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Original article

Perceived vs Actual Denture Hygiene Among Complete Denture Wearers: A Clinical Survey in Tripoli, Libya

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Abstract
Edentulism remains a significant global oral health concern. In Libya, where edentulism among adults aged 20 years and above has been reported at 7.6%, complete dentures continue to represent the most common modality for oral rehabilitation. However, understanding hygiene behavior among denture wearers is essential for improving oral health outcomes. This clinical survey aimed to evaluate denture hygiene practices, self-perceived and actual denture hygiene status among complete denture wearers in Tripoli, Libya. A cross-sectional observational study was conducted from August to December 2025 on 62 complete denture wearers recruited by convenience sampling. Participants completed a self-administered questionnaire addressing demographics, denture hygiene habits, and self-perceived hygiene. Clinical evaluation of 98 dentures was performed using a plaque-disclosing solution and assessed with the Budtz-Jörgensen denture plaque index. Data were analyzed in SPSS using descriptive statistics and Chi-square tests. Questionnaire reliability was confirmed with Cronbach's alpha, and inter-examiner agreement was assessed using Cohen's kappa. Statistical significance was set at $p < 0.05$. Most participants were older females with low educational levels. Although most of them self-reported adherence to favorable denture-hygiene practices and rated their dentures as having good or excellent hygiene, clinical assessment showed that their denture hygiene, especially for upper ones, was largely inadequate, as only 20.4% demonstrated optimal hygiene, while a substantial proportion of participants were classified as unsatisfactory (34.7%) or poor (18.4%). Significant associations were found between denture hygiene status and demographic factors ($p < 0.05$), as well as key hygiene practices ($p < 0.001$). In conclusion, denture hygiene among complete denture wearers in Tripoli, Libya, was predominantly suboptimal, revealing a clear discrepancy between self-perceived and clinically assessed hygiene standards. Demographic factors and daily hygiene practices significantly impacted hygiene outcomes. These findings highlighted the need for improved patient awareness and organized, evidence-based denture care education to enhance oral health among denture wearers.
Keywords. Edentulism, Denture Hygiene, Denture Plaque Index, Plaque Disclosing Solution.

Introduction

Oral health is more than just the absence of disease, as compromised oral health can adversely impact nutrition, systemic health, and quality of life. Over the past few decades, life expectancy in both developed and developing countries has increased. Aligned with this increase, the status of oral health of the old population also became of prime importance, as tooth loss in the elderly increases with age, as do the contributing factors leading to it over time. As a result, the rates of complete loss of teeth are customarily the highest in the oldest age groups [1].

Globally, over 350 million individuals are completely edentulous, and this number is expected to surpass 600 million by 2050 as the population ages [2]. Recent data indicated that approximately one in seven adults aged 65 years and older has lost all their teeth, with the prevalence rising from around 11% in those aged 65–74 to nearly 20% among individuals 75 years and above [3]. Although national prevalence percentages are not directly available, the WHO dataset is currently the only confirmed national prevalence figure. WHO oral health data reported that the prevalence of edentulism among Libyan adults aged 20 years and above is 7.6% [4]. As a result, edentulism is projected to become the 15th most impactful Level 4 disease or condition worldwide, moving up nine positions in the global ranking since 2021 [2]. These figures highlight the growing public health challenge related to oral health and the demand for prosthetic dental care.

Complete dentures remain the most common treatment modality for the rehabilitation of completely edentulous patients. However, the success of prosthetic rehabilitation largely depends on the patient's awareness and adherence to proper denture use and hygiene practices [5]. Denture hygiene plays a crucial role in preventing oral lesions. Food debris and plaque accumulation between the denture base and the oral tissues provide an ideal environment for the growth of Candida species and bacteria, which can lead to denture stomatitis and other mucosal infections. Several studies have reported different methods used by denture wearers to clean their dentures, ranging from simple mechanical cleaning with a toothbrush and toothpaste to more advanced techniques involving vibrational cleansers and soaking tablets [6].

