)30038-x

Davis, L. L. (1992). Instrument review: Getting the most from a panel of experts. *Applied Nursing Research*, *5*(4), 194-197. https://doi.org/https://doi.org/10.1016/S0897-1897(05)80008-4

de Molon, R. S., Rossa, C., Jr., Thurlings, R. M., Cirelli, J. A., & Koenders, M. I. (2019). Linkage of Periodontitis and Rheumatoid Arthritis: Current Evidence and Potential Biological Interactions. *International Journal of Molecular Science*, *20*(18). https://doi.org/10.3390/ijms20184541

de Pinho, A. M., Borges, C. M., de Abreu, M. H., EF, E. F., & Vargas, A. M. (2012). Impact of periodontal disease on the quality of life of diabetics based on different clinical diagnostic criteria. *International Journal of Dentistry*, *2012*, 986412. https://doi.org/10.1155/2012/986412

Deng, K., Pelekos, G., Jin, L., & Tonetti, M. S. (2021a). Diagnostic accuracy of a point-of-care aMMP-8 test in the discrimination of periodontal health and disease. *Journal of Clinical Periodontology*, *48*(8), 1051-1065. https://doi.org/10.1111/jcpe.13485

Deng, K., Pelekos, G., Jin, L., & Tonetti, M. S. (2021b). Diagnostic accuracy of self-reported measures of periodontal disease: A clinical validation study using the 2017 case definitions. *Journal of Clinical Periodontology*, *48*(8), 1037-1050. https://doi.org/10.1111/jcpe.13484

Dietrich, T., Ower, P., Tank, M., West, N. X., Walter, C., Needleman, I., Hughes, F. J., Wadia, R., Milward, M. R., Hodge, P. J., & Chapple, I. L. C. (2019). Periodontal diagnosis in the context of the 2017 classification system of periodontal diseases and conditions - implementation in clinical practice. *British Dental Journal*, *226*(1), 16-22. https://doi.org/10.1038/sj.bdj.2019.3

Dominy, S. S., Lynch, C., Ermini, F., Benedyk, M., Marczyk, A., Konradi, A., Nguyen, M., Haditsch, U., Raha, D., Griffin, C., Holsinger, L. J., Arastu-Kapur, S., Kaba, S., Lee, A., Ryder, M. I., Potempa, B., Mydel, P., Hellvard, A., Adamowicz, K., . . . Potempa, J. (2019). Porphyromonas gingivalis in Alzheimer's disease brains: Evidence for disease causation and treatment with small-molecule inhibitors. *Science Advances*, *5*(1), eaau3333. https://doi.org/10.1126/sciadv.aau3333

Durham, J., Fraser, H. M., McCracken, G. I., Stone, K. M., John, M. T., & Preshaw, P. M. (2013). Impact of periodontitis on oral health-related quality of life. *Journal of Dentistry*, *41*(4), 370-376. https://doi.org/10.1016/j.jdent.2013.01.008

Ebersole, J. L., Nagarajan, R., Akers, D., & Miller, C. S. (2015). Targeted salivary biomarkers for discrimination of periodontal health and disease(s) [Original Research]. *Frontiers in Cellular and Infection Microbiology*, *5*. https://doi.org/10.3389/fcimb.2015.00062

Ebersole, J. L., Schuster, J. L., Stevens, J., Dawson, D., 3rd, Kryscio, R. J., Lin, Y., Thomas, M. V., & Miller, C. S. (2013). Patterns of salivary analytes provide diagnostic capacity for distinguishing chronic adult periodontitis from health. *Journal of Clinical Immunology*, *33*(1), 271-279. https://doi.org/10.1007/s10875-012-9771-3

Eke, P. I., & Dye, B. (2009). Assessment of self-report measures for predicting population prevalence of periodontitis. *Journal of Periodontology*, *80*(9), 1371-1379. https://doi.org/10.1902/jop.2009.080607

