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**RESEARCH ARTICLE** **OPEN ACCESS**

# Indonesian Tooth Loss Predictor in Middle-aged and Elderly Populations based on Sociodemographic Factors and Systemic Disease: A Cross-sectional Study

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**Abstract:**

***Background:*** Predictors of tooth loss in Indonesians have not been identified. This prediction is very useful for tooth loss prevention in middle-aged and elderly.

***Objective:*** The study aimed to predict tooth loss in the middle-aged and elderly populations based on sociodemographic and systemic disease.

***Methods:*** A cross-sectional study of secondary data from the National Basic Health Research was conducted on a sample of 16,973 respondents following the inclusion criteria. Sociodemographic and systemic diseases as independent variables and tooth loss as a dependent variable were assessed. Data were analyzed using a logistic regression model.

***Results:*** Respondents with at least one missing tooth were 20.6%. Among them, 55.6% were females, and 68.1% belonged to the pre-elderly age group (49.0% lived in urban areas and 51.0% lived in rural areas). Only 30.5% had tertiary education, and 61.2% held a formal job. History of systemic diseases like diabetes, heart disease, hypertension, stroke, and cancer were found to be in 5.4%, 3.7%, 17.3%, 2.3%, and 0.4% of respondents. The predictive value of tooth loss was 0.976, and the range was > 0.5. In this study, the predictive value of the respondents' tooth loss was 1.

***Conclusion:*** Indonesian tooth loss predictor value in middle-aged and elderly populations based on sociodemographic and systemic disease was found to be 1. This value indicates a risk of tooth loss. The predictive factor influencing tooth loss of 80.2% can be predicted based on age, occupation, and history of diabetes mellitus and heart disease. Tooth loss can be predicted if the sample is in the elderly group who are still working and have a history of diabetes and heart disease.

**Keywords:** Predictor tooth loss, Middle-aged, Elderly, Sociodemographic, Systemic disease, Aging.



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## 1. INTRODUCTION

Aging is a biological process that leads to progressive decline in physical function, tissue and organ repair, and regenerative potential. This process is irreversible due to the severe damage in various organ systems in response to different stressors. It is influenced by a combination of physical, environmental, and social factors [1]. Changes in the tissue structure and function of the oral cavity occur as a part of the aging process. Tooth loss, primarily due to dental caries and periodontitis, is one of the most common causes of changes in the oral cavity among the aging population.

Dental caries and periodontitis, the two main causes of tooth loss, are associated with various factors, including chronic diseases, such as stroke and diabetes. Several studies have demonstrated that depression [2] and obesity [3] are linked to dental caries and contribute to teeth loss. Furthermore, chronic kidney disease [4], diabetes [5], rheumatoid arthritis [6], and cancer treatments [7] have been found to increase the risk of periodontitis and tooth loss. Additional factors identified as contributing to tooth loss include age, insurance status, race, income, education, and smoking [8, 9]. In the United States, Zhang found that tooth loss was associated with Chronic Obstructive Pulmonary Disease (COPD), cardiovascular disease, arthritis, diabetes, and kidney disease; however, no association was found with cancer, stroke, or asthma [10].

Tooth loss not only leads to a decrease in masticatory efficiency but also contributes to various health problems in the elderly population. This condition represents a significant public health concern that reduces the quality of life for both adult and older individuals. The rise in systemic diseases can further affect the quality of life among the elderly. In addition, tooth loss increases significantly with increasing advancing age, which has an impact on Oral Health-Related Quality of Life (OHRQoL) [11].

Tooth loss is an important indicator of oral health, as it reflects the accumulation of diseases and conditions affecting the oral cavity [12]. Edentulism, which refers to the condition of partial or complete loss of teeth, serves as a measure of the oral health status of a population. This condition provides insights into the effectiveness of various preventive and treatment measures implemented by health services. Furthermore, previous research has reported that tooth loss is indicative of oral health, as it reveals the historical development of oral diseases [13]

Gabiec *et al*. [14] reported that tooth loss is associated with sociodemographic factors and systemic diseases, including diabetes mellitus, heart disease, and hypertension. The predictors of this condition are primarily related to demographic and socio-economic variables, as well as oral health status. Elani [8] found that age, education, routine dental hygiene, employment, family income, poverty levels, race, and home-ownership are strong predictors of tooth loss. Additionally, several systemic diseases, such as hypertension and diabetes, are significant predictors.