Nevertheless, many denture wearers have been observed to neglect proper denture and oral hygiene. Moreover, variations in hygiene habits and attitudes may be influenced by several factors, including education level, gender, social status, and age. Therefore, understanding the hygiene practices and awareness among denture wearers is essential for improving oral health outcomes in this population, ensuring the long-term success of removable prosthodontic treatment [6]. Therefore, this study aimed to

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assess the care practices and the actual status related to denture hygiene among complete denture wearers in Tripoli, Libya.

Methods

Study design

A cross-sectional observational study based on a clinical survey and a self-administered questionnaire was conducted across a convenience sampling of complete denture wearers from multiple settings in Tripoli, Libya, over a time interval between August and December 2025. Standardizing data collection procedures was considered to minimize sampling bias. The purpose of the study was explained to the participants, and written informed consent was obtained before the start of the study.

Data collection

A sample of 62 complete denture wearers voluntarily participated in the study through face-to-face interviews using a questionnaire that was pretested on a small group of participants to assess its relevance and validity. All data was coded without any personal identifiers to ensure participant confidentiality.
The questionnaire comprised 16 questions divided into three main sections; the first section collected demographic data, the second section focused on assessing daily denture hygiene practice habits, and the third section involved a self-assessment of denture hygiene status. To evaluate the actual status of participants' denture hygiene, a clinical assessment by three trained investigators of 98 complete dentures was performed. Staining of the internal surface of the dentures with a plaque disclosing solution according to the manufacturer's instructions was used to facilitate assessment [7]. All clinical procedures adhered to standard infection control protocols [8], and dentures were thoroughly cleaned after assessment to remove residual solution and maintain participants' comfort.
According to Budtz-Jörgensen denture plaque index [7, 9], the assessment criteria were optimal, good, unsatisfactory, and poor, based on four grades of plaque extension on the internal surface of the denture: 0 = nonvisible, 1 = less than one-third, 2 = one-third to two-thirds, 3 = more than two-thirds.

Data analysis

The null hypothesis (H_0) stated that there were no significant associations between denture hygiene status and demographic variables, denture hygiene practices, or self-perceived hygiene among complete denture wearers. The obtained data were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) software, version (29.0.10). Reliability of the questionnaire items was evaluated using Cronbach's Alpha to assess internal consistency across related sections. Descriptive statistics were used for data analysis. Inter-examiner agreement in denture Hygiene assessment was measured using the Cohen's Kappa (κ) statistic to confirm scoring Consistency among the three examiners. Associations between categorical variables were analyzed using the Chi-square (x^2) test. Statistical significance was determined at a p-value of less than 0.05, providing evidence of meaningful relationships between variables and supporting the validity of the study findings.

Results

Reliability of the Questionnaire

The internal consistency of the questionnaire was assessed using Cronbach's alpha, which showed acceptable reliability ($\alpha > 0.70$).

Demographic Information

(Table 1) shows a statistically significant difference among all demographic studied independent variables ($p < 0.05$). Most complete denture wearers were older adults, with the largest proportion aged 61–70 years (43.8%), and females constituted a higher percentage of the sample (65.6%) compared to males (34.4%). Regarding educational level, participants with no formal education and those with primary education represented more than half of the sample, with (31.2%) for each. Concerning the type of denture (53.1%) of the participants wore both upper and lower dentures. Finally, half of the participants had been using dentures for more than six years (50.0%), while only 9.4% had used dentures for less than one year.

