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The Relationship Between Tooth Brushing Methods and Gum Bleeding Among the Elderly at Posyandu Lansia in Surabaya

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ABSTRACT Age-related immunosenescence predisposes elderly individuals to increased susceptibility to oral pathologies, including gingival bleeding. Inadequate oral hygiene practices, particularly improper tooth brushing techniques characterized by incorrect directional movements and insufficient plaque removal, constitute significant risk factors for gingival inflammation and subsequent bleeding episodes. The elderly population at Posyandu Lansia Kampung Mustika Baru Ngagel Surabaya demonstrated a concerning prevalence of gingival bleeding associated with suboptimal tooth brushing methodologies in 2024. This study aimed to examine the correlation between tooth brushing techniques and gingival bleeding among elderly participants at Posyandu Lansia Kampung Mustika Baru Ngagel Surabaya in 2024. An analytical cross-sectional study design was employed to investigate the relationship between variables. Purposive sampling was utilized to recruit 36 elderly participants who met the inclusion criteria. Data collection was conducted using standardized observation sheets to assess tooth brushing methodologies and clinical examination forms to document the gingival bleeding status. Statistical analysis was performed using Chi-square tests to determine the association between variables. Observational assessment revealed that the majority of elderly participants demonstrated inadequate tooth brushing techniques. Statistical analysis indicated a statistically significant relationship between tooth brushing methods and gingival bleeding incidence (asymp.sig α = 0.000, $p < 0.05$), confirming a strong association between these variables among the study population. The findings demonstrate that proper tooth brushing techniques are inversely correlated with gingival bleeding in elderly individuals. Implementation of appropriate oral hygiene practices, specifically correct tooth brushing methodologies, significantly reduces the risk of gingival bleeding and associated oral health complications in this vulnerable population. These results underscore the importance of targeted oral health education programs for elderly communities.

INDEX TERMS Tooth Brushing Methods, Gingival Bleeding, Elderly Population, Oral Hygiene, Cross-sectional Study.

I. INTRODUCTION

The global demographic transition toward an aging population presents unprecedented challenges for oral health maintenance, particularly among elderly individuals who experience progressive physiological deterioration and immunological compromise. According to the Indonesian Ministry of Health Regulation (Permenkes), the elderly cohort encompasses individuals aged 60 years and above, representing a population segment characterized by multifaceted biological, psychological, and social transformations that fundamentally alter their health status and quality of life [1]. Age-related immunosenescence significantly impairs the body's capacity to resist pathogenic microorganisms, rendering elderly individuals particularly vulnerable to oral pathologies, including periodontal diseases and associated complications [2][3]. Periodontal diseases constitute a major public health concern globally, with gingival bleeding serving as a primary clinical manifestation

and early indicator of periodontal tissue inflammation [4]. Epidemiological data reveal alarming prevalence rates of gingival bleeding among elderly populations, with Indonesian national statistics indicating 13.9% prevalence in the general elderly population and 15.4% in East Java specifically [5]. These statistics underscore the critical need for a comprehensive understanding of modifiable risk factors contributing to periodontal disease progression in elderly communities [6]. Contemporary periodontal research has established a robust foundation of evidence regarding optimal oral hygiene practices and their correlation with periodontal health outcomes. Current literature demonstrates that mechanical plaque removal through systematic tooth brushing remains the cornerstone of periodontal disease prevention [7][8]. Various tooth brushing techniques have been developed and refined, including the Bass technique for patients with gingivitis and gingival sulcus complications, the Stillman technique for widespread gingivitis management,

the Charters technique for prosthetic appliance wearers, the rolling technique for general population use, and the Fones technique for pediatric applications [9][10]. Recent systematic reviews and meta-analyses have evaluated the comparative effectiveness of manual tooth brushing methodologies in plaque removal and gingivitis reduction [11][12]. However, current evidence remains inconclusive regarding the superiority of any single brushing technique over others, highlighting the complexity of oral hygiene practice optimization [13]. Risk factor analysis for periodontal diseases has identified both modifiable factors (including inadequate oral hygiene, tobacco use, diabetes mellitus, and systemic inflammatory conditions) and non-modifiable factors (such as genetic predisposition, age, and hereditary factors) [14][15]. Advanced research methodologies, including molecular diagnostics and biomarker analysis, have enhanced our understanding of periodontal disease pathogenesis and progression patterns [16][17].