In developing programs and strategies to prevent tooth loss in older adults, it is important to understand these behavioral predictors involved [15]. This study uses secondary data from the National Basic Health Survey (2018) to predict tooth loss based on participant characteristics and systemic diseases. The objective of this study is to identify predictors of tooth loss in middle-aged and elderly individuals based on sociodemographic factors and systemic diseases. The finding of this study is anticipated to provide recommendations for the development of oral disease prevention programs for the elderly, integrated with strategies for preventing non-communicable diseases.

## 2. MATERIALS AND METHODS

This study used a cross-sectional and analytical design. Secondary data were obtained from public health questionnaires and the results of oral examinations based on the National Basic Health Research (2018). These results were sourced from the Health Research and Development Agency of the Ministry of Health of Indonesia, under license number IR.03.01/4/6264/2021. An internal research grant was provided by the Universitas Padjadjaran.

This study was based on secondary data collected from respondents aged 45 years and older who underwent oral examinations as part of the National Basic Health Survey in 2018. These respondents were selected from 2,500 census blocks across 26 provinces. A total of 2,499 census blocks were successfully visited, resulting in an impressive response rate of 99.95%. The target number of households was set at 24,990, with a total of 19,553 households participating, yielding a response rate of 78.2%. This study used a purposive sampling method, with the inclusion criteria focusing on secondary data from respondents aged 45 and over who were interviewed using a public health questionnaire and underwent oral examinations. The total sample size, based on the inclusion criteria, was 16,973 respondents of 17,095 available secondary data sources.

The independent variables in this research included socio-demographic factors, such as gender, age, education level, occupation, and place of residence. Other independent variables included the history of chronic diseases, such as diabetes mellitus, heart disease, hypertension, stroke, and diagnosed cancer.

The dependent variable in this research was tooth loss, which was determined based on the results of oral examinations according to World Health Organization (WHO) criteria. Tooth loss was assessed through clinical examination following WHO guidelines for basic oral health assessment methods established in 2013. The examination of permanent teeth included an evaluation of both the crown and roots. The coding system for the crowns is as follows: 0 (healthy), 1 (caries), 2 (filling with caries), 3 (filling without caries), 4 (missing teeth due to caries), 5 (missing teeth not due to caries), 6 (teeth with fissure sealant), 7 (abutment teeth, teeth with special crowns, veneers, or implants), 8 (unerupted teeth), and 9 (not recorded). In addition, the component of tooth loss

based on WHO criteria includes codes 4 and 5 for each examined tooth. Code 4 indicates teeth that were lost or removed due to caries, while code 5 means teeth lost or removed for other reasons. Code 5 is included in the analysis of tooth loss if the respondent is 30 years of age or older. Data from dental examinations were collected by trained and calibrated dentists serving as examiners. Training was provided by experts from the Indonesian Dental Association, the Indonesian Dental Public Health Association, and in collaboration with the Ministry of Health Research and Development [16, 17].

The data set was managed and subsequently subjected to both descriptive and analytical data processing. To determine the frequency distribution of respondents, univariate data analysis was conducted. Bivariate analysis was performed by tabulating the independent and dependent variables, followed by testing for associations. The risk factor for tooth loss was assessed using the odds ratio (OR). Additionally, multivariate analysis using logistic regression tests was carried out to examine the predictive effects of socio-demographic factors and a history of chronic disease on tooth loss.

**Table 1. Description of respondent characteristics based on socio-demographic factors (N=16,973).**

| Respondent characteristics | N | % |
|---|---|---|
| Gender | | |
| Male | 7,540 | 44.4 |
| Female | 9,433 | 55.6 |
| Age | | |
| Preelderly (4565 years) | 11,565 | 68.1 |
| Elderly (> 65 years old) | 5,408 | 31.9 |
| Location | | |
| Urban | 8,321 | 49.0 |
| Rural | 8,652 | 51.0 |
| Education | | |
| Low education | 11,795 | 69.5 |
| High education | 5,178 | 30.5 |
| Occupation | | |
| Nonformal | 6,584 | 38.8 |
| Formal | 10,389 | 61.2 |