Table 1. Distribution of Demographic Information among the Participants

Variable	Category	Number	Percent	x^2 test	P-value
Age	<40 years	0	0.0%	30.00	<0.001*
	41–50 years	12	18.8%		
	61–70 years	28	43.8%		
	>71 years	24	37.5%		
Gender	Male	22	34.4%	6.25	0.012*
	Female	42	65.6%		

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Education	No formal	20	31.2%	16.00	0.003*
	Primary	20	31.2%		
	Preparatory	8	12.5%		
	Secondary	12	18.8%		
	University+	4	6.2%		
Type of Denture	Upper	20	31.2%	13.63	0.001*
	Lower	10	15.6%		
	Both	34	53.1%		
Duration of Use	<1 year	6	9.4%	23.50	<0.001*
	1–3 years	12	18.8%		
	4–6 years	14	21.9%		
	>6 years	32	50.0%		

Denture Cleaning Habits

As (Table 2) summarizes, most participants reported cleaning their dentures 2–3 times per day (59.4%), followed by 31.2% who cleaned once daily, and only 9.4% cleaned their dentures rarely, with a statistically significant difference in cleaning frequency ($x^2 = 24.12$, $p < 0.001$). Regarding the tools used for denture cleaning, the regular toothbrush was the most used tool (34.4%), showing a significant variation among participants ($x^2 = 14.75$, $p = 0.005$). In terms of time spent cleaning dentures, a highly statistically significant difference ($x^2 = 33.50$, $p < 0.001$) was found, in which more than half of the participants (53.1%) spent 1–2 minutes cleaning dentures. Concerning daily denture wearing time, significantly ($x^2 = 8.50$, $p = 0.037$) more than one third (37.5%) wore their dentures for 12–16 hours per day, and only (12.6%) wore them for less than 8 hours. Most participants reported always removing their dentures during sleep (75.0%), whereas equal proportions sometimes or never removed them (12.6% each), showing a significant difference ($x^2 = 50.00$, $p < 0.001$). With respect to denture storage, more than half of the participants stored their dentures immersed in water with disinfectant (53.1%), and very few did not remove their dentures or left them uncovered in the air (6.2% and 3.1%, respectively), and this distribution was statistically significant ($x^2 = 45.50$, $p < 0.001$). Finally, although a higher proportion of participants reported receiving denture cleaning instructions from their dentist (59.4%) compared to those who did not (40.6%), this difference was not statistically significant ($x^2 = 2.25$, $p = 0.134$).

Table 2. Distribution of Denture Cleaning Habits among the Participants

Variable	Category	Number	Percent (%)	x^2 test	P-Value
Frequency of denture cleaning per day	Once	20	31.2%	24.12	<0.001*
	2–3 times	38	59.4%		
	Rarely	6	9.4%		
Tools used for denture cleaning	Regular toothbrush	22	34.4%	14.75	0.005*
	Special denture brush	6	9.4%		
	Toothpaste	14	21.9%		
	Denture cleanser	16	25%		
	Water only	6	9.4%		
Time spent cleaning dentures	Less than 1 minute	16	25.0%	33.50	<0.001*
	1–2 minutes	34	53.1%		
	3–5 minutes	12	18.7%		
	More than 5 minutes	2	3.1%		
Daily denture wearing time	Less than 8 hours	8	12.6%	8.50	0.037*
	8–12 hours	14	21.9%		
	12–16 hours	24	37.5%		
	More than 16 hours	18	28.1%		
Removal of denture during sleep	Yes, always	48	75.0%	50.00	<0.001*
	Sometimes	8	12.6%		
	Never	8	12.6%		
Method of denture storage	Do not remove/store	4	6.2%	45.50	<0.001*
	Immersed in plain water	24	37.5%		
	Immersed in water with disinfectant	34	53.1%		
	Left uncovered in the air	2	3.1%		
Received denture cleaning instructions from the dentist	Yes	38	59.4%	2.25	0.134
	No	26	40.6%		

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Self-Assessment and Oral Health

