

Assessment of oral health status of old age home residents and community dwelling older adults and its association with depression in Eastern Nepal: A comparative cross-sectional analytical study

Ujwal Gautam¹ Ashish Shrestha¹ Tarakant Bhagat¹, Dharanidhar Baral², Suraj Nepal³

¹Department of Public Health Dentistry; ²School of Public Health and Community Medicine

³Department of Psychiatry; BP Koirala Institute of Health Sciences, Dhara, Nepal

Academic Editor: Shreejana K.C.

Corresponding Author: Dr. Ujwal Gautam; Email: ujwal.gautam@gmail.com

ABSTRACT

Background: Changing family practice has led to increased number of ageing population in old age homes. Multiple factors have a role in deteriorating oral health of older adults. The study assesses and compares oral health status in old-age home residents of eastern Nepal with community dwelling counterparts and look into its association with depression.

Data and Methods: A cross-sectional comparative analytical study was conducted among 42 older adults from old age homes and community each. Old age home residents were selected using multistage random sampling while community dwelling older adults were selected using systematic random sampling after matching for age and sex. Structured questionnaires were used to interview participants on oral health behaviour and depression. Oral examination was conducted to assess plaque control, caries outcome and periodontal status. Oral health outcomes were compared across two population using inferential statistics like chi-square test, or Mann Whitney U test. Logistic regression was conducted to explore how oral health outcome variables were influenced by depression and other covariates.

Results: Of the total participants, four were edentulous. About 63.8% of the participants had periodontitis while 45.2% had less than 20 remaining teeth. DMFT (Decayed, Missing, Filled Teeth) scores and prevalence of periodontitis were significantly higher in old age home residents; median DMFT [17.5 (Range: 0-32); $p=0.014$] and periodontitis [37.5%; $p=0.036$] respectively. Depression, after adjusting for other covariates, was significantly associated with periodontitis (OR: 7.124; CI: 1.310-38.730) and number of remaining teeth (OR: 0.11; CI: 0.011-0.497).

Conclusion: The older adults in this study had poor oral health status. Significant difference exists in the oral health status outcome between old-age home residents and community dwelling older adults. Moreover, depression is found to be associated with oral health outcomes. It is worthwhile to assess the factors behind the disparity in oral health status between old age residents and community dwelling older adults.

Keywords: Depression, Geriatric health, Old-age homes, Oral Health Status

Article Information

Received: 18 November 2024

Accepted: 28 May 2025

Published online: 4 June 2025

Copyright © 2025 by the author(s), wherein the author(s) are the only owners of the copyright of the published content

Licensing: This published content is distributed under the terms of the [Creative Commons Attribution International License \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/) license, and is free to access on the Journal's website. The author(s) retain ownership of the copyrights and publishing rights without limitations for their content, and they grant others permission to copy, use, print, share, modify, and distribute the article's content even for commercial purposes.

Disclaimer: This publication's claims, opinions, and information are the sole creations of the specific author(s) and contributor(s). Errors in the contents and any repercussions resulting from the use of the information included within are not the responsibility of the publisher, editor, or reviewers. Regarding any jurisdictional assertions in any published articles, their contents, and the author's institutional affiliations, the Journal and its publisher maintain their objectivity.

INTRODUCTION

A comprehensive public health response is needed to target diversity in older people's physical and social environment that impacts on their health behaviour and needs. World Health Organization's (WHO's) Sustainable Development Goal (SDG) requires the need to take account of the rapid population ageing which is relevant to 15 of the 17 SDG goals [1]. Compartmentalization involved in treating mouth separately from the body has posed a challenge in ensuring quality health care delivery to older adults. There is a need to integrate oral health into global health agenda via common risk factor approach [2]. Evidences suggest retaining of natural teeth in older population directly affects diet, quality of life, cognition and longevity [3]. The issues with health care in elder population is further compounded with problems like changing demographics and lifestyle in Nepalese culture [4]. Caring of elderly, traditionally, has been undertaken by the family members, especially children, in Nepal. In the wake of modernization, the unavoidable societal changes have resulted in ending of concept regarding co-residence with family. Old-age homes can be a noble way to address the need of elder population living alone [5].

Proper healthcare access should be ensured to older adults regardless of their residential status. The vulnerable population at old age homes need special attention to ensure health equity. Understanding the disparity in access to basic oral care among such population in communities can help inform authorities to ensure provisions for delivery of service provisions to such groups. The studies conducted in Nepalese context to examine normative oral health need among community dwelling and old age home residents in Nepal lack a robust methodology. However, studies conducted in other countries have identified a contrast between the normative oral health needs between these two groups [6,7]. Concerning the common risk factor nature of the disease, several studies have shown relationship between oral

health and mental health [8]. People with depression are more likely to have edentulism, caries, periodontal disease, oral dryness and reduced oral health-related quality of life [9]. Concerns on underutilization of dental services and reluctance in oral hygiene behaviour also exist in depressed individuals which might affect oral health outcome [10]. Hence, treatment planning and course of prognosis for oral disorders may depend on underlying social constructs of an individual and how their general health deficiencies are addressed.

This study intended to shed light on need of multidisciplinary approach for efficient delivery of oral health related disorders in older adults and help develop strategies specific to different population needs. The objective of the study was to assess oral health status of old-age home residents and community dwelling older adults of eastern Nepal and investigate its association with depression.