## 3. RESULTS

Table 1 presents the characteristics of the respondents based on socio-demographic factors. Among the respondents, 55.6% were females, and 68.1% belonged to the pre-elderly age group (45-65 years). The distribution of respondents living in urban areas (49.0%) and rural areas (51.0%) were nearly equal. Only 30.5% of respondents had a high level of education, while those with formal employment accounted for 61.2%. Table 2 illustrates the percentages of respondents with a history of systemic illnesses, such as diabetes mellitus, heart disease, hypertension, stroke, and cancer, which were 5.4%, 3.7%, 17.3%, 2.3%, and 0.4%, respectively. Based on Table 2, diabetes mellitus and hypertension were the most common conditions among respondents. Additionally, 20.6% of respondents reported having at least one missing tooth.

**Table 2. Frequency of systemic diseases of respondents (N=16,973).**

| Systemic Disease | N | % |
|---|---|---|
| History of diabetes mellitus | | |
| Yes | 912 | 5.4 |
| No | 16,061 | 94.6 |
| History of heart disease | | |
| Yes | 621 | 3.7 |
| No | 16,352 | 96.3 |
| History of hypertension | | |
| Yes | 2,935 | 17.3 |
| No | 8,579 | 50.5 |
| Missing* | 5,459 | 32.2 |
| History of stroke | | |
| Yes | 390 | 2.3 |
| No | 16,583 | 97.7 |
| History of cancer | | |
| Yes | 74 | 0.4 |
| No | 16,899 | 99.6 |
| Tooth loss | | |
| Yes | 3,495 | 20.6 |
| No | 13,478 | 79.4 |

Table 3 illustrates the effect of socio-demographic factors and systemic conditions on tooth loss. The factors that significantly influence tooth loss include gender, age, occupation, and a history of diabetes mellitus, heart disease, and stroke ($p<0.05$). In contrast, the location of the respondent's residence, educational history, hypertension, and cancer did not show a significant effect on tooth loss ($p>0.05$).

**Table 3. Effect of socio-demographic and systemic conditions on tooth loss.**

| Variable | OR | 95% CI | | *p*-value |
|---|---|---|---|---|
| Gender | 1.174 | 1.090 | 1.265 | 0.000 |
| Age | 2.442 | 2.226 | 2.679 | 0.000 |
| Location | 0.928 | 0.862 | 1.000 | 0.051 |
| Education | 0.996 | 0.998 | 1.004 | 0.369 |
| Occupation | 0.964 | 0.957 | 0.972 | 0.000 |
| History of diabetes mellitus | 0.687 | 0.571 | 0.826 | 0.000 |
| History of heart disease | 0.653 | 0.521 | 0.818 | 0.000 |
| History of hypertension | 0.940 | 0.845 | 1.045 | 0.250 |
| History of stroke | 0.738 | 0.562 | 0.969 | 0.029 |
| History of cancer | 1.151 | 0.669 | 1.981 | 0.612 |

The results of logistic regression modelling are presented in Table 4, indicating that age and occupation significantly affect tooth loss ($p = 0.000$). A history of diabetes and heart disease also significantly affected tooth loss ($p < 0.05$). The elderly group had a 2.310-fold increased risk of tooth loss compared to the pre-elderly group (OR 2.310). Respondents with a history of diabetes mellitus had a 0.788-fold increased risk of tooth loss compared to those without such a history. In addition, respondents with a history of heart disease had a 0.694 risk of tooth loss.

**Table 4. The effects of socio-demographic and systemic conditions on tooth loss.**

| Variable | B | OR | 95% CI | | *p*-value |
|---|---|---|---|---|---|
| Age | 0.837 | 2.310 | 2.061 | 2.589 | 0.000 |
| Occupation | -0.020 | 0.980 | .971 | 0.990 | 0.000 |
| History of diabetes mellitus | -0.238 | 0.788 | .647 | 0.960 | 0.018 |
| History of heart disease | -0.366 | 0.694 | .538 | 0.895 | 0.005 |
| Constant | 3.479 | - | - | - | - |

**Note:** Overall percentage: 80.2%.

Based on Table **4**, the following equations were obtained:

Ln P/1-P = 3.479 + 0.837 (age) – 0.020 (occupation) – 0.238 (history of diabetes mellitus) – 0.366 (history of heart disease), or

Probability = exp (3.479 + 0.837 (age) – 0.020 (occupation) – 0.238 (history of diabetes mellitus) – 0.366 (history of heart disease)) / 1 + exp (3.479 + 0.837 (age) – 0.020 (occupation) – 0.238 (history of diabetes mellitus) – 0.366 (history of heart disease))

As an illustration, if the sample is older (1), has a formal job (1), and has a history of diabetes mellitus (1) and heart disease (1), then the equation becomes:

Probability = (exp (3.479 + (0.837x 1) – (0.020x 1) – (0.238x 1) – (0.366 x 1))) / (1 + exp (3.479 + (0.837x1) – (0.020x1) – (0.238 x 1)) –(0.366 x1))

Probability = ((exp (3,479 + (0,837x 1) – (0,020x 1) – (0,238x 1) – (0,366 x 1)))/ ((1 + exp (3,479 + (0,837x1) – (0,020x1) – (0,238 x 1)) –(0,366 x1)))

Probability/Predicted = 40,125/41,125 = 0.976

As the predicted value was 0.976, which was greater than 0.5, the predicted tooth loss value for the sample was 1, where 1 indicates the risk of tooth loss. Therefore, if the sample consists of elderly individuals who are still working and have a history of diabetes mellitus and heart disease, it can be predicted that they will experience tooth loss. Age, occupation, and a history of diabetes mellitus and heart disease account for 80.2% of the influence of tooth loss, with the remaining influence attributed to uninvestigated factors.

## 4. DISCUSSION

The study results demonstrated that the gender, age, occupation, and medical history of the respondents partially influenced teeth loss. Multivariate analysis revealed that age, occupation, a history of diabetes, and heart disease are significant predictors of tooth loss. The risk for respondents with diabetes mellitus was greater than for those with a history of heart disease. These results are consistent with the report by Singh [18], which stated that patients with a history of anemia, bleeding disorders, heart disease, high blood pressure, stroke, kidney problems, arthritis, lupus, asthma, chronic bronchitis, smoking, and the use of narcotics, as well as illegal drugs, are significantly associated with an increased number of missing teeth.

The correlation between diabetes mellitus and tooth loss has been widely researched. In this research, the elderly population with a history of diabetes mellitus was found to be at an increased risk of losing teeth. This result is consistent with the findings reported by Ahmadinia, which indicated an association between diabetes mellitus and tooth loss [19]. Diabetes can lead to various complications, including retinopathy, neuropathy, micro-vascular and macrovascular changes, as well as oral complications, such as tooth decay, periodontal disease, dry mouth, and tooth loss. In addition, diabetes increases the risk of oral diseases both directly through gingival inflammation and indirectly due to reduced salivation caused by medication. About one-third of individuals with diabetes experience severe periodontal disease, known as periodontitis. This condition can result in the loss of one or more teeth and may also cause teeth to become loose, ultimately leading to tooth loss. Recent studies have reported that one in five cases of tooth loss is associated with diabetes [20]. Unfortunately, few individuals with diabetes attend regular dental check-ups, and many are unaware of how diabetes affects their oral health. These patients do not realize that diabetes can lead to tooth loss [21].

Diabetes is a chronic disease that leads to numerous complications, including cardiovascular disease, chronic kidney disease, blindness, and nerve damage. It has also been associated with a reduced immune response. Individuals with diabetes experience a range of oral complications, including periodontal disease, xerostomia, tooth decay, salivary gland dysfunction, taste disorders, and tooth loss. Moreover, diabetes and periodontitis are interconnected. The results of previous studies support a two-way relationship between diabetes and oral disease. Diabetes alters the function of immune cells, making the body vulnerable and unable to fight off infections. This vulnerability is particularly evident in terms of the gingival sulcus, which can cause damage to the periodontium. On the other hand, individuals with periodontitis have a 27%-58% higher risk of developing diabetes compared to those without the condition [18].