Eke, P. I., Dye, B. A., Wei, L., Slade, G. D., Thornton-Evans, G. O., Beck, J. D., Taylor, G. W., Borgnakke, W. S., Page, R. C., & Genco, R. J. (2013). Self-reported measures for surveillance of periodontitis. *Journal of Dental Research*, *92*(11), 1041-1047. https://doi.org/10.1177/0022034513505621

Eke, P. I., & Genco, R. J. (2007). CDC Periodontal Disease Surveillance Project: Background, Objectives, and Progress Report. *Journal of Periodontology*, *78*(7S), 1366-1371. https://doi.org/10.1902/jop.2007.070134

Fayers, P. M., & Machin, D. (2007). Quality of Life: The assessment, analysis and interpretation of patient-reported outcomes.

Ferreira, M. C., Dias-Pereira, A. C., Branco-de-Almeida, L. S., Martins, C. C., & Paiva, S. M. (2017). Impact of periodontal disease on quality of life: a systematic review. *Journal of Periodontal Research*, *52*(4), 651-665. https://doi.org/10.1111/jre.12436

Frencken, J. E., Sharma, P., Stenhouse, L., Green, D., Laverty, D., & Dietrich, T. (2017). Global epidemiology of dental caries and severe periodontitis - a comprehensive review. *Journal of Clinical Periodontology*, *44 Suppl 18*, S94-S105. https://doi.org/10.1111/jcpe.12677

Gardiner, F. W., Richardson, A., Gale, L., Bishop, L., Harwood, A., Lucas, R. M., Strickland, L., Taylor, S., & Laverty, M. (2020). Rural and remote dental care: Patient characteristics and health care provision. *Australian Journal of Rural Health*, *28*(3), 292-300. https://doi.org/10.1111/ajr.12631

Genco, R. J., & Borgnakke, W. S. (2013). Risk factors for periodontal disease. *Periodontology 2000*, *62*(1), 59-94. https://doi.org/10.1111/j.1600-0757.2012.00457.x

Genco, R. J., Graziani, F., & Hasturk, H. (2020). Effects of periodontal disease on glycemic control, complications, and incidence of diabetes mellitus. *Periodontology 2000*, *83*(1), 59-65. https://doi.org/10.1111/prd.12271

Genco, R. J., & Sanz, M. (2020). Clinical and public health implications of periodontal and systemic diseases: An overview. *Periodontology 2000*, *83*(1), 7-13. https://doi.org/10.1111/prd.12344

Giannobile, W. V., Beikler, T., Kinney, J. S., Ramseier, C. A., Morelli, T., & Wong, D. T. (2009). Saliva as a diagnostic tool for periodontal disease: current state and future directions. *Periodontology 2000*, *50*, 52-64. https://doi.org/10.1111/j.1600-0757.2008.00288.x

Guillemin, F., Bombardier, C., & Beaton, D. (1993). Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. *Journal of Clinical Epidemiology*, *46*(12), 1417-1432. https://doi.org/10.1016/0895-4356(93)90142-n

Hadie, S. N. H., Hassan, A., Ismail, Z. I. M., Asari, M. A., Khan, A. A., Kasim, F., Yusof, N. A. M., Manan Sulong, H. A., Tg Muda, T. F. M., Arifin, W. N., & Yusoff, M. S. B. (2017). Anatomy education environment measurement inventory: A valid tool to measure the anatomy learning environment. *Anatomical Sciences Education*, *10*(5), 423-432. https://doi.org/10.1002/ase.1683

Hajishengallis, G. (2022). Interconnection of periodontal disease and comorbidities: Evidence, mechanisms, and implications. *Periodontology 2000*, *89*(1), 9-18. https://doi.org/10.1111/prd.12430

Institute for Health Metrics and Evaluation (IHME). (2021). *Global Burden of Disease Study 2021 (GBD 2021). Cause and Risk Summary: Periodontal Diseases – Level 4 cause*. Retrieved 27 March 2024 from https://www.thelancet.com/pb-assets/Lancet/gbd/summaries/diseases/periodontal-diseases.pdf