METHODS

Study design, setting, and participants

The study used a comparative cross-sectional analytical design in eastern Nepal. Sample size (n) was calculated considering 95% CI, 90% power and difference of mean using formula; $n = 2 \times \sigma^2 \times (Z_{\alpha/2} + Z_{\beta/2})^2 / (\mu_1 - \mu_2)^2$ and after adjusting for 20% probable non response. A final sample size of 42 individuals each from old age homes and community households was calculated by considering standard deviation ($\sigma = 7.84$) and difference in mean DMFT (Decayed, Missing, Filled Teeth) in older adults of community households ($\mu_1 = 14.4$) and old age home ($\mu_2 = 8.28$) from published literatures [6,11]. The participants were selected using multistage sampling technique. Of a total seven old age homes present in eastern Nepal, three old age homes were selected by lottery method. About 12, 14 and 16 older adults were selected respectively from Birateswor Briddhashram Sewa Samiti, Biratnagar, Shri Krishna Pranami Pratisthan Nepal, Itahari and Bishranti Mandir, Dhankuta by population proportion sampling

from a sampling frame of 30, 37 and 42 residents. The residents from each old age home were selected through simple random sampling using lottery method. Equal number of community dwelling older adults were enrolled from respective wards where old age homes were located. Residents were recruited from Biratnagar-13, Itahari-4, and Dhankuta-9 using systematic random sampling after matching for age and sex as for old age home residents. Using significant identifying character identified as a landmark s, every n^{th} house from the landmark was considered into the study with the total households in the corresponding ward considered as the sampling frame. Elders aged 60 years and above with no reported limitations in activities of daily living defined as being unable to walk, take a bath, or use the toilet without assistance were included in the study. Individuals who were not present during community visit and those who did not provide consent were excluded. The data collection was done from March 2019 to June 2019. A single investigator (UG) was involved in the data collection under the supervision of other investigators.

Study variables

Oral health status was assessed for primary outcome measures of mean caries experience, number of remaining teeth and prevalence of periodontitis using appropriate pro forma following an oral examination. WHO Oral Health Assessment Form for Adults 2013 was used to assess caries experience (DMFT score) using plain mouth mirror and WHO probe [12]. WHO's criteria require maintaining a minimum natural dentition of 20 teeth throughout the life for acceptable level of oral function [13]. The outcome variable of number of remaining natural teeth were dichotomised for analysis with a cut-off of 20. Number of functioning teeth was derived from dentition status by counting tooth having crown score as 0 or 3 and root score of either 0 or 8. Probing depth (PD) and Clinical Attachment Loss (CAL) were measured using UNC-15 colour coded probe for assessing periodontitis. Periodontitis case definition by

Centres for Disease Control and Prevention (CDC) / American Academy of Periodontology (AAP) was used to define mild, moderate, and severe periodontitis. The variables were dichotomised into "No periodontitis" and "Periodontitis" with the mild, moderate and severe forms of periodontitis categorised altogether as 'Periodontitis' [14].

Interview of participants was done using structured questionnaires to collect data on covariates of sociodemographic characteristics including age, gender, marital status, literacy, ethnicity, geographical residence, household income, previous occupation, oral hygiene behaviour, tobacco usage, utilization of health services and self-reported medical comorbidities. Tobacco usage in the present and the past was assessed using Global Adult Tobacco Survey (GATS) questionnaire and responses dichotomised as "lifetime exposure absent" and "lifetime exposure present" for both smoked and smokeless tobacco forms [15]. Oral health behaviour related questionnaires were adapted from previous literatures. The questionnaires were translated and validated in Nepali language through standard back translation method following standard WHO guidelines by three separate experts. Geriatric Depression Scale – 15 items (GDS-15), translated and validated in Nepali language by Gautam R and Houde SC in 2011, was used to assess depression in older adults [16]. GDS score category was dichotomised for statistical analysis as 'No depression' and 'Depression' with a cut-off of score 5 [17].

Oral dryness was assessed by recording salivary secretion using modified cotton method and outcomes were assessed for oral dryness at hyoglossus and oral dryness at tongue surface [18]. Plaque control was assessed using Silness and Loe Plaque index [19]. The pretesting and intra-examiner calibration were done prior to the study in 25 individuals of Foklyan, Dharan. Pretesting did not warrant any major modifications to the tool. The kappa coefficient for intra-examiner reliability of a single examiner

was found to be 0.98 for DMFT measure, 0.81 for plaque control and 0.96 for periodontal status.

Statistical methods

Descriptive statistics were used to illustrate sociodemographic data. Bivariate analysis using chi-square test, or Mann-Whitney U test, was employed to compare the oral health outcomes across two groups. Shapiro Wilk test was used to examine the assumptions for Normality of continuous outcomes. Association between respective independent variables and dependent oral health status variables i.e., number of remaining teeth and periodontal status were assessed using unadjusted odds ratio. Multiple logistic regression models were carried out, at three levels, to determine the association between outcome variable of oral health status and depression. Hierarchical model was derived for statistical modelling on the basis of causal approach model by Holst to assess association at three levels [20].³⁵ Distal external factors represented by sociodemographic variables were added in first model. Subsequent model included behavioural factors related to oral hygiene while the proximal most factors represented by biological factors of saliva and plaque biofilm were included in third model. Dependent variables with a p value <0.2 for their association with independent variables in the unadjusted model were entered into subsequent models. Multicollinearity between various covariates were assessed by variance inflation factor to decide whether any of correlated variables needed to be omitted. Statistical significance was indicated at $p < 0.05$. Goodness-of-fit was assessed using Hosmer-Lemeshow test. Nagelkerke R^2 was used to examine how useful the independent variables are in predicting the dependent variable. Data was entered in Microsoft Excel 2007 and exported to Statistical Package for Social Sciences software (SPSS) Version 21 for statistical analysis.