As (Table 3) illustrates, most participants rated the cleanliness of their dentures as good (43.8%) or excellent (31.2%), while smaller proportions rated it as fair (18.8%) or poor (6.2%), with a statistically highly significant difference among categories ($x^2 = 18.00$, $p < 0.001$). Regarding oral problems related to denture use, nearly two-thirds (62.5%) of the participants significantly ($x^2 = 4.00$, $p = 0.046$) reported no problems. Among those who reported oral problems (n = 24), inflammation was equally present and absent (50.0% each), showing no statistically significant difference ($x^2 = 0.00$, $p = 1.000$). Although sores or ulcers were reported by more than half (58.3%) of those with oral problems, this distribution was also statistically non-significant ($x^2 = 1.33$, $p = 0.248$). Concerning dental attendance, very few reported regular visits every six months (3.1%) or once a year (12.5%), with a highly significant difference ($x^2 = 28.50$, $p < 0.001$). Finally, a large majority (68.8%) of participants expressed a need for more education about denture cleaning, with a statistically significant difference ($x^2 = 9.00$, $p = 0.003$).

Table 3. Distribution of Self-Assessment and Oral Health among the Participants

Variable	Category	Number	Percent (%)	x^2 test	P-Value
Self-rating of denture cleanliness	Excellent	20	31.2%	18.00	<0.001*
	Good	28	43.8%		
	Fair	12	18.8%		
	Poor	4	6.2%		
Presence of oral problems due to dentures	No	40	62.5%	4.00	0.046*
	Yes	24	37.5%		
Inflammation (among those with problems, n = 24)	Yes	12	50.0%	0.00	1.000
	No	12	50.0%		
Bad breath (among those with problems, n = 24)	Yes	6	25.0%	6.00	0.014*
	No	18	75.0%		
Sores/ulcers (among those with problems, n = 24)	Yes	14	58.3%	1.33	0.248
	No	10	41.7%		
Regular dental visits	Every 6 months	2	3.1%	28.50	<0.001*
	Once a year	8	12.5%		
	Only when a problem occurs	26	40.6%		
	Do not visit	28	43.8%		
Need for more education about denture cleaning	Yes	44	68.8%	9.00	0.003*
	No	20	31.2%		

Assessment of the Denture Hygiene Status

Denture hygiene status was assessed, and the findings were categorized into optimal, good, unsatisfactory, and poor based on graded plaque extension (Figure 1).

Figure 1. Grading of Denture Plaque Extension

As (Figure 2) shows, a substantial proportion of participants exhibited inadequate denture hygiene, categorized as unsatisfactory (34.7%) and as poor (18.4%). In contrast, only (20.4%) of participants demonstrated optimal denture hygiene, with (26.5%) having good hygiene. When analyzed by denture type, upper dentures showed higher frequencies of unsatisfactory (16.3%) and poor (14.3%) hygiene compared to lower dentures. Overall, these findings indicated that more than half of the studied dentures had moderate to extensive plaque accumulation on their mucosal surfaces, highlighting a generally compromized level of denture hygiene among the participants.