The present study showed a positive correlation between cardiovascular disease (CVD) and a reduction in the number of teeth. Patients with CVD tend to have significantly fewer teeth and exhibit poor oral hygiene [22]. Periodontal disease serves as a risk factor for myocardial infarction, although the precise nature of this relationship remains unclear. A recent review found that patients who experience a myocardial infarction had a higher chance of developing periodontitis and tooth loss. Most research has not emphasized coronary heart disease as a significant risk factor for oral conditions, primarily because oral health is often overlooked in discussions of overall well-being. Recently, research has begun to investigate chronic diseases as potential contributors to tooth loss [18].

The results of a systematic review found that stroke can lead to tooth loss and reduce oral health-related quality of life. Patients with a history of stroke exhibit

poorer oral health (including caries, tooth loss, and periodontal health) compared to those without such a history [18, 23]. The association between stroke and tooth loss can be linked to low oral health. However, it remains a considerable debate, primarily due to the limited strength of the existing evidence. This result indicates the need for further research with a better methodological design to conclude a relationship between tooth loss and stroke.

The mechanisms of cancer and tooth loss are generally associated with cancer therapies, which can increase the risk of dental caries and periodontitis. Cancers located in the head and neck region are typically treated with a combination of surgery, radiation, and chemotherapy. Radiation therapy can significantly reduce saliva production, increasing the risk of caries by 29%-37% [24]. A decrease in saliva production reduces the re-mineralization of teeth and diminishes the buffering capacity of saliva, resulting in a lower pH, which is conducive to cariogenic bacteria. Moreover, the combination of cariogenic bacteria and reduced saliva causes a decline in the deep cleaning effect of the oral cavity. The resulting caries can affect the gum line and the tips of the teeth cusps. If left untreated, this condition can rapidly progress to pain and osteoradionecrosis. In addition, hyposalivation increases the risk of periodontitis due to the accelerated loss of tooth-supporting tissue. Similarly, cancer treatment can worsen pre-existing periodontitis, leading to osteoradionecrosis. In summary, cancer treatment is known to increase the risk of dental caries and periodontal disease; however, the potential for a bidirectional relationship remains unclear [18].

The results of previous research indicated that there is no association between hypertension and tooth loss [25]. A systematic review of the literature showed that individuals who experience tooth loss have a higher risk of developing hypertension. Similarly, those with hypertension are also at increased risk of tooth loss. These results suggest a bidirectional relationship between tooth loss and hypertension [26].

Based on this description, the systemic diseases experienced by the respondents can significantly affect dental and oral health. This condition worsens the development of infections in the oral cavity and contributes to the onset of dental caries and periodontitis, which may ultimately result in tooth loss. Consequently, patients with systemic conditions may have an increased risk of losing their teeth.

A low level of awareness of oral health among older people is one of the risk factors for tooth loss. Our results showed that 20.6% of respondents had at least one missing tooth. This reflects the lack of awareness of oral health among middle-aged and elderly populations. They perceived tooth loss as a normal part of aging. The older population is less likely to seek help from dentists when they have problems. This is reflected in the low utilization of dental health facilities by the older population.

One of the reasons for the low awareness of oral health in the middle-aged and elderly populations is their educational background. The results of our study showed that 69.5% of respondents had a low level of education. Some research findings demonstrated that the higher the level of education, the more likely people are to have positive perceptions and awareness of oral health [27] [28].

The findings of our study regarding the prediction of tooth loss are in line with the research of Cooray [15], who stated that predictors associated with tooth loss include older adults, demographic factors, and socioeconomic factors. In our study, age group and occupation were identified as socio-demographic factors predicting tooth loss. Based on the research by Cooray, the prediction model had an accuracy of 90.5%, while our study had an accuracy of 80.2%. The reason for the difference in accuracy is that some variables, such as behavioral factors and oral health factors, were not part of our study. The results of our study will be very useful in planning a tooth loss prevention program for the elderly, which will be integrated into existing health programs. In Japan, research on predictors of tooth loss is also useful for planning health programs, especially as a predictor of long-term care needs in the elderly [29].

In Indonesia, a study by Sopianah on predictors of tooth loss examined the effect of smoking habits, reasons for seeking dental care when ill, and last dental visit on tooth loss in the elderly [30]. The research by Sopianah on 2000 elderly samples in 5 villages in Tasikmalaya Regency, West Java, showed that the variable of last dental visit had the most significant contribution to tooth loss in the elderly. The difference between our study and that research is that our study uses secondary data from 17,095 samples aged 45-65 from 26 provinces in Indonesia.