RESULT

Mean age (\pm SD) of the participants was 74.3 (\pm 8.8) years; majority (52%) being female. All the participants belonged from urban region. Nearly

half of the participants (48.8%) reported being unemployed while there were 13.7% individuals with no source of income. Most (64.3%) were either widow/divorcee with majority of them from the old age homes. No statistically significant difference was noted for sociodemographic characteristics across two groups.

More than half (53.6%) of the participants reported brushing their tooth at least once a day. There was no significant difference in the oral health behaviour responses on brushing, availability of health services and frequency of sweet consumptions among community dwelling older adults and old age home residents. (Table 1) Only 16.7 per cent of the participants reported dental service utilisation in the past of whom significantly higher proportion of individuals were from old age homes ($p=0.019$). Similarly, significantly higher number of participants (77%) from the community reported having failed to seek dental care in the past ($p < 0.001$).

About 36 per cent respondents had oral dryness (< 0.1 gm salivary secretion) when examined at hyoglossus. However, dryness on tongue surface (< 0.02 gm salivary secretion) was present in 30 of the participants. Dryness on both surfaces were, relatively, more for old-age home residents but the difference was not statistically significant. (Table 2) The study found statistically significant difference in scores of Plaque Index, Decayed teeth, Root caries, Missing teeth, Caries experience, number of remaining teeth and prevalence of periodontitis.

Bivariate analysis showed significant association of periodontitis with older age (OR:1.063; CI: 1.002-1.129), literacy status (OR:0.294; CI: 0.113-0.763), lifetime exposure of smoked tobacco (OR:4.156; CI: 1.579-10.937), brushing practice (OR:0.146; CI: 0.048-0.444), oral dryness (hyoglossus) (OR:3.943; CI: 1.299-11.967), higher plaque score (OR:11.715; CI: 4.009-34.236) and presence of depression (OR:12.381; CI: 3.311-46.291). Similarly, number of remaining teeth was significantly associated with older age (OR:0.93;

CI: 0.880-0.983), literacy status (OR:1.117; CI:), living with spouse (OR:5.167; $p=0.002$), lifetime smoked tobacco exposure (OR:0.251; CI: 0.099-0.637), lack of brushing practice (OR:6.955; CI: 2.659-18.192), oral dryness (hyoglossus) (OR:0.088; CI: 0.030-0.258) and oral dryness (tongue surface) (OR:0.260; CI: 0.096-0.703), higher plaque score (OR:0.195; CI: 0.091-0.418) and presence of depression (OR:0.0975; CI: 0.035-0.271). Variables significant at $p<0.2$ in bivariate analysis were included in multiple logistic regression. Sociodemographic variables significant at $p<0.2$ in model I were added to model II along with behavioural variables and

then subsequently to model III (Table 3). The final logistic regression model was statistically significant, $\chi^2(6) = 50.114$, $p < 0.001$. The final model (model III) explained 63.8 per cent (Nagelkerke R^2) of the variance in periodontitis and correctly classified 85 per cent of cases. Depression after adjusting for other covariates was significantly associated (OR: 7.124; CI: 1.310 - 38.730; $p=0.023$) with periodontitis. Variables that remained significant in final model were literacy (OR: 0.203; CI: 0.045 - 0.909; $p=0.037$) and Plaque Index scores (OR: 8.443; CI: 2.248 - 31.706; $p=0.002$).

Table 1: Oral Health behaviour among community dwelling adults and old age home residents

| | Community dwelling [n (%)] | Old-age home [n (%)] | Overall [n (%)] | p-value ⁺ |
|---|-------------------------------|-------------------------|--------------------|----------------------|
| Toothbrushing practice | | | | |
| At least once a day | 25 (59.5%) | 20 (47.6%) | 45 (53.6%) | 0.274 |
| Other (never, sometimes) | 17 (40.5%) | 22 (52.4%) | 39 (46.4%) | |
| Dental Service Utilisation | | | | |
| Yes | 3 (7.1%) | 11 (26.2%) | 14 (16.7%) | 0.019 |
| No | 39 (92.9%) | 31 (73.8%) | 70 (83.3%) | |
| Inability to seek dental care | | | | |
| Yes | 9 (21.4%) | 28 (66.7%) | 37 (44%) | <0.001 |
| No | 33 (78.6%) | 14 (33.3%) | 47 (56%) | |
| Availability of Health Services | | | | |
| < 30 min | 33 (78.6%) | 41 (97.6%) | 74 (88.1%) | 0.070 |
| > 30 min | 9 (21.4%) | 1 (2.4%) | 10 (11.9%) | |
| Frequency of sweet consumption in a day | | | | |
| Once and more | 30 (71.4%) | 32 (76.2%) | 62 (73.8%) | 0.620 |
| Never | 12 (28.6%) | 10 (23.8%) | 22 (26.2%) | |
| Smoked form of Tobacco usage in lifetime | | | | |
| Exposure | 20 (23.8%) | 27 (32.1%) | 47 (56%) | 0.187 |
| Non-exposure | 22 (26.2%) | 15 (17.9%) | 37 (44%) | |
| Smokeless form of Tobacco usage in lifetime | | | | |
| Exposure | 22 (26.2%) | 21 (25%) | 43 (51.2%) | 0.999 |
| Non-exposure | 20 (23.8%) | 21 (25%) | 41 (48.8%) | |