Institute for Health Systems Research (IHSR). (2020). *National Health and Morbidity Survey (NHMS) 2019: Vol. II: Healthcare Demand*. National Institutes of Health, Ministry of Health Malaysia. https://doi.org/10.13140/RG.2.2.16717.05603

Iwamoto, Y., Nishimura, F., Soga, Y., Takeuchi, K., Kurihara, M., Takashiba, S., & Murayama, Y. (2003). Antimicrobial periodontal treatment decreases serum C-reactive protein, tumor necrosis factor-alpha, but not adiponectin levels in patients with chronic periodontitis. *Journal of Periodontology*, *74*(8), 1231-1236. https://doi.org/10.1902/jop.2003.74.8.1231

Iwasaki, M., Usui, M., Ariyoshi, W., Nakashima, K., Nagai-Yoshioka, Y., Inoue, M., Kobayashi, K., Borgnakke, W. S., Taylor, G. W., & Nishihara, T. (2021). Validation of a self-report questionnaire for periodontitis in a Japanese population. *Scientific Reports*, *11*(1), 15078. https://doi.org/10.1038/s41598-021-93965-4

Jansson, H., Wahlin, Å., Johansson, V., Åkerman, S., Lundegren, N., Isberg, P. E., & Norderyd, O. (2014). Impact of periodontal disease experience on oral health-related quality of life. *Journal of Periodontology*, *85*(3), 438-445. https://doi.org/10.1902/jop.2013.130188

Jepsen, S., Blanco, J., Buchalla, W., Carvalho, J. C., Dietrich, T., Dorfer, C., Eaton, K. A., Figuero, E., Frencken, J. E., Graziani, F., Higham, S. M., Kocher, T., Maltz, M., Ortiz-Vigon, A., Schmoeckel, J., Sculean, A., Tenuta, L. M., van der Veen, M. H., & Machiulskiene, V. (2017). Prevention and control of dental caries and periodontal diseases at individual and population level: consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. *Journal of Clinical Periodontology*, *44 Suppl 18*, S85-S93. https://doi.org/10.1111/jcpe.12687

Jin, L. (2015). Group E. Initiator paper. Interprofessional education and multidisciplinary teamwork for prevention and effective management of periodontal disease. *Journal of the International Academy of Periodontology*, *17*(1 Suppl), 74-79. https://www.ncbi.nlm.nih.gov/pubmed/25764596

Jin, L. J., Armitage, G. C., Klinge, B., Lang, N. P., Tonetti, M., & Williams, R. C. (2011). Global oral health inequalities: task group--periodontal disease. *Advances in Dental Research*, *23*(2), 221-226. https://doi.org/10.1177/0022034511402080

Kassebaum, N. J., Bernabe, E., Dahiya, M., Bhandari, B., Murray, C. J., & Marcenes, W. (2014). Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. *Journal of Dental Research*, *93*(11), 1045-1053. https://doi.org/10.1177/0022034514552491

Keszei, A. P., Novak, M., & Streiner, D. L. (2010). Introduction to health measurement scales. *Journal of Psychosomatic Research*, *68*(4), 319-323. https://doi.org/10.1016/j.jpsychores.2010.01.006

Kiili, M., Cox, S. W., Chen, H. Y., Wahlgren, J., Maisi, P., Eley, B. M., Salo, T., & Sorsa, T. (2002). Collagenase-2 (MMP-8) and collagenase-3 (MMP-13) in adult periodontitis: molecular forms and levels in gingival crevicular fluid and immunolocalisation in gingival tissue. *Journal of Clinical Periodontology*, *29*(3), 224-232. https://doi.org/10.1034/j.1600-051x.2002.290308.x

Kim, H. D., Lee, C. S., Cho, H. J., Jeon, S., Choi, Y. N., Kim, S., Kim, D., Jin Lee, H., Vu, H., Jeong, H. J., & Kim, B. (2020). Diagnostic ability of salivary matrix metalloproteinase-9 lateral flow test point-of-care test for periodontitis. *Journal of Clinical Periodontology*, *47*(11), 1354-1361. https://doi.org/10.1111/jcpe.13360