Despite substantial advances in periodontal research, significant knowledge gaps persist regarding the specific relationship between tooth brushing methodologies and gingival bleeding in elderly populations within community-based healthcare settings. The majority of existing studies have been conducted in controlled clinical environments, limiting the generalizability of findings to real-world community health contexts where elderly individuals routinely receive care [18][19]. Furthermore, there is a paucity of research specifically addressing the oral hygiene practices and periodontal health outcomes among Indonesian elderly populations participating in community-based integrated health service programs (Posyandu Lansia) [20]. The heterogeneity in research methodologies and the absence of standardized assessment protocols for evaluating tooth brushing techniques in elderly populations represent additional critical gaps in the current literature [21][22]. Moreover, limited evidence exists regarding the correlation between specific tooth brushing practices and gingival bleeding prevalence among elderly individuals in Southeast Asian community health settings, necessitating targeted investigation to inform evidence-based oral health interventions [23][24].

This investigation aims to analyze the relationship between tooth brushing methodologies and gingival bleeding among elderly participants at Posyandu Lansia Kampung Mustika Baru Ngagel Surabaya in 2024. This research provides significant contributions to the existing scientific literature through three primary domains:

1. Community-Based Empirical Evidence Generation: This study generates robust empirical data from authentic community health settings (Posyandu Lansia), providing insights into actual oral hygiene practices among Indonesian elderly populations rather than artificial clinical laboratory conditions, thereby enhancing the ecological validity and practical applicability of research findings.
2. Population-Specific Risk Stratification and Assessment: The investigation establishes specific correlations

between tooth brushing methodologies and gingival bleeding prevalence within the Indonesian elderly demographic, contributing to the development of targeted, culturally appropriate preventive care strategies for this vulnerable population segment.
3. Evidence-Based Public Health Policy Development: The research findings will inform the development and implementation of evidence-based oral health education programs and intervention strategies specifically designed for elderly care facilities and community health centers throughout Indonesia, potentially reducing the overall burden of periodontal diseases in aging populations and improving quality of life outcomes.

This paper is organized as follows: Section II reviews related works and theoretical foundations of elderly oral health and tooth brushing methodologies; Section III delineates the cross-sectional research methodology, including participant selection procedures and statistical analytical approaches; Section IV presents the empirical results and their comprehensive analysis regarding the relationship between tooth brushing methods and gingival bleeding; and Section V discusses the clinical and public health implications, study limitations, and potential future research directions.

II. METHOD

A. STUDY DESIGN AND SETTING

This investigation employed an analytical cross-sectional study design to examine the prevalence and associated factors of gingival bleeding among elderly participants. The study was conducted in Kampung Mustika Baru Ngagel, Surabaya, East Java, Indonesia, between September 2023 and March 2024. The research was carried out at the Posyandu Lansia (Elderly Integrated Health Service Post), a community-based healthcare facility that provides regular health services to the elderly population in the designated area [25]. The cross-sectional design was selected to provide a snapshot of the relationship between oral hygiene practices and gingival bleeding status at a specific point in time, allowing for the assessment of prevalence and identification of potential risk factors within the target population [26]. This design is particularly appropriate for descriptive studies examining the distribution of health-related characteristics in defined populations [27].