Note. Bold signifies statistical significance at $p<0.05$; * Mann-Whitney U test; + Chi-square test; NA: Not Applicable due to missing cell value

Table 2: Oral Health Status outcomes among community dwelling adults and old age home residents

| | | Community dwelling | Old-age home | Overall | p-value |
|-----------------------------------|----------------|--------------------|---------------|---------------|-------------------|
| Plaque Index Score | Median (Range) | 1.1 (0 – 3) | 1.8 (0 – 3) | 1.4 (0 – 3) | 0.014* |
| Decayed Teeth | Median (Range) | 3 (0 – 11) | 4.5 (0 – 22) | 3 (0 – 22) | <0.001* |
| Root caries | Median (Range) | 2 (0 – 12) | 4 (0 – 21) | 3 (0 – 21) | 0.001* |
| Missing Teeth | Median (Range) | 4 (0 – 32) | 7 (0 – 32) | 6 (0 – 32) | 0.025* |
| Filled Teeth | Median (Range) | 0 (0 – 2) | 0 | 0 (0 – 2) | NA |
| Caries Experience | Median (Range) | 7 (0 – 32) | 17.5 (0 – 32) | 10.5 (0 – 32) | 0.014* |
| Number of remaining teeth [n (%)] | < 20 teeth | 13 (31%) | 25 (59.5%) | 38 (45.2%) | 0.009* |
| | ≥ 20 teeth | 29 (69%) | 17 (40.5%) | 46 (54.8%) | |
| Periodontitis [n (%)] | Present | 21 (52.5%) | 30 (75%) | 51 (63.8%) | 0.036* |
| | Absent | 19 (47.5%) | 10 (25%) | 29 (36.3%) | |

Note. Bold signifies statistical significance at $p < 0.05$; * Mann-Whitney U test; + Chi-square test; NA: Not Applicable due to missing cell value

Table 3: Logistic regression with adjusted odds for association of periodontitis with depression across different models

| | OR | p-value | 95% CI | |
|---|-----------|--------------|--------|--------|
| | | | Lower | Upper |
| Depression Status ^{a,b,c} | | | | |
| No depression (GDS <5) | Reference | | | |
| Depression (GDS ≥5) | 7.124 | 0.023 | 1.310 | 38.730 |
| Age ^a | 1.029 | 0.436 | 0.957 | 1.107 |
| Education ^{a,b,c} | | | | |
| Illiterate | Reference | | | |
| Literate | 0.203 | 0.037 | 0.045 | 0.909 |
| Marital Status ^a | | | | |
| Unmarried/Widowed/Divorcee | Reference | | | |
| Living with spouse | 2.149 | 0.250 | 0.584 | 7.904 |
| Lifetime Exposure: Smoked Tobacco ^b | | | | |
| No | Reference | | | |
| Yes | 1.988 | 0.380 | 0.428 | 9.230 |
| Lifetime Exposure: Smokeless Tobacco ^b | | | | |
| No | Reference | | | |
| Yes | 1.903 | 0.433 | 0.381 | 9.500 |
| Toothbrushing practice ^{b,c} | | | | |
| No | Reference | | | |
| Yes | 0.471 | 0.406 | 0.080 | 2.775 |
| Oral Dryness (Hyoglossus) ^c | | | | |
| No dryness (>0.1 gm) | Reference | | | |
| Dryness (<0.1 gm) | 1.558 | 0.616 | 0.275 | 8.815 |

| | | | | |
|--|-----------|--------------|-------|--------|
| Oral Dryness (Tongue Surface) ^c | | | | |
| No dryness (>0.02 gm) | Reference | | | |
| Dryness (<0.02 gm) | 0.440 | 0.401 | 0.065 | 2.995 |
| Plaque score ^c | 8.443 | 0.002 | 2.248 | 31.706 |

Note. OR: Odds Ratio; bold signifies statistical significance at $p < 0.05$; ^a adjusted for variables for sociodemographic characteristics; ^b adjusted for general health behaviour and oral health related variables; ^c adjusted for oral health indicators of oral dryness and plaque control