Kinane, D. F., Peterson, M., & Stathopoulou, P. G. (2006). Environmental and other modifying factors of the periodontal diseases. *Periodontology 2000*, *40*, 107-119. https://doi.org/10.1111/j.1600-0757.2005.00136.x

Kinane, D. F., Stathopoulou, P. G., & Papapanou, P. N. (2017). Periodontal diseases. *Nature Reviews Disease Primers*, *3*, 17038. https://doi.org/10.1038/nrdp.2017.38

Lang, N. P., Adler, R., Joss, A., & Nyman, S. (1990). Absence of bleeding on probing An indicator of periodontal stability. *Journal of Clinical Periodontology*, *17*(10), 714-721. https://doi.org/https://doi.org/10.1111/j.1600-051X.1990.tb01059.x

Lang, N. P., Schätzle, M. A., & Löe, H. (2009). Gingivitis as a risk factor in periodontal disease. *Journal of Clinical Periodontology*, *36 Suppl 10*, 3-8. https://doi.org/10.1111/j.1600-051X.2009.01415.x

Lau, A., Yusoff, M. S. B., Lee, Y. Y., Choi, S. B., Abdul Rashid, F., Wahid, N., Xiao, J.-Z., & Liong, M.-T. (2017). Development, Translation and Validation of Questionnaires for Diarrhoea and Respiratory-related Illnesses during Probiotic Administration in Children. *Education in Medicine Journal*, *9*, 19-30. https://doi.org/10.21315/eimj2017.9.4.3

Lau, A. S. Y., Yusoff, M. S. B., Lee, Y. Y., Choi, S. B., Xiao, J. Z., & Liong, M. T. (2018). Development and validation of a Chinese translated questionnaire: A single simultaneous tool for assessing gastrointestinal and upper respiratory tract related illnesses in pre-school children. *Journal of Taibah University Medical Sciences*, *13*(2), 135-141. https://doi.org/10.1016/j.jtumed.2017.11.003

Listl, S., Galloway, J., Mossey, P. A., & Marcenes, W. (2015). Global Economic Impact of Dental Diseases. *Journal of Dental Research*, *94*(10), 1355-1361. https://doi.org/10.1177/0022034515602879

Locker, D., & Quiñonez, C. (2009). Functional and psychosocial impacts of oral disorders in Canadian adults: a national population survey. *Journal of the Canadian Dental Association. Journal de L'Association Dentaire Canadienne*, *75*(7), 521.

Löe, H. (1993). Periodontal disease: the sixth complication of diabetes mellitus. *Diabetes Care*, *16*(1), 329-334. https://pubmed.ncbi.nlm.nih.gov/8422804/

Loesche, W. J., & Grossman, N. S. (2001). Periodontal Disease as a Specific, albeit Chronic, Infection: Diagnosis and Treatment. *Clinical Microbiology Reviews*, *14*(4), 727-752. https://doi.org/doi:10.1128/cmr.14.4.727-752.2001

Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, *35*(6), 382-385.

Mahadi, N., Chin, R. W., Chua, Y., Chu, M., Wong, M. S., Yusoff, M. S. B., & Lee, Y. Y. (2018). Malay Language Translation and Validation of the Oldenburg Burnout

Inventory Measuring Burnout. *Education in Medicine Journal*, *10*. https://doi.org/10.21315/eimj2018.10.2.4

Mandrekar, J. N. (2010). Receiver operating characteristic curve in diagnostic test assessment. *Journal of Thoracic Oncology*, *5*(9), 1315-1316. https://doi.org/10.1097/JTO.0b013e3181ec173d

Marcenes, W., Kassebaum, N. J., Bernabe, E., Flaxman, A., Naghavi, M., Lopez, A., & Murray, C. J. (2013). Global burden of oral conditions in 1990-2010: a systematic analysis. *Journal of Dental Research*, *92*(7), 592-597. https://doi.org/10.1177/0022034513490168