B. STUDY POPULATION AND SAMPLING

The target population comprised elderly individuals aged 60 years and above who were registered users of the Posyandu Lansia services in Kampung Mustika Baru Ngagel. The study population was specifically limited to elderly participants presenting with clinical evidence of gingival bleeding during the study period. Inclusion criteria encompassed: (1) individuals aged 60 years or older, (2) presence of at least ten natural teeth, (3) clinical evidence of gingival bleeding during examination, (4) regular attendance at Posyandu Lansia services, and (5) provision of informed consent for participation. Exclusion criteria included: (1) individuals with systemic conditions affecting periodontal status such as diabetes mellitus or cardiovascular disease, (2)

current use of anticoagulant medications, (3) presence of acute oral infections or trauma, (4) cognitive impairment preventing adequate cooperation during examination, and (5) recent dental treatment within the preceding four weeks. The sample size was determined using purposive sampling methodology, a non-probability sampling technique appropriate for specialized populations with specific characteristics [28]. A total of 36 elderly participants were recruited based on the availability of eligible individuals meeting the inclusion criteria during the study period. This sample size was considered adequate for a preliminary investigation of oral hygiene practices and gingival bleeding patterns in the target demographic [29].

C. DATA COLLECTION PROCEDURES

Data collection was conducted through direct clinical examination and structured observation protocols. The data collection process was implemented in two phases: (1) clinical assessment of gingival bleeding status, and (2) observation of tooth brushing techniques and oral hygiene practices. Clinical examinations were performed by trained dental health professionals using standardized protocols to ensure consistency and reliability of measurements. Each participant underwent a comprehensive oral examination to assess the gingival bleeding index, plaque accumulation, and overall periodontal status. The bleeding on probing (BOP) assessment was conducted using gentle probing pressure to identify sites of gingival inflammation and bleeding tendency [30]. Observation of oral hygiene practices was conducted using structured observation sheets specifically designed to evaluate tooth brushing techniques, frequency, duration, and effectiveness. Participants were asked to demonstrate their routine tooth brushing method while being observed by trained personnel who recorded their techniques using standardized assessment criteria [31].

D. RESEARCH INSTRUMENTS AND MATERIALS

The primary research instruments included: (1) standardized checklist examination sheets for recording clinical findings and participant demographics, (2) dental mouth mirrors for intraoral examination and visualization, (3) periodontal probes for bleeding assessment, and (4) structured observation forms for documenting oral hygiene practices. Checklist examination sheets were developed based on established periodontal assessment protocols and included sections for recording participant identification, demographic information, medical history, clinical findings, and oral hygiene assessment results. The observation sheets for tooth brushing evaluation incorporated standardized criteria for assessing technique effectiveness, including brush positioning, stroke patterns, duration, and coverage of tooth surfaces [32]. All examination instruments were sterilized according to standard infection control protocols, and single-use disposable items were employed where appropriate to prevent cross-contamination between participants [33].

E. DATA ANALYSIS FRAMEWORK

Data analysis was planned using descriptive and analytical statistical methods to examine the relationship between oral hygiene practices and gingival bleeding. Descriptive statistics were employed to characterize the study population and summarize clinical findings, while analytical techniques were utilized to identify potential associations between variables of interest. The analytical approach was designed to accommodate the cross-sectional nature of the data while providing meaningful insights into the factors influencing gingival health in the elderly population. Statistical significance was set at $p < 0.05$ for all analyses, and appropriate statistical software was utilized for data processing and analysis [34].

F. ETHICAL CONSIDERATIONS

The study protocol was developed by ethical principles for research involving human subjects. Informed consent was obtained from all participants before data collection, and confidentiality of participant information was maintained throughout the study process. The research design ensured minimal risk to participants while providing valuable information for improving oral health services in community settings.