Table 4: Logistic regression with adjusted odds for association of number of remaining teeth with depression across different models

| | OR | p-value | 95% CI | |
|---|-----------|--------------|--------|---------|
| | | | Lower | Upper |
| Depression Status ^{a,b,c} | | | | |
| No depression (GDS <5) | Reference | | | |
| Depression (GDS ≥5) | 0.11 | 0.008 | 0.011 | 0.497 |
| Age ^{a,b} | 0.954 | 0.253 | 0.881 | 1.034 |
| Sex ^a | | | | |
| Female | Reference | | | |
| Male | 0.624 | 0.449 | 0.184 | 2.116 |
| Education ^{a,b,c} | | | | |
| Illiterate | Reference | | | |
| Literate | 3.671 | 0.184 | 0.538 | 25.035 |
| Marital Status ^{a,b,c} | | | | |
| Unmarried/Widowed/Divorcee | Reference | | | |
| Living with spouse | 27.328 | 0.025 | 1.510 | 494.464 |
| Lifetime Exposure: Smoked Tobacco ^{b,c} | | | | |
| No | Reference | | | |
| Yes | 0.162 | 0.077 | 0.022 | 1.219 |
| Toothbrushing practice ^{b,c} | | | | |
| No | Reference | | | |
| Yes | 2.705 | 0.376 | 0.299 | 24.486 |
| Inability to seek dental care in the past year ^b | | | | |
| No | Reference | | | |
| Yes | 0.912 | 0.897 | 0.227 | 3.667 |
| Frequency of sugar intake ^b | | | | |
| Never | Reference | | | |
| Once a day or more | 0.856 | 0.856 | 0.856 | 0.856 |
| Oral Dryness (Hyoglossus) ^c | | | | |
| No dryness (>0.1 gm) | Reference | | | |
| Dryness (<0.1 gm) | 0.020 | 0.005 | 0.001 | 0.309 |
| Oral Dryness (Tongue Surface) ^c | | | | |
| No dryness (>0.02 gm) | Reference | | | |
| Dryness (<0.02 gm) | 1.212 | 0.847 | 0.172 | 8.544 |
| Plaque score ^c | 0.836 | 0.829 | 0.164 | 4.255 |

Note. OR: Odds Ratio; bold signifies statistical significance at $p < 0.05$; ^a adjusted for variables for sociodemographic characteristics; ^b adjusted for general health behaviour and oral health related variables; ^c adjusted for oral health indicators of oral dryness and plaque control

The final logistic regression model showing association of number of remaining teeth with different covariates was statistically significant, $\chi^2(8) = 67.256$, $p < 0.001$ (Table 4). The final model explained 77.1 per cent (Nagelkerke R^2) of the variance in number of remaining teeth and correctly classified 89.9 per cent of cases. The final model showed presence of depression was significantly associated with lesser odds (OR: 0.11; CI: 0.011 - 0.497; $p=0.008$) of having more than 20 teeth. Variables that remained significant were marital status (OR: 27.3; CI: 1.510 - 494.464; $p = 0.025$) and oral dryness measured at hyoglossus (OR: 0.020; CI: 0.001 – 0.309; $p = 0.005$).

DISCUSSION

Old age homes in Nepal, mostly, accommodate older adults who have no families to look after. They can be favourable for society in providing holistic care to these vulnerable sections [21]. Traditionally, older adults with no one to look after are housed in old age homes called '*Bridddhashram*' which are located in religious places across the country. Modernisation, migration and changing family trends have, nowadays, changed people's preference for rather voluntary admittance to these *brisddhashrams* [22]. Social relations are shown to be related to oral health status in elder population [23]. Social support is found to be associated with use of dental services and oral health related behavior among non-institutionalized older people in a study in Belgium [24]. Institutionalized adults were more likely than non-institutionalized adults to be edentulous in a Canadian study. Sociodemographic factors prior to institutionalization were depicted as a major factor for oral disease in the group of older adults.¹¹ This study has examined different components of oral health using a more elaborative sampling strategy and compare the outcomes between two groups. Poor oral health was, also, demonstrated among elderly inmates

in different studies conducted in old age homes across India [25,26].

Our study found association of depression with oral health outcomes of number of remaining teeth and periodontitis after adjusting for sociodemographic and behavioural factors. Oral diseases, mainly caries, have been demonstrated to result from a complex interaction between behavioural, contextual and societal factors [27]. Such complex hierarchical interrelationships are better approached using conceptual frameworks to guide statistical analysis and interpretation of results. Depression can influence oral health outcome through biological or behavioural pathway. A significant association was seen between periodontitis and depression along with other significant covariates of education and plaque score. The risk of depression in periodontitis patient above 65 years age was 1.66 (95% CI: 1.27 – 2.17) in a study conducted in Taiwan. Rosania et al demonstrated that depression was correlated with measures of periodontal disease ($p = 0.018$) in a small homogenous sample [30]. Another study by Shrestha et al in Nepalese population demonstrated high prevalence of depression in more severe cases of periodontitis [31]. Borokowska et al have shown a series of negative associations between plaque scores and adherence intent [32]. Non-compliant patients tend to pose a barrier in attaining good prognosis for periodontal disease outcome. A metanalysis by DiMatteo et al demonstrated depressed patients to have three times greater odds to be noncompliant with medical treatment compared to nondepressed [33]. Depressive symptoms were associated with lower dental health behavior of toothbrushing frequency suggesting psychological distress as a possible risk factor for poor dental health. Attachment loss was found to be significantly higher in individuals with lower education. Possible explanation for the difference was made by citing the role of lack of dental service utilization among illiterates leading to poor health status [34]. Being illiterate was associated with significant odds of

developing periodontitis among depressed individuals in this study.