McDonald, M. P. (2005). Validity, Data Sources. In K. Kempf-Leonard (Ed.), *Encyclopedia of Social Measurement* (pp. 939-948). Elsevier. https://doi.org/https://doi.org/10.1016/B0-12-369398-5/00046-3

Md Bohari, N. F., Kruger, E., John, J., & Tennant, M. (2019). Analysis of dental services distribution in Malaysia: a geographic information systems - based approach. *International Dental Journal*, *69*(3), 223-229. https://doi.org/10.1111/idj.12454

Metz, C. E. (1978). Basic principles of ROC analysis. *Seminars in Nuclear Medicine*, *8*(4), 283-298. https://doi.org/10.1016/s0001-2998(78)80014-2

Mohamad Marzuki, M. F., Yaacob, N. A., & Yaacob, N. M. (2018). Translation, Cross-Cultural Adaptation, and Validation of the Malay Version of the System Usability Scale Questionnaire for the Assessment of Mobile Apps. *JMIR Human Factors*, *5*(2), e10308. https://doi.org/10.2196/10308

Mohd Dom, T., Ayob, R., Nur, A., Manaf, M., Ishak, N., Abd Muttalib, K., Aljunid, S., Ahmad-Yaziz, Y., Abdul-Aziz, H., Kasan, N., & Mohd Asari, A. (2014). Cost analysis of Periodontitis management in public sector specialist dental clinics. *BMC Oral Health*, *14*, 56. https://doi.org/10.1186/1472-6831-14-56

Mohd Dom, T. N., Ayob, R., Abd Muttalib, K., & Aljunid, S. M. (2016). National Economic Burden Associated with Management of Periodontitis in Malaysia. *International Journal of Dentistry*, *2016*, 1891074. https://doi.org/10.1155/2016/1891074

Monaghan, T. F., Rahman, S. N., Agudelo, C. W., Wein, A. J., Lazar, J. M., Everaert, K., & Dmochowski, R. R. (2021). Foundational Statistical Principles in Medical Research: Sensitivity, Specificity, Positive Predictive Value, and Negative Predictive Value. *Medicina (Kaunas, Lithuania)*, *57*(5). https://doi.org/10.3390/medicina57050503

Montero, E., La Rosa, M., Montanya, E., Calle-Pascual, A. L., Genco, R. J., Sanz, M., & Herrera, D. (2020). Validation of self-reported measures of periodontitis in a Spanish Population. *Journal of Periodontal Research*, *55*(3), 400-409. https://doi.org/10.1111/jre.12724

Mougeot, J. C., Stevens, C. B., Paster, B. J., Brennan, M. T., Lockhart, P. B., & Mougeot, F. K. (2017). Porphyromonas gingivalis is the most abundant species detected in coronary and femoral arteries. *Journal of Oral Microbiology*, *9*(1), 1281562. https://doi.org/10.1080/20002297.2017.1281562

Newell, S. A., Girgis, A., Sanson-Fisher, R. W., & Savolainen, N. J. (1999). The accuracy of self-reported health behaviors and risk factors relating to cancer and cardiovascular disease in the general population: a critical review. *American Journal of Preventive Medicine*, *17*(3), 211-229. https://doi.org/10.1016/s0749-3797(99)00069-0

Ng, S. K., & Leung, W. K. (2006). Oral health-related quality of life and periodontal status. *Community Dentistry and Oral Epidemiology*, *34*(2), 114-122. https://doi.org/10.1111/j.1600-0528.2006.00267.x

Nunnally, J., & Bernstein, I. H. (1994). *Psychometric Theory*. McGraw-Hill Companies,Incorporated. https://books.google.com.my/books?id=r0fuAAAAMAAJ

Oral Health Division. (2017). *National Health and Morbidity Survey 2017: National Oral Health Survey of Schoolchildren 2017*. Putrajaya: National Institutes of Health Retrieved from https://hq.moh.gov.my/ohd/images/pdf/research/NHMS%202017%20NOHSS%202017%20Vol%20II%20Oral%20Health%20Status%20of%2012%20yr%20olds.pdf