III. RESULTS

TABLE 1 presents the demographic characteristics of the study participants stratified by gender and age distributions. The sample composition demonstrated a pronounced gender disparity, with female participants constituting the predominant proportion at 25 individuals (69.4%), while male participants represented 11 individuals (30.6%) of the total cohort. Regarding age stratification, the sample exhibited a heterogeneous distribution across multiple age categories. The largest demographic segment comprised participants aged 66-72 years, accounting for 17 individuals (47.2%) of the total sample population. The second most represented age group encompassed participants aged 60-65 years, with 15 individuals (41.7%). The remaining participants were distributed across older age categories, with 2 individuals (5.6%) in the 73-79 years group and 2 individuals (5.6%) aged 80 years and above.

TABLE 1
Frequency Distribution of Respondents' Gender and Age

Characteristics	Frequency	Percentage (%)
Gender		
Man	11	30.6
Woman	25	69.4
Amount	36	100
Age		
60-65	15	41.7
66-72	17	47.2
73-79	2	5.6
>80	2	5.6
Amount	36	100

The demographic analysis reveals that the study population was predominantly characterized by female participants, representing approximately two-thirds of the total sample (n=25, 69.4%), while male participants constituted approximately one-third (n=11, 30.6%). The age distribution analysis indicates that participants aged 60-65 years comprised 15 individuals (41.7%), those aged 66-72 years represented 17 individuals (47.2%), and participants

aged 73-80 years accounted for 4 individuals (11.2%) of the total sample. The consolidated demographic profile demonstrates that the majority of study participants were female individuals within the 60-72 years age range, representing the predominant demographic segment of the elderly population examined in this investigation. Participants exceeding 73 years of age constituted a smaller proportion of the overall sample, reflecting the age distribution patterns typically observed in community-based elderly health studies. These demographic characteristics provide important contextual information for interpreting the study findings and may influence the generalizability of results to broader elderly populations with similar demographic profiles.

TABLE 2
Frequency Distribution of Respondents' Tooth Brushing Method Categories

How to Brush Your Teeth	Frequency	Percentage (%)
Good	15	41.7
Bad	21	58.3
Amount	36	100

TABLE 2 delineates the oral hygiene practices of the study participants through a comprehensive assessment of tooth brushing behaviors. The analysis of brushing technique proficiency revealed a bimodal distribution within the sample population (N=36). Participants demonstrating adequate brushing techniques comprised 15 individuals (41.7%), while those exhibiting suboptimal brushing practices constituted 21 individuals (58.3%). The evaluation of tooth brushing methodologies indicates that the majority of study participants demonstrated inadequate oral hygiene practices. Specifically, 58.3% of the elderly population examined (n=21) exhibited deficient brushing techniques, whereas 41.7% (n=15) demonstrated satisfactory brushing proficiency.

The predominance of inadequate brushing techniques within the study cohort suggests potential deficiencies in oral health education and mechanical plaque control efficacy among the elderly population examined. The observation that approximately three-fifths of participants demonstrated suboptimal brushing practices highlights the necessity for targeted oral hygiene interventions and educational programs within this demographic group. These findings indicate that the majority of elderly participants in this investigation require enhanced instruction in proper tooth brushing methodologies to optimize oral health outcomes and potentially reduce the incidence of gingival bleeding associated with inadequate plaque removal.

TABLE 3
Distribution of Respondents' Gum Bleeding Frequency

Bleeding Gums	Frequency	Percentage (%)
Bloody	21	58.3
No bleeding	15	41.7
Amount	36	100

TABLE 3 presents the clinical assessment results of the gingival bleeding status among the study participants. The periodontal examination revealed that the majority of participants exhibited positive bleeding indicators, with 21 individuals (58.3%) demonstrating clinically detectable gingival bleeding during the assessment period. Conversely, 15 participants (41.7%) presented with no evidence of gingival bleeding upon clinical examination. The clinical evaluation demonstrates a notable prevalence of gingival bleeding within the elderly study population, affecting more than half of the examined participants. This finding indicates that 58.3% of the cohort presented with bleeding on probing or spontaneous gingival bleeding, suggesting the presence of gingival inflammation and compromised periodontal health status. The predominance of gingival bleeding among the study participants reflects potential underlying periodontal pathology and indicates suboptimal oral health status within this elderly population. The observation that approximately three-fifths of participants exhibited bleeding manifestations underscores the clinical relevance of gingival inflammation as a prevalent oral health concern in this demographic group.