Our study, also, showed number of remaining teeth in older adults as an associated factor for depression along with oral dryness and marital status. Similar association (OR:1.94; 95% CI:1.062 – 3.544) was apparent in a Korean study; however, the association was not significant when adjusted for other covariates [35]. Depression is shown to be associated with high lactobacillus count, thus increasing caries susceptibility for caries. Similarly, increased risk behavior, such as negligence in oral hygiene, diet change, tobacco use and noncompliance to treatment, has been shown to be associated with depression [36]. Biological component seems to play role by inducing changes in salivary immune defense [37]. This study showed significant association in having more than 20 teeth and salivary accumulation was more than 0.1 gm. However, it was not evident in measurements obtained at tongue surface. Psycho-neuro-immunologic network seems to play an important role in association of stress and periodontal disease. It is mediated by feedback mechanism with secretion of cortisol [38]. Our study shows influence of spouses over oral health outcome of number of remaining teeth indicating spouses as an important model for behavior. The effect remained apparent in final adjusted model. Similarly, lack of association with other behavioural factors is in contrary to other body of evidences. Association is reported between low level education and tooth loss in older adults [39]. However, no effect of literacy was apparent in this final model.

Limitation

This study has excluded older population reporting limitation in daily activities. The exclusion might have resulted in underrepresentation for prevalence of dental disease. However, inclusion of individuals with reduced functional ability could have confounded the relation of oral health status outcomes and depression. The sample size might place constraints on the analyses performed to

highlight the association between oral health status outcomes and depression; thus, limiting the generalisability of our findings. Despite the limitation imposed by sample size, the study nonetheless sheds light into the relationship between depression and oral health status outcomes in this particular sample population. The interpretation of wide confidence interval should, therefore, be taken with skepticism. Moreover, causal relation cannot be established by this cross-sectional design. A longitudinal design, preferably, should be considered in establishing the direction of causal relation between oral health and depression. Similarly, complex causal pathways do pose significant challenge in statistical modelling process for understanding oral health diseases like dental caries and are subjected to criticisms. The model employed in this study may have limitation as it may not explain all causal links and interlinking pathways to give a detailed consideration of carious process. This begs for cautious interpretation of the study findings pertaining to the causal process considered.

CONCLUSION

The study, nonetheless, found poor oral health status outcomes among old age home residents compared to community dwelling older adults. Similarly, depression was significantly associated with oral health outcomes of remaining number of teeth and periodontitis among study population. It is worthwhile to assess the factors behind the disparity in oral health status between old age residents and community dwelling older adults. Initiatives can then be taken to closing the gap. Interdisciplinary approach can address various factors associated with disparity. The paradigm of disease etiology has shifted from biomedical perspective to a focus on social determinants which focuses on social causes of health and the resulting inequalities. Oral health inequalities can be addressed only when a thorough understanding of the social causes can be made. Future studies can clarify this

psychological and oral health interaction for comprehensive geriatric care.

Acknowledgements: The authors would like to acknowledge contributions made by Dr. Krishna Subedi, Dr. Resham Koirala, Dr. Naresh Prasad Joshi, Dr Abanish Singh at different stages of the study.

Conflict of Interest: None

Ethical considerations: Ethical approval was obtained from Ethical Review section, Nepal Health Research Council (NHRC) (Ref. No. 2306).

Consent: Written informed consent was obtained from each participant prior to the interview and examination.

Data Availability Statement: The data associated with the study can be obtained from the Principal Investigator on reasonable request.

Source of Funding: The study received grant from NHRC, Kathmandu.

Author's contribution: UG was involved in conceptual framework, literature review, data collection and report writing. SN and DB helped in data analysis and report writing. AS and TB were involved in data collection, report writing and manuscript editing.

Layman Summary: Older population should have proper access to basic health care. With increasing age, oral health has a vital role in wellbeing of an individual. Initiatives should be focused on improving health needs of institutionalised older population. Also, older adults may require holistic care for the ailments they might face because of ageing. Our study highlights how oral health outcomes are influenced by a multitude of factors including psychological wellbeing.

REFERENCES

1. WHO. Global strategy and action plan on ageing and health. World Health Organisation; 2017.
2. Sheiham A. Oral health, general health and quality of life. *Bull World Health Organ.* 2015 Sep;83(9):2.
3. Müller F, Shimazaki Y, Kahabuka F, Schimmel M. Oral health for an ageing population: the importance of a natural dentition in older adults. *Int Dent J* [Internet]. 2017 Oct [cited 2019 Jul 31];67:7–13. Available from: <http://doi.wiley.com/10.1111/idj.12329>
4. Dhakal MR. Ageing and health in Nepal. In: *Regional Health Forum* [Internet]. 2012. p. 12–6. (1; vol. 16). Available from: http://www.searo.who.int/publications/journals/regional_health_forum/media/2012/rhf2012v16n1p12.pdf
5. Rajan SI, Kumar S. Living Arrangements among Indian Elderly: New Evidence from National Family Health Survey. *Econ Political Wkly* [Internet]. 2003;38(1):75–80. Available from: <http://www.jstor.org/stable/4413048>
6. Srivastava R, Gupta SK, Mathur VP, Goswami A, Nongkynrih B. Prevalence of dental caries and periodontal diseases, and their association with sociodemographic risk factors among older persons in Delhi, India: a community-based study. *SE Asian J Trop Med.* 2013;44(3):523–33.
7. Slade GD, Locker D, Leake JL, Price SA, Chao I. Differences in oral health status between institutionalized and non-institutionalized older adults. *Community Dent Oral Epidemiol* [Internet]. 1990 Oct [cited 2019 Aug 1];18(5):272–86. Available from: <http://doi.wiley.com/10.1111/j.1600-0528.1990.tb00076.x>
8. Kim YS, Kim HN, Lee JH, Kim SY, Jun EJ, Kim JB. Association of stress, depression, and suicidal ideation with subjective oral health status and oral functions in Korean adults aged 35 years or more. *BMC Oral Health* [Internet]. 2017 Dec [cited 2019 Jul 31];17(1). Available from: <http://bmcoralhealth.biomedcentral.com/articles/10.1186/s12903-017-0391-4>
9. Yamamoto T, Aida J, Kondo K, Fuchida S, Tani Y, Saito M, et al. Oral Health and Incident Depressive Symptoms: JAGES Project Longitudinal Study in Older Japanese. *J Am Geriatr Soc* [Internet]. 2017 May [cited 2019 Jul 31];65(5):1079–84. Available from: <http://doi.wiley.com/10.1111/jgs.14777>
10. Anttila S, Knuuttila M, Ylostalo P, Joukamaa M. Symptoms of depression and anxiety in relation to dental health behavior and self-perceived dental treatment need. *Eur J Oral Sci* [Internet]. 2006 Apr [cited 2019 Jul 31];114(2):109–14. Available from: <http://doi.wiley.com/10.1111/j.1600-0722.2006.00334.x>