Oral Health Programme. (2023). *National Health and Morbidity Survey (NHMS) 2020: National Oral Health Survey of Adults (NOHSA) 2020 - Key Findings*. Putrajaya: Ministry of Health Malaysia

Ozair, M., Baharuddin, K. A., Mohamed, S., Esa, W., & Yusoff, M. S. B. (2017). Development and Validation of the Knowledge and Clinical Reasoning of Acute Asthma Management in Emergency Department (K-CRAMED). *Education in Medicine Journal*, *9*, 1-17. https://doi.org/10.21315/eimj2017.9.2.1

Page, R. C., Offenbacher, S., Schroeder, H. E., Seymour, G. J., & Kornman, K. S. (1997). Advances in the pathogenesis of periodontitis: summary of developments, clinical implications and future directions. *Periodontology 2000*, *14*, 216-248. https://doi.org/10.1111/j.1600-0757.1997.tb00199.x

Palma, P. V., Caetano, P. L., & Leite, I. C. (2013). Impact of periodontal diseases on health-related quality of life of users of the brazilian unified health system. *Internationa Journal of Dentistry*, *2013*, 150357. https://doi.org/10.1155/2013/150357

Papapanou, P. N., Sanz, M., Buduneli, N., Dietrich, T., Feres, M., Fine, D. H., Flemmig, T. F., Garcia, R., Giannobile, W. V., Graziani, F., Greenwell, H., Herrera, D., Kao, R. T., Kebschull, M., Kinane, D. F., Kirkwood, K. L., Kocher, T., Kornman, K. S., Kumar, P. S., . . . Tonetti, M. S. (2018). Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *Journal of Periodontology*, *89*(S1), S173-S182. https://doi.org/https://doi.org/10.1002/JPER.17-0721

Pihlstrom, B. L., Michalowicz, B. S., & Johnson, N. W. (2005). Periodontal diseases. *Lancet*, *366*(9499), 1809-1820. https://doi.org/10.1016/S0140-6736(05)67728-8

Polit, D. F., & Beck, C. T. (2006). The content validity index: are you sure you know what's being reported? Critique and recommendations. *Research in Nursing and Health*, *29*(5), 489-497. https://doi.org/10.1002/nur.20147

Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing and Health*, *30*(4), 459-467. https://doi.org/10.1002/nur.20199

Puzhankara, L., & Janakiram, C. (2021). Common Risk Factor Approach to Limit Noncommunicable Diseases and Periodontal Disease-The Molecular and Cellular Basis: A Narrative Review. *Journal of International Society of Preventive & Community Dentistry*, *11*(5), 490-502. https://doi.org/10.4103/jispcd.JISPCD_109_21

Rani, H., Mohd Dom, T., & Mohd-Said, S. (2020). Self-assessment tool for evaluating periodontal conditions. *Makara Journal of Health Research*, *24*, 193-197. https://doi.org/10.7454/msk.v24i3.1232

Reiniger, A. P. P., Londero, A. B., Ferreira, T. G. M., da Rocha, J. M., Moreira, C. H. C., & Kantorski, K. Z. (2020). Validity of self-reported measures for periodontitis surveillance in a rural sample. *Journal of Periodontology*, *91*(5), 617-627. https://doi.org/10.1002/jper.19-0292

Santos Tunes, R., Foss-Freitas, M. C., & Nogueira-Filho Gda, R. (2010). Impact of periodontitis on the diabetes-related inflammatory status. *Journal of the Canadian Dental Association. Journal de L'Association Dentaire Canadienne*, *76*, a35.