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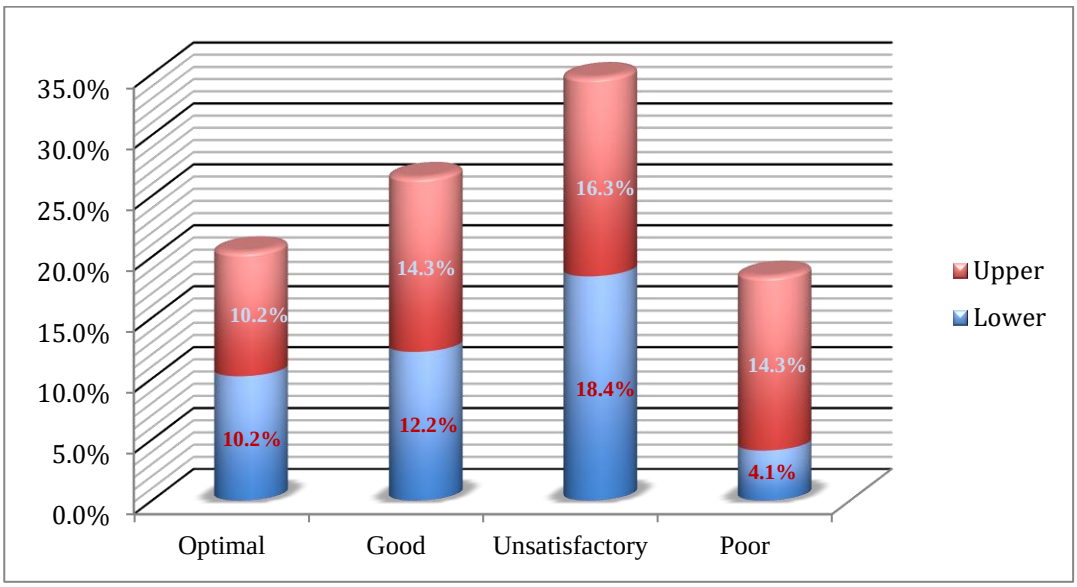

Figure 2. Distribution of Denture Hygiene Status among Participants. Inter-Examiner Agreement

Inter-examiner agreement among three examiners using the Kappa (κ) statistic demonstrated consistent scoring in 96 out of 98 cases, with disagreement observed in only two cases. This resulted in an excellent overall percentage agreement of 98.0%. The calculated Kappa coefficient was κ = 0.97, which indicated almost perfect agreement according to the Landis and Koch classification. These findings confirmed that the denture hygiene assessment criteria were applied reliably and consistently among the examiners, ensuring high reproducibility and minimizing subjective variation in clinical evaluation, as shown in (Table 4).

Table 4. Inter-Examiner Reliability for Denture Hygiene Assessment among Three Examiners

Variable Assessed	Total Cases (N)	Agreement Cases	Disagreement Cases	Percent Agreement (%)	Kappa Value (κ)	Interpretation
Denture hygiene status score	98	96	2	98.0%	0.97	Almost perfect agreement

Association between Demographic Characteristics and Denture Assessment

(Table 5) demonstrates a statistically significant association between demographic characteristics and denture assessment using the Chi-square test. Denture status varied significantly across age groups (x^2 = 12.66, p = 0.041), with participants aged 41–50 years showing better denture conditions, reflected by higher proportions classified as optimal (20.0%) and good (30.0%), whereas older participants, particularly those aged over 71 years, exhibited higher percentages of unsatisfactory (37.5%) and poor (29.2%) denture conditions. A significant association was also observed between gender and denture assessment (x^2 = 8.48, p = 0.038), with males demonstrating slightly better denture status than females, as indicated by higher proportions of optimal (18.2%) and good (27.3%) assessments, while females showed increased unsatisfactory (38.1%) and poor (23.8%) conditions.

Furthermore, educational level was significantly associated with denture assessment (x^2 = 9.65, p = 0.022), where participants with low educational levels exhibited poorer denture conditions, with 45.0% assessed as unsatisfactory and 25.0% as poor, whereas those with higher education demonstrated better denture status, characterized by higher proportions of optimal (25.0%) and good (37.5%) and lower proportions of unsatisfactory (25.0%) and poor (12.5%) conditions.

Table 5. Association between Demographic Characteristics and Denture Assessment

Demographics	Optimal	Good	Unsatisfactory	Poor	x^2 test	p-value
41–50 years	20.0%	30.0%	35.0%	15.0%	12.66	0.041*
61–70 years	14.3%	25.0%	39.3%	21.4%		
>71 years	12.5%	20.8%	37.5%	29.2%		
Male	18.2%	27.3%	36.4%	18.1%	8.48	0.038*
Female	14.3%	23.8%	38.1%	23.8%		
Low education*	10.0%	20.0%	45.0%	25.0%	9.65	0.022*
Higher education**	25.0%	37.5%	25.0%	12.5%		