11. Agrawal R, Gautam NR, Kumar PM, Kadhiresan R, Saxena V, Jain S. Assessment of Dental Caries and Periodontal Disease Status among Elderly Residing in Old Age Homes of Madhya Pradesh. *Journal of International Oral Health*. 2015;7(8):57–64.
12. World Health Organization, editor. *Oral health surveys: basic methods*. 5th edition. Geneva: World Health Organization; 2013. 125 p.
13. Hobdell M, Petersen PE, Clarkson J, Johnson N. Global goals for oral health 2020. *Int Dent J* [Internet]. 2003 Oct [cited 2019 Sep 3];53(5):285–8. Available from: <http://doi.wiley.com/10.1111/j.1875-595X.2003.tb00761.x>
14. Eke PI, Page RC, Wei L, Thornton-Evans G, Genco RJ. Update of the Case Definitions for Population-Based Surveillance of Periodontitis. *J Periodontol* [Internet]. 2012 Dec [cited 2019 Aug 7];83(12):1449–54. Available from: <http://doi.wiley.com/10.1902/jop.2012.110664>
15. Global Adult Tobacco Survey Collaborative Group. Global Adult Tobacco Survey (GATS): Core Questionnaire with Optional Questions, Version 2.0 [Internet]. Centers for Disease Control and Prevention; 2010 [cited 2019 Aug 7]. Available from: https://www.who.int/tobacco/surveillance/en/tfi/gats_corequestionnairewithoptionalquestions_v2_FINAL_03_Nov2010.pdf
16. Gautam R, Houde SC. Geriatric Depression Scale for community-dwelling older adults in Nepal. *Asian Journal of Gerontology & Geriatrics*. 2011 Dec 2;6(2):93–9.
17. Almeida OP, Almeida SA. Short versions of the geriatric depression scale: a study of their validity for the diagnosis of a major depressive episode according to ICD-10 and DSM-IV. *Int J Geriatr Psychiatry* [Internet]. 1999 Oct [cited 2019 Sep 3];14(10):858–65. Available from: <http://doi.wiley.com/10.1002/%28SICI%291099-1166%28199910%2914%3A10%3C858%3A%3AAID-GPS35%3E3.0.CO%3B2-8>
18. Takahashi F, Koji T, Morita O. Oral Dryness Examinations : Use of an Oral Moisture Checking Device and a Modified Cotton Method. *Prosthodontic Research & Practice* [Internet]. 2006 [cited 2019 Aug 7];5(1):26–30. Available from: <http://joijlc.jst.go.jp/JST.JSTAGE/prp/5.26?from=CrossRef>
19. Löe H. The Gingival Index, the Plaque Index and the Retention Index Systems. *J Periodontol* [Internet]. 1967 Nov 1;38(6):7. Available from: <https://doi.org/10.1902/jop.1967.38.6.610>
20. Holst D, Schuller AA, Aleksejuniene J, Eriksen HM. Caries in populations - a theoretical, causal approach. *Eur J Oral Sci* [Internet]. 2001 Jun [cited 2019 Sep 17];109(3):143–8. Available from: <http://doi.wiley.com/10.1034/j.1600-0722.2001.00022.x>
21. Acharya P. Senior Citizens and the Elderly Homes: A Survey from Kathmandu. *DHAULAGIRI* [Internet]. 2008 [cited 2019 Sep 11];2:211–26. Available from: <https://www.nepjol.info/index.php/DSAJ/article/view/1365>
22. Chalise HN. Depression among elderly living in Briddashram (old age home). *Advances in Aging Research* [Internet]. 2014 [cited 2019 Aug 1];03(01):6–11. Available from: <http://www.scirp.org/journal/doi.aspx?DOI=10.4236/aar.2014.31002>
23. Avlund K, Holm-Pedersen P, Morse DE, Viitanen M, Winblad B. Social relations as determinants of oral health among persons over the age of 80 years. *Community Dent Oral Epidemiol* [Internet]. 2003 Dec [cited 2019 Sep 14];31(6):454–62. Available from: <http://doi.wiley.com/10.1046/j.1600-0528.2003.00115.x>
24. McGrath C, Bedi R. Influences of social support on the oral health of older people in Britain. *J Oral Rehabil*. 2002;29:978–922.
25. Shaheen SS, Kulkarni S, Doshi D, Reddy S, Reddy P. Oral health status and treatment need among institutionalized elderly in India. *Indian J Dent Res* [Internet]. 2015 [cited 2019 Aug 13];26(5):493. Available from: <http://www.ijdr.in/text.asp?2015/26/5/493/172045>
26. Rekhi A, Marya CM, Oberoi SS, Nagpal R, Dhingra C, Kataria S. Periodontal status and oral health-related quality of life in elderly residents of aged care homes in Delhi: Periodontal status and OHRQoL in elderly. *Geriatr Gerontol Int* [Internet]. 2016 Apr [cited 2019 Sep 10];16(4):474–80. Available from: <http://doi.wiley.com/10.1111/ggi.12494>
27. Petersen PE. Sociobehavioural risk factors in dental caries - international perspectives. *Community Dent Oral Epidemiol* [Internet]. 2005 Aug [cited 2019 Sep 11];33(4):274–9. Available from: <http://doi.wiley.com/10.1111/j.1600-0528.2005.00235.x>