Schenkein, H. A., Papapanou, P. N., Genco, R., & Sanz, M. (2020). Mechanisms underlying the association between periodontitis and atherosclerotic disease. *Periodontology 2000*, *83*(1), 90-106. https://doi.org/10.1111/prd.12304

Schierz, O., Baba, K., & Fueki, K. (2021). Functional oral health-related quality of life impact: A systematic review in populations with tooth loss. *Journal of Oral Rehabilitation*, *48*(3), 256-270. https://doi.org/10.1111/joor.12984

Sheiham, A., & Watt, R. G. (2000). The common risk factor approach: a rational basis for promoting oral health. *Community Dentistry and Oral Epidemiology*, *28*(6), 399-406. https://doi.org/10.1034/j.1600-0528.2000.028006399.x

Simpson, T. C., Clarkson, J. E., Worthington, H. V., MacDonald, L., Weldon, J. C., Needleman, I., Iheozor-Ejiofor, Z., Wild, S. H., Qureshi, A., Walker, A., Patel, V. A., Boyers, D., & Twigg, J. (2022). Treatment of periodontitis for glycaemic control in people with diabetes mellitus. *Cochrane Database of Systematic Reviews*, *4*(4), Cd004714. https://doi.org/10.1002/14651858.CD004714.pub4

Slade, G. D. (2007). Interim analysis of validity of periodontitis screening questions in the Australian population. *Journal of Periodontology*, *78*(7 Suppl), 1463-1470. https://doi.org/10.1902/jop.2007.060344

Slots, J. (2017). Periodontitis: facts, fallacies and the future. *Periodontology 2000*, *75*(1), 7-23. https://doi.org/10.1111/prd.12221

Sorsa, T., Alassiri, S., Grigoriadis, A., Räisänen, I. T., Pärnänen, P., Nwhator, S. O., Gieselmann, D. R., & Sakellari, D. (2020). Active MMP-8 (aMMP-8) as a Grading and Staging Biomarker in the Periodontitis Classification. *Diagnostics (Basel)*, *10*(2). https://doi.org/10.3390/diagnostics10020061

Sorsa, T., Tjäderhane, L., Konttinen, Y. T., Lauhio, A., Salo, T., Lee, H. M., Golub, L. M., Brown, D. L., & Mäntylä, P. (2006). Matrix metalloproteinases: contribution to pathogenesis, diagnosis and treatment of periodontal inflammation. *Annals of Medicine*, *38*(5), 306-321. https://doi.org/10.1080/07853890600800103

Streiner, D. L. (2003). Starting at the beginning: an introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment*, *80*(1), 99-103. https://doi.org/10.1207/s15327752jpa8001_18

Stumvoll, M., Goldstein, B. J., & Van Haeften, T. W. (2005). Type 2 diabetes: principles of pathogenesis and therapy. *The Lancet*, *365*(9467), 1333-1346.

Taber, K. S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, *48*(6), 1273-1296. https://doi.org/10.1007/s11165-016-9602-2

Tan, Y. R., Tan, E. H., Jawahir, S., Mohd Hanafiah, A. N., & Mohd Yunos, M. H. (2021). Demographic and socioeconomic inequalities in oral healthcare utilisation in Malaysia: evidence from a national survey. *BMC Oral Health*, *21*(1), 34. https://doi.org/10.1186/s12903-020-01388-w

Tonetti, M., & Kornman, K. S. (2013). Special Issue: Periodontitis and Systemic Diseases: Proceedings of a workshop jointly held by the European Federation of Periodontology and American Academy of Periodontology. *Journal of Clinical Periodontology*, *40*(Suppl 14), S1-S209. https://onlinelibrary.wiley.com/toc/1600051x/2013/40/s14

Tonetti, M. S., Chapple, I. L., & Working Group 3 of Seventh European Workshop on, P. (2011). Biological approaches to the development of novel periodontal therapies--consensus of the Seventh European Workshop on Periodontology. *Journal of Clinical Periodontology*, *38 Suppl 11*, 114-118. https://doi.org/10.1111/j.1600-051X.2010.01675.x

Tonetti, M. S., D'Aiuto, F., Nibali, L., Donald, A., Storry, C., Parkar, M., Suvan, J., Hingorani, A. D., Vallance, P., & Deanfield, J. (2007). Treatment of periodontitis and endothelial function. *New England Journal of Medicine*, *356*(9), 911-920. https://doi.org/10.1056/NEJMoa063186