TABLE 4
Results of Analysis of the Relationship between Tooth Brushing Method and Gum Bleeding in the Elderly

How to Brush Your Teeth	Bleeding Gums				Total	p value
	No Bleeding		Bloody			
	n	%	N	%		
Good	15	100	0	0	15	0.000
Bad	0	0	21	100	21	
Total	15	38.9	21	61.1	36	

TABLE 4 demonstrates the cross-tabulation analysis examining the relationship between tooth brushing technique proficiency and gingival bleeding among the study participants. The data reveal a distinct pattern wherein participants demonstrating adequate brushing techniques exhibited minimal incidence of gingival bleeding, while those with suboptimal brushing practices showed a higher prevalence of bleeding manifestations. The association between tooth brushing methodology and gingival bleeding status was evaluated using the chi-squared test of independence. The statistical analysis of the complete sample (N=36) yielded a p-value of 0.000, which is substantially below the predetermined significance threshold of $\alpha = 0.05$. Consequently, the null hypothesis (H_0) was rejected in favor of the alternative hypothesis (H_1), indicating a statistically significant association between the variables examined.

The statistical evaluation establishes a significant correlation between tooth brushing technique quality and gingival bleeding within the elderly population studied. Participants employing appropriate brushing methodologies demonstrated reduced incidence of gingival bleeding, whereas those utilizing inadequate brushing techniques exhibited increased bleeding prevalence. The Chi-Square analysis provides robust statistical evidence ($p < 0.001$) supporting the existence of a significant relationship between tooth brushing technique proficiency and gingival bleeding status among elderly participants at the Posyandu Lansia in Kampung Mustika Baru Ngagel, Surabaya, during the 2024 study period. These findings substantiate the clinical hypothesis that proper oral hygiene practices directly influence periodontal health outcomes in the elderly population examined. The statistical significance of this association underscores the importance of effective tooth brushing education and technique modification as preventive interventions for reducing gingival bleeding and improving overall oral health status in elderly community populations.

IV. DISCUSSION

Represents a fundamental preventive intervention designed to eliminate food debris and address various dental

pathologies, including plaque accumulation, dental caries, cavities, and oral infections. Contemporary research emphasizes that tooth brushing constitutes the primary preventive strategy for controlling plaque formation and food residue removal [35]. However, inadequate brushing techniques frequently precipitate gingival bleeding, particularly when inappropriate brushing motions compromise gingival tissue integrity. The current investigation revealed that the majority of elderly participants demonstrated suboptimal tooth brushing methodologies, with particular deficiencies observed in cleaning the buccal surfaces, lingual aspects of mandibular teeth, and palatal surfaces of maxillary teeth. These findings align with established clinical protocols that recommend specific directional movements for different oral regions: circular motions for posterior buccal surfaces, gingiva-to-crown sweeping movements for mandibular lingual surfaces, and similar gingiva-to-crown techniques for maxillary palatal areas [36].

Several predisposing factors influence oral hygiene behaviors among elderly populations, including knowledge acquisition, attitudinal formation, and health awareness development. Enhanced understanding of oral health significance directly correlates with improved hygiene practices and behavioral modification [37]. Research demonstrates that inadequate knowledge regarding proper oral care techniques significantly impacts both attitudes and practical implementation of preventive measures among elderly individuals [38]. Reinforcing factors, encompassing healthcare provider support, health promotion initiatives, and professional training programs, play crucial roles in modifying elderly tooth brushing behaviors. Healthcare professionals can substantially influence oral hygiene practices through systematic supervision, comprehensive education, and continuous monitoring [39]. Community-based interventions addressing prevalent oral health issues, including dental caries, gingivitis, and oral ulcerations, require enhanced integration of dental therapy services in promotive and preventive healthcare delivery systems. Supporting factors include healthcare infrastructure, facility accessibility, and programmatic activities that facilitate health practice implementation. Primary healthcare facilities must incorporate comprehensive oral health services, encompassing promotive, preventive, curative, and rehabilitative interventions to address individual and community oral health needs effectively [40].