** Low Education: no Formal + Primary Education ** Higher Education: Preparatory, Secondary, University*

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Association between Denture Cleaning Practices and Denture Assessment

(Table 6) reveals a statistically significant association between denture cleaning practices and denture assessment outcomes. Cleaning frequency was strongly related to denture condition ($x^2 = 22.51$, $p < 0.001$), as participants who cleaned their dentures two to three times daily demonstrated better denture status, with higher proportions rated as optimal and good, whereas those who rarely cleaned showed poorer conditions, with half assessed as unsatisfactory and a large proportion as poor. The type of cleaning tool used was also significantly associated with denture assessment ($x^2 = 10.87$, $p = 0.005$), with denture cleanser users exhibiting better denture conditions compared with those using a regular toothbrush. In addition, time spent cleaning was significantly related to denture status ($x^2 = 18.90$, $p < 0.001$), as participants who cleaned for one to two minutes had better outcomes than those cleaning for less than one minute. Furthermore, removal of dentures during sleep showed a significant association with denture condition ($x^2 = 20.44$, $p < 0.001$), with participants who always removed their dentures at night demonstrating better denture assessments, while those who never removed them had a higher prevalence of unsatisfactory and poor denture status.

Table 6. Association between Denture Cleaning Practices and Denture Assessment

Practice Variable	Optimal	Good	Unsatisfactory	Poor	x^2 test	p-value
Cleaning once/day	10%	20%	45%	25%	22.51	<0.001*
Cleaning 2–3 times/day	20%	30%	35%	15%		
Rarely cleaning	0%	10%	50%	40%		
Regular toothbrush	15%	25%	40%	20%	10.87	0.005*
Denture cleanser	25%	35%	25%	15%		
< 1 min cleaning	5%	20%	45%	30%	18.90	<0.001*
1–2 min cleaning	20%	30%	35%	15%		
Always remove at night	20%	30%	35%	15%	20.44	<0.001*
Never remove at night	5%	15%	45%	35%		

Discussion

The findings of the current study revealed that the majority of complete denture wearers were older adults, with the highest proportion belonging to the 61–70 years age group 43.8% and those older than 71 years representing (37.5%). This age distribution is consistent with several previous studies that reported denture use being most prevalent among elderly populations. For example, Naeem et al. (2025) [10] found a mean participant age of 64.68 years among complete denture wearers, while Bacali et al. (2021) [7] also reported that most denture wearers in Central Transylvania were above 60 years of age. Similarly, Sharma et al. (2020) [11] observed that the majority of their 1000 participants were aged between 50 and 74 years. Regarding gender, the present study showed a predominance of females 65.6% compared to males 34.4%, which aligns with the findings of Sharma et al. (2020) [11], who also reported that female denture wearers outnumbered males. In contrast, Naeem et al. (2025) [10] found an almost equal distribution between males 49.38% and females 50.63%. Educational level in the current study demonstrated that 62.4% of participants had either no formal or only primary education, and this was significantly associated with poorer denture hygiene assessment, which supports the results of Naeem et al. (2025) [10], who reported a strong association between education level and denture hygiene knowledge scores ($p < 0.001$). Shankar et al. (2017) [6] similarly highlighted that illiterate participant experienced worse oral hygiene outcomes, including significantly higher reports of bad breath ($x^2 = 47.452$, $p < 0.001$).