Tonetti, M. S., Greenwell, H., & Kornman, K. S. (2018). Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. *Journal of Periodontology*, *89 Suppl 1*, S159-s172. https://doi.org/10.1002/jper.18-0006

Tonetti, M. S., Jepsen, S., Jin, L., & Otomo-Corgel, J. (2017). Impact of the global burden of periodontal diseases on health, nutrition and wellbeing of mankind: A call for global action. *Journal of Clinical Periodontology*, *44*(5), 456-462. https://doi.org/10.1111/jcpe.12732

Trindade, D., Carvalho, R., Machado, V., Chambrone, L., Mendes, J. J., & Botelho, J. (2023). Prevalence of periodontitis in dentate people between 2011 and 2020: A systematic review and meta-analysis of epidemiological studies. *Journal of Clinical Periodontology*, *50*(5), 604-626. https://doi.org/10.1111/jcpe.13769

Trombelli, L., Farina, R., Silva, C. O., & Tatakis, D. N. (2018). Plaque-induced gingivitis: Case definition and diagnostic considerations. *Journal of Clinical Periodontology*, *45 Suppl 20*, S44-s67. https://doi.org/10.1111/jcpe.12939

Tsang, S., Royse, C. F., & Terkawi, A. S. (2017). Guidelines for developing, translating, and validating a questionnaire in perioperative and pain medicine. *Saudi Journal of Anaesthesia*, *11*(Suppl 1), S80-s89. https://doi.org/10.4103/sja.SJA_203_17

Van Dyke, T. E., Kholy, K. E., Ishai, A., Takx, R. A. P., Mezue, K., Abohashem, S. M., Ali, A., Yuan, N., Hsue, P., Osborne, M. T., & Tawakol, A. (2021). Inflammation of the periodontium associates with risk of future cardiovascular events. *Journal of Periodontology*, *92*(3), 348-358. https://doi.org/10.1002/jper.19-0441

van Griethuijsen, R. A. L. F., van Eijck, M. W., Haste, H., den Brok, P. J., Skinner, N. C., Mansour, N., Savran Gencer, A., & BouJaoude, S. (2015). Global Patterns in Students' Views of Science and Interest in Science. *Research in Science Education*, *45*(4), 581-603. https://doi.org/10.1007/s11165-014-9438-6

Verhulst, M. J. L., Teeuw, W. J., Bizzarro, S., Muris, J., Su, N., Nicu, E. A., Nazmi, K., Bikker, F. J., & Loos, B. G. (2019). A rapid, non-invasive tool for periodontitis screening in a medical care setting. *BMC Oral Health*, *19*(1), 87. https://doi.org/10.1186/s12903-019-0784-7

Wright, F. V., Law, M., Crombie, V., Goldsmith, C. H., & Dent, P. (1994). Development of a self-report functional status index for juvenile rheumatoid arthritis. *Journal of Rheumatology*, *21*(3), 536-544.

Yamamoto, T., Koyama, R., Tamaki, N., Maruyama, T., Tomofuji, T., Ekuni, D., Yamanaka, R., Azuma, T., & Morita, M. (2009). Validity of a questionnaire for periodontitis screening of Japanese employees. *Journal of Occupational Health*, *51*(2), 137-143. https://doi.org/10.1539/joh.l8108

Yusoff, M. S. B. (2019a). ABC of Content Validation and Content Validity Index Calculation. *Education in Medicine Journal*, *11*, 49-54. https://doi.org/10.21315/eimj2019.11.2.6

Yusoff, M. S. B. (2019b). ABC of Response Process Validation and Face Validity Index Calculation. *Education in Medicine Journal*, *11*. https://doi.org/10.21315/eimj2019.11.3.6

Yusoff, M. S. B., Arifin, W. N., & Hadie, S. N. H. (2021). ABC of Questionnaire Development and Validation for Survey Research. *Education in Medicine Journal*, *13*, 97–108. https://doi.org/10.21315/eimj2021.13.1.10