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Association between dental pain and tooth loss with health-related quality of life: the Korea national health and nutrition examination survey

A population-based cohort study

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Abstract

Dental pain and tooth loss are global public health concerns. However, there have been no large cross-sectional epidemiologic studies of a representative sample of an entire country's populations. The purpose of this study was to evaluate the relationships between dental pain and tooth loss with health-related quality of life (HRQOL) using a well characterized, nationally representative, population-based study.

This study analyzed data of 3924, representing 21,836,566 adults from the 2012 Korea National Health and Nutrition Examination Survey. Subjects were divided into 4 groups as follows: tooth loss of up to 8 teeth without dental pain, tooth loss of up to 8 teeth with dental pain, tooth loss of 8 to 28 teeth without dental pain, and tooth loss of 8 to 28 teeth with dental pain. Logistic regression was applied to estimate the adjusted odds ratios (ORs) and 95% confidence intervals (CI), controlling for a range of covariates.

Among the 3924 subjects, representing an estimated 21,836,566 adults, the prevalence of tooth loss of 8 to 28 teeth was 24.6% and the prevalence of dental pain was 35%. The tooth loss of 8 to 28 teeth with dental pain group showed the highest level of impaired HRQOL in all 5 dimensions, and the tooth loss up to 8 teeth without dental pain group showed the lowest level. The proportion of both groups without dental pain decreased significantly from the younger age to older age group. After adjustment for sociodemographic factors, the ORs (95% CI) of mobility, self-case, usual activity, pain/discomfort, and anxiety/depression were 1.93 (1.32–2.84), 1.90 (1.25–2.90), 1.46 (0.88–2.43), 1.48 (0.88–2.49), and 1.46 (0.85–2.51) in tooth loss of 8 to 28 teeth with dental pain group. Although the ORs of tooth loss of 8 to 28 teeth without dental pain group did not significantly increase.

Dental pain and tooth loss has a considerable impact of HRQOL in the Korean adult population. In our study, HRQOL is more closely associated with dental pain than with tooth loss.

Abbreviations: BMI = body mass index, EQ-5D = The EuroQoL 5-dimension, EQ-VAS = EuroQoL visual analogue scale, HRQOL = health-related quality of life, KNHANES = Korea National Health and Nutrition Examination Survey, OR = odds ratio.

Keywords: dental pain, general population, health-related quality of life, Korea National Health and Nutrition Examination Survey, tooth loss

1. Introduction

Dental pain indicates that "toothache" originating from innervated tissues of a tooth or immediately adjacent to it.[1,2] Reversible or irreversible pulpitis can cause toothache, acute, or chronic periodontitis, and symptomatic 3rd molars also can cause toothache. Dental pain is the major cause of impairment of daily activity because individuals who suffer from dental pain have difficulty in chewing foods and have trouble sleeping.[1,3] Therefore, dental pain has social and psychological impacts that can reduce health-related quality of life (HRQOL).[4,5]

Previous studies have demonstrated the impact of tooth loss on HRQOL.[6–9] The loss of natural teeth can compromise normal chewing, speaking, laughing, appearance, self-image, and social interaction. In a recent systematic review, it was concluded that tooth loss impacts on quality of life independently of the instrument used to measure QOL.[10]

The EuroQol Group developed 5-dimension instrument (The EuroQoL 5-dimension [EQ-5D]) to standardize non-disease-specific instrument for describing and valuing HRQOL. The EQ-5D has been translated and used by an increasing number of researchers in various countries.[11,12]

The aim of this study was to analyze the association of tooth loss and dental pain with HRQOL based on the EQ-5D in a well characterized, nationally representative, population-based study. In addition, the prevalence of tooth loss and dental pain and its potential risk factors, including socioeconomic measurements, were also evaluated based on the EQ-5D.

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2. Materials and methods

2.1. Survey overview and study subjects

This study analyzed data from the 2012 Korea National Health and Nutrition Examination Survey (KNHANES), a nationwide survey that has been performed since 1998 by the Division of Chronic Disease Surveillance at the Korean Center for Disease Control and Prevention. The KNHANES, designed to assess national health and nutritional levels, consists of a health interview, health examination, and a nutritional assessment, which are carried out by trained interviewers and examiners. The survey subjects were randomly selected using stratified, multistage, and cluster-sampling designs, with proportional allocation based on geographic area, gender, and age from the 2005 National Census Registry, to represent the entire noninstitutionalized civilian population in Korea.

The Oral Health Examination Survey was performed by 30 Korea Centers for Disease Control public health dentists. Public health dentists serve a 3-year period in rural health centers in place of military service in Korea. Dentists were trained in theoretical, photographic, and modular education principles to obtain reliable oral health interview data and clinical examination survey data. Dentists examined the subject's oral health only and were not aware of other health interview survey results. During the 4th simulated screening tests, the reliability of the trained dentists in terms of dental status was 0.94.

All participants signed an informed consent form, and this study was approved by the Institutional Review Board of the Seoul St. Mary's Hospital, Catholic University of Korea, Seoul, Korea (KC14QISI0661). Of the 5,757 subjects who participated in both a health interview and a health examination, we excluded 1,833 subjects with missing data and under 40 years old. Thus, a total of 3,924 individuals participated in the study in the general population group, representing an estimated 21,836,566 adults aged 40 years and over.

2.2. Oral health behaviors and status

Oral health behaviors such as daily tooth brushing frequency, the use of oral hygiene devices (floss, interdental brush, and mouthwash), and the use of oral health services were assessed. Daily tooth brushing frequency was categorized into 4 groups: less than once a day, once a day, twice a day, and 3 or more times a day. Answers regarding the use of oral hygiene devices were categorized into 2 groups: yes and no. Questions on the use of oral health services included questions on oral health screening during the previous year and answers were categorized into 2 groups: yes and no.