To overcome the highest tooth loss among the middle-aged and elderly populations due to caries and periodontitis, Indonesia needs to develop a comprehensive prevention program for caries and periodontitis that is integrated with strategies for preventing non-communicable diseases. Currently, there is a Chronic Disease Management Program (Prolanis) in Indonesia, which is a health service system that employs proactive methods that involve participants, health facilities (specifically Community Health Centers), and National Health Insurance. The activities of Prolanis at the Community Health Center aim to improve the quality of life for elderly individuals suffering from non-communicable diseases. This program develops the capacity of the elderly, enabling them to take preventive measures against health issues. Prolanis activities include exercise, health check-ups, health consultations, outreach, and home visits. Unfortunately, oral health efforts have not integrated into Prolanis. Therefore, it is hoped that the results of this research will encourage policymakers to strengthen Prolanis by implementing a program aimed at preventing dental and oral diseases among the elderly.

The development of a geriatric dentistry program at Dental Education Institutions or Dental Health Service

Institutions is an important initiative that should be considered. In this context, geriatric dentistry plays a very important role in assessing and maintaining oral health conditions, which is essential for improving the quality of life of elderly patients. Regular dental visits can help reduce the incidence of various systemic conditions, including cardiovascular disease, diabetes, hypertension, and others. Older edentulous patients should have regular dental check-ups to evaluate soft tissue status and proper denture fitting. In the absence of acute conditions that require close monitoring, a six-month interval between visits is generally appropriate. The limitation of this study is that the model only addresses the middle-aged and elderly age groups.

Our study has limitations, including the cross-sectional design, where the causal relationship could not be described in a cross-sectional study. The use of logistic regression as a statistical testing tool to simulate causal relationships is an attempt to overcome the weakness of cross-sectional research in this study. The presence of incomplete data on the variable of hypertension disease is another limitation of the study. The missing data is the hypertension variable, but this variable has no relationship with other variables in the dataset (missing completely at random). The hypertension variable was not included in the final logistic regression modelling to avoid potential bias.

For further recommendation, a comprehensive epidemiological study that includes health behavior factors, such as smoking habits, oral hygiene, and clinical assessment factors in the oral cavity, needs to be carried out to develop a more accurate tooth loss prediction model. Tooth loss prediction models, such as those obtained in this study, are needed to plan oral health programs for the elderly.

## CONCLUSION

The tooth loss predictor value for middle-aged and elderly Indonesians based on sociodemographic factors and systemic diseases was found to be 1. The value indicates a significant risk of tooth loss. The predictive factor that influences tooth loss accounts for 80.2% of the variance and can be identified based on age, occupation, and a history of diabetes mellitus and heart disease. Tooth loss is particularly predictable among elderly individuals who are still working and have a history of diabetes and heart disease. In comparison to pre-elderly individuals, the elderly group that is still working and has a history of these conditions is at a higher risk of experiencing tooth loss.

## AUTHORS' CONTRIBUTION

S.S., F.M.P., and A.A.S.: Study conception and design; Y.Y.: Data collection; S.S., F.M.P., and A.A.S.: Analysis and interpretation of results; S.S., F.M.P., A.A.S., and A.A.: Draft manuscript; T.J., K.W., S.S., F.M.P., and A.A.S.: Methodology. All authors reviewed the results and approved the final version of the manuscript.

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| COPD | = | Chronic Obstructive Pulmonary Disease |
| OHRQoL | = | Oral Health-Related Quality of Life |
| WHO | = | World Health Organization |
| CVD | = | Cardiovascular Disease |

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance of this research was obtained from the Health Research and Development Agency of the Ministry of Health of Indonesia, Indonesia with license number IR.03.01/4/6264/2021.

## HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

## CONSENT FOR PUBLICATION

All respondents were informed and completed the informed consent form. Consent was obtained from the National Basic Health Research 2018 data collection team.

## STANDARDS OF REPORTING

STROBE guidelines were followed.

## AVAILABILITY OF DATA AND MATERIALS

The data that support the findings of this study are available from the corresponding author [S.S] upon reasonable request.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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