28. Fejerskov O. Concepts of dental caries and their consequences for understanding the disease. Community Dentistry and Oral Epidemiology [Internet]. 1997 Feb [cited 2020 Nov 20];25(1):5–12. Available from: <http://doi.wiley.com/10.1111/j.1600-0528.1997.tb00894.x>
29. Hsu CC, Hsu YC, Chen HJ, Lin CC, Chang KH, Lee CY, et al. Association of Periodontitis and Subsequent Depression: A Nationwide Population-Based Study. Medicine [Internet]. 2015 Dec [cited 2019 Jul 31];94(51):e2347. Available from: <http://content.wkhealth.com/linkback/openurl?sid=WKPTLP:landingpage&an=00005792-201512210-00033>
30. Rosania AE, Low KG, McCormick CM, Rosania DA. Stress, Depression, Cortisol, and Periodontal Disease. J Periodontol [Internet]. 2009 Feb [cited 2019 Sep 22];80(2):260–6. Available from: <http://doi.wiley.com/10.1902/jop.2009.080334>
31. Shrestha S, Sharma S, Sapkota N, Giri DK, Baral D. Association between anxiety and depression with chronic periodontitis. J Coll Med Sci Nepal [Internet]. 2017 Jul 17 [cited 2019 Jul 31];13(2):268–74. Available from: <https://www.nepjol.info/index.php/JCMSN/article/view/17712>
32. Borkowska ED, Watts TLP, Welnman J. The relationship of health beliefs and psychological mood to patient adherence to oral hygiene behaviour. J Clin Periodontol [Internet]. 1998 Mar [cited 2019 Jul 31];25(3):187–93. Available from: <http://doi.wiley.com/10.1111/j.1600-051X.1998.tb02427.x>
33. DiMatteo MR, Lepper HS, Croghan TW. Depression Is a Risk Factor for Noncompliance With Medical Treatment: Meta-analysis of the Effects of Anxiety and Depression on Patient Adherence. Arch Intern Med [Internet]. 2000 Jul 24 [cited 2019 Jul 31];160(14):2101. Available from: <http://archinte.jamanetwork.com/article.aspx?doi=10.1001/archinte.160.14.2101>
34. Guiney H, Woods N, Whelton H, Morgan K. Predictors of utilisation of dental care services in a nationally representative sample of adults. Community Dental Health. 2011;28(4):269–73.
35. Cho MJ, Ma JK. Relationship between the number of remaining teeth and depression in Korean adults. J Korean Soc Dent Hyg [Internet]. 2016 Feb 28 [cited 2019 Sep 22];16(1):19–25. Available from: <http://koreascience.or.kr/journal/view.jsp?kj=CHOSAB&py=2016&vnc=v16n1&sp=19>
36. Monteiro da Silva AM, Oakley DA, Newman HN, Nohl FS, Lloyd HM. Psychosocial factors and adult onset rapidly progressive periodontitis. J Clin Periodontol [Internet]. 1996 Aug [cited 2019 Sep 15];23(8):789–94. Available from: <http://doi.wiley.com/10.1111/j.1600-051X.1996.tb00611.x>
37. Phillips AC, Carroll D, Evans P, Bosch JA, Clow A, Hucklebridge F, et al. Stressful life events are associated with low secretion rates of immunoglobulin A in saliva in the middle aged and elderly. Brain Behav Immun [Internet]. 2006 Mar [cited 2019 Sep 15];20(2):191–7. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S0889159105001091>
38. Genco RJ, Ho AW, Kopman J, Grossi SG, Dunford RG, Tedesco LA. Models to Evaluate the Role of Stress in Periodontal Disease. Ann Periodontol [Internet]. 1998 Jul [cited 2019 Sep 15];3(1):288–302. Available from: <http://doi.wiley.com/10.1902/annals.1998.3.1.288>
39. Paulander J, Axelsson P, Lindhe J. Association between level of education and oral health status in 35-, 50-, 65- and 75-year-olds. J Clin Periodontol [Internet]. 2003 Aug [cited 2019 Sep 4];30(8):697–704. Available from: <http://doi.wiley.com/10.1034/j.1600-051X.2003.00357.x>