In terms of denture cleaning habits, the current study found that 59.4% of participants cleaned their dentures 2–3 times daily, while 31.2% cleaned once daily and 9.4% rarely cleaned. These findings are comparable to Bacali et al. (2021) [7], who reported that 54.3% of participants cleaned their dentures 2–3 times per day, demonstrating a similar pattern of frequent cleaning. However, Kosuru et al. (2017) [12] and Sharma et al. (2020) [11] reported that the majority of denture wearers cleaned their dentures only once daily, indicating that participants in the present study showed relatively better cleaning frequency. Regarding cleaning tools, the regular toothbrush was the most common method in this study, 34.4%, followed by denture cleanser tablets or solutions, 25.0%. Bacali et al. (2021) [7] reported an even higher reliance on toothbrushes 93.2% and toothpaste 76.5%, while Namrata and Ganapathy (2017) [13] found that water alone 45% and brushing with water 40% were the most frequent methods. These comparisons suggest that although toothbrush use remains the dominant practice globally, the use of specialized denture cleansers in the current study 25.0% reflects a moderate awareness of recommended hygiene products.

An important observation in the present study was that 75.0% of participants always removed their dentures during sleep, whereas only 12.6% sometimes or never removed them. This is a more favorable practice compared to many previous reports. Bacali et al. (2021) [7] found that only 30.9% of participants removed their dentures overnight, while Shankar et al. (2017) [6] reported that 13.2% of subjects slept with their dentures. Mushtaq et al. (2019) [14] similarly noted that 29.3% of denture wearers normally slept with their prosthesis in place. The higher proportion of nocturnal denture removal in the current study may reflect

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improved awareness or better adherence to clinical instructions among participants. However, despite these relatively positive behaviors, 40.6% of participants in the present study reported not receiving denture cleaning instructions from their dentist, which is comparable to Mushtaq et al. (2019) [14], where 42.7% of participants were not instructed, and Namrata and Ganapathy (2017) [13], where only 45% received cleaning guidance. These findings highlight the ongoing need for dentists to provide consistent and structured patient education regarding denture care.

Clinical assessment of denture hygiene status in the current study revealed that only 20.4% of participants demonstrated optimal hygiene, while 26.5% had good hygiene, whereas the majority showed inadequate hygiene, with 34.7% categorized as unsatisfactory and 18.4% as poor. These results indicate that more than half of dentures had moderate to extensive plaque accumulation, supporting the findings of Kosuru et al. (2017) [12], who reported that slightly more than half of participants had poor denture status on clinical examination despite self-reporting good or fair denture condition. Similarly, Sharma et al. (2020) [11] observed that although nearly 90% of participants perceived their denture status as good or fair, clinical evaluation showed that more than half had poorly maintained dentures, suggesting a discrepancy between perceived and actual hygiene. Bacali et al. (2021) [7] reported somewhat better outcomes, with 12.3% optimal hygiene, 40.1% good, 32.7% unsatisfactory, and 14.8% bad, which is comparable but indicates slightly higher proportions of good hygiene compared to the current study. Furthermore, the present study demonstrated statistically significant associations between denture hygiene assessment and demographic factors such as age ($p = 0.041$), gender ($p = 0.038$), and education level ($p = 0.022$), as well as cleaning practices including frequency, tool type, cleaning duration, and nocturnal removal (all $p < 0.001$). These associations are consistent with Naeem et al. (2025) [10] and Nideesha et al. (2025) [15], who emphasized the significant influence of socioeconomic and educational factors on denture hygiene awareness and plaque levels. Overall, the present findings reinforce the global conclusion that denture hygiene remains suboptimal among many wearers and that targeted educational interventions are essential to improve oral health outcomes in complete denture patients.

Considering the study findings, the null hypothesis was rejected, as statistically significant associations were observed between the studied variables ($p < 0.05$). Additionally, rejection of the null hypothesis suggests that the observed differences are unlikely to be due to chance alone.

Conclusion

This clinical survey demonstrated, with statistically significant findings, that denture hygiene among complete denture wearers in Tripoli, Libya, remains suboptimal and is strongly influenced by demographic variables, despite the participants' reported claims of good denture hygiene habits. The clear gap between self-perceived and objectively assessed hygiene status underscores the need for improved patient awareness and strengthened oral health education programs focused on evidence-based denture care practices.

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Conflicts of Interest

The authors declare no conflicts of interest.

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