Gingival bleeding represents a multifactorial condition precipitated by various etiological factors, including inappropriate brushing techniques, plaque accumulation at the gingival margin, and infectious processes. Prevention strategies necessitate the utilization of soft-bristled toothbrushes, maintenance of optimal oral hygiene, and regular periodontal health monitoring [41]. The current study's findings indicate that gingival bleeding among elderly participants primarily resulted from excessive brushing force and the utilization of hard-bristled toothbrushes. These observations corroborate evidence suggesting that optimal dental care requires implementation of appropriate and technically correct brushing methodologies [42]. Proper technique modification can significantly reduce the incidence of oral health complications, including dental caries, gingival bleeding, and gingival inflammation.

Tooth brushing methodologies function as preventive interventions targeting food debris removal and management of dental pathologies such as plaque formation, carious lesions, cavities, and oral infections. Research demonstrates that inadequate brushing habits represent significant contributing factors to gingival bleeding, as suboptimal techniques result in compromised oral hygiene maintenance [43]. Clinical evidence indicates that gingival bleeding often serves as an early indicator of gingivitis, frequently associated with excessive brushing pressure or deficient oral hygiene practices. The relationship between mechanical trauma from inappropriate brushing techniques and gingival tissue damage has been well-established in contemporary literature. Elderly populations demonstrate particular vulnerability to gingival bleeding due to age-related changes in tissue resilience, medication effects, and systemic health conditions that may compromise healing responses [44]. The statistical analysis conducted in this investigation established a significant correlation between tooth brushing techniques and gingival bleeding among elderly participants. The predominance of inadequate brushing methodologies observed in the study population reflects the influence of multiple contributing factors, including individual attitudes, healthcare provider interventions, and healthcare service accessibility.

Behavioral attitudes encompass individual actions and practices that evolve into habitual patterns through repeated performance. Human behavioral interactions with environmental factors manifest through knowledge acquisition, attitudinal development, and practical implementation. The practice domain encompasses multiple proficiency levels, with mechanical competency representing advanced skill development [45]. Individuals demonstrating correct technique execution achieve higher practice domain levels, indicating a comprehensive understanding and capability in proper oral hygiene implementation. These findings demonstrate consistency with previous research examining the relationship between brushing technique variations and gingival recession. Studies indicate that horizontal and vertical brushing methods are associated with gingival tissue displacement, with horizontal techniques producing more severe recession patterns [46]. While optimal oral hygiene practices may not directly correlate with gingival recession development, inappropriate brushing techniques significantly contribute to gingival tissue damage and recession formation.

Contemporary oral hygiene protocols emphasize tooth brushing as the primary method for plaque and food debris removal from tooth surfaces, recommending twice-daily brushing with proper technique implementation, particularly after breakfast and before bedtime [47]. Effective plaque control through systematic tooth cleaning represents the initial intervention in preventing both hard and soft tissue pathologies. However, conventional brushing techniques demonstrate limited effectiveness in accessing interproximal areas, necessitating supplementary cleaning methods for comprehensive plaque removal. Personal hygiene

maintenance, including oral care practices, represents a fundamental component of overall health preservation. Proper tooth brushing habits significantly reduce the risk of dental caries and periodontal diseases [48]. Elderly populations frequently experience oral health challenges, including gingival bleeding, often attributed to inappropriate brushing techniques and unsuitable toothbrush selection.

Several limitations must be acknowledged in interpreting these findings. The cross-sectional design prevents the establishment of causal relationships, and the purposive sampling methodology may limit generalizability to broader elderly populations. Additionally, the study's focus on a single community setting may not reflect diverse socioeconomic and cultural factors influencing oral hygiene practices. The clinical implications of these findings emphasize the critical need for targeted oral health education programs specifically designed for elderly populations. Healthcare providers should prioritize technique demonstration, regular monitoring, and individualized instruction to optimize oral hygiene outcomes. Community-based interventions should incorporate systematic assessment of brushing techniques and provide corrective guidance to prevent gingival bleeding and associated complications. Future research should investigate longitudinal relationships between technique modification interventions and clinical outcomes, while exploring the effectiveness of different educational approaches in improving elderly oral hygiene practices. Additionally, investigation of age-related physiological changes affecting gingival health and their interaction with mechanical trauma from improper brushing would enhance understanding of optimal preventive strategies for elderly populations.

V. CONCLUSION

This investigation aimed to examine the relationship between tooth brushing methodologies and gingival bleeding among elderly individuals attending Posyandu Lansia services in Kampung Mustika Baru Ngagel, Surabaya. The analytical cross-sectional study successfully achieved its primary objective by establishing a statistically significant association between oral hygiene practices and periodontal health outcomes in the target population. The comprehensive assessment of 36 elderly participants revealed concerning patterns in oral health practices and clinical manifestations within this demographic group. The evaluation of tooth brushing technique proficiency demonstrated that 58.3% (n=21) of elderly participants exhibited inadequate brushing methodologies, indicating suboptimal oral hygiene practices among the majority of the study population. Concurrently, clinical examination findings revealed that 58.3% (n=21) of participants presented with gingival bleeding, suggesting a high prevalence of periodontal inflammation and compromised gingival health status. The statistical analysis employing the Chi-Square test methodology provided robust evidence supporting the hypothesized relationship between these variables, yielding a highly significant p-value of 0.000, which substantially exceeded the predetermined significance threshold of $\alpha = 0.05$. Consequently, the null

hypothesis (H_0) was rejected in favor of the alternative hypothesis (H_1), confirming the existence of a statistically significant correlation between tooth brushing technique quality and gingival bleeding occurrence among elderly participants. These findings underscore the critical importance of proper oral hygiene education and technique modification as essential preventive interventions for maintaining periodontal health in elderly populations. The research contributes valuable insights into the relationship between mechanical plaque control methods and gingival health outcomes, providing evidence-based support for targeted oral health promotion strategies. Future investigations should explore longitudinal relationships between brushing technique interventions and clinical outcomes, evaluate the effectiveness of structured educational programs in improving elderly oral hygiene practices, and examine the impact of age-related physiological changes on gingival tissue response to mechanical trauma. Additionally, research should investigate the development of culturally appropriate oral health education materials and assess the long-term sustainability of technique modification interventions within community-based elderly care settings to optimize preventive oral health strategies for this vulnerable population demographic.

DATA AVAILABILITY

The datasets generated and analyzed during the current study are not publicly available due to privacy and confidentiality considerations of the elderly participants, but are available from the corresponding author upon reasonable request and approval from the institutional ethics committee. All data collection procedures were conducted in accordance with ethical guidelines for research involving human subjects, and participant confidentiality has been maintained throughout the study process.

AUTHOR CONTRIBUTION

Dinda Alifiani conceptualized and designed the study, developed the research methodology, conducted primary data collection and clinical examinations, and participated in

statistical analysis and interpretation of results. Sunomo Hadi supervised the research design and methodology, provided guidance on statistical analysis procedures, contributed to data interpretation, and provided critical feedback on manuscript development and revisions. Siti Fitria Ulfah assisted with literature review and theoretical framework development, participated in data collection procedures, contributed to manuscript writing and editing, and provided expertise in oral health assessment protocols. All authors collaborated in the interpretation of findings, contributed to the discussion of results, reviewed and approved the final version of the manuscript, and agreed to be responsible for all aspects of the work, ensuring the integrity and accuracy of the research.

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