Periodontal status and caries in permanent teeth were assessed clinically during an oral health examination. The World Health Organization Community Periodontal Index was used to assess periodontal treatment needs and defined subjects with periodontal treatment needs as having a Community Periodontal Index code ≥3. Oral health status including self-perceived oral health status, presence of mastication problems, and presence of speaking problems were determined from an oral health interview. Self-perceived oral health status was assessed with a 5-point scale: subjects with "very poor" or "poor" oral health status were classified as unhealthy, those with "fair" were classified as fair, and those with "good" or "very good" were classified as healthy. Mastication and speaking problems were assessed using a 5-point scale. The answers were classified into 3 groups: "very uncomfortable" and "uncomfortable" were categorized into uncomfortable, "fair" was categorized into fair, and "not uncomfortable" and "not uncomfortable at all" were categorized into comfortable.

2.3. Sociodemographic variables

The sociodemographic characteristics in this study included age, gender, body mass index (BMI), physical activity, marital status, education level (0–9 years, ≥10 years), and monthly household income.[13] In addition, subjects were asked about current smoking status and alcohol consumption during the previous year. "Yes, I smoke" and "I smoke occasionally" were categorized into the current smoker group. In terms of alcohol consumption status, "2 to 3 times a week" and "more than 4 times a week" were categorized into the heavy drinker group.

2.4. Dental pain

Dental pain was defined as a dull and aching tooth, throbbing tooth pain, or pain in the teeth when consuming hot or cold drinks or foods during the previous year.

2.5. Tooth loss

Tooth loss was categorized into 2 groups: "tooth loss of up to 8 teeth" and "tooth loss of 8 to 28 teeth."

2.6. Quality of life measurements

QOL was evaluated with the EQ-5D and EuroQoL visual analogue scale (EQ-VAS), used with the permission of the EuroQol Group.[14] The EQ-5D instrument has been previously used in Korea, and the validation of the Korean version was demonstrated in previous study.[15] These questionnaires were included in the KNHANES and used for the evaluation of QOL in the Korean population.[16–18]

The EQ-5D questionnaire includes a simple self-classifier section that assesses 5 dimensions, mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, with higher scores reflecting a lower level of HRQOL. The original responses to the EQ-5D, such as "no problems," "some/moderate problems," "severe/extreme problems," and "unable to function," were reclassified into 2 categories: no problems and any problems.

The EQ-5D index scores were calculated using a formula to estimate the weighted value in the EQ-5D.[19] A higher EQ-5D index score indicated a higher health-related QOL. The EQ-5D index scores ranged from −0.171 (severe problems in all five dimensions) to 1.0 (no problem in any dimension), on a scale where 0 indicates death and 1.0 indicates perfect health. Negative values indicate a health status worse than death. The EQ-VAS is a 20-cm visual analogue scale on which respondents record their perceptions of overall health. EQ-VAS scores range from 0 (worst imaginable health) to 100 (best imaginable health).

2.7. Statistical analyses

Statistical analyses were conducted using the SAS software version 9.2 (SAS Institute Inc., Cary, NC) to account for the

complex sampling design and to provide nationally representative prevalence estimates. All data were presented as the mean ± standard error or proportions (standard error) for continuous or categorical variables, respectively. We compared the differences in general characteristics between the 4 groups according to the presence of dental pain and tooth loss using the Chi-square test for categorical data and the Student *t* test for continuous data.

We used multiple logistic regression analyses to examine the association between dental pain and tooth loss with HRQOL. The adjusted odds ratios (ORs) and 95% confidence intervals for dental pain were calculated using tooth loss of up to 8 teeth without dental pain as the reference group.

Calculations were made adjusting for age, gender, and sociodemographic factors, current smoking status, and alcohol consumption. Model 1 included only basic variables (age and gender), model 2 included the variables in model 1 with the addition of BMI, current smoker, heavy drinker, and physical activity. Model 3 included the variables in model 2 with addition of income, education, diabetes, and hypertension. *P*-values of less than 0.05 were considered statistically significant.

3. Results

3.1. General characteristics of the study population

Among the weighted 21,836,566 subjects, the prevalence of tooth loss of 8 to 28 teeth was 24.6% and the prevalence of dental pain was 35%. In both groups with dental pain and without dental pain, subjects with tooth loss of 8 to 28 teeth were older and less likely to be educated, less likely to be married, more likely to have a low income, and more likely to have a chronic disease such as diabetes or hypertension compared with subjects with tooth loss of up to 8 teeth. Subjects with tooth loss of 8 to 28 teeth were more likely to have speaking and mastication problems, and less likely to use oral health services and oral hygiene devices (Table 1). In both the tooth loss of up to 8 teeth and tooth loss of 8 to 28 teeth groups, subjects with dental pain had a higher percentage of periodontitis, decayed-missing-filled index, and poor self-perceived oral health status.

3.2. EQ-5D scores according to dental pain and tooth loss

The tooth loss of 8 to 28 teeth with dental pain group showed the highest level of impaired HRQOL in all 5 dimensions of EQ-5D,

Table 1

Analysis of factors potentially associated with tooth loss and dental pain (*n* = 21,836,566; weighted).

	Tooth loss <8		Tooth loss 8–28		
	dental pain (−)	dental pain (+)	dental pain (−)	dental pain (+)	*P*-value
Age (years)	52.7 ± 0.3	53.4 ± 0.4	69.3 ± 0.4	67.6 ± 0.9	<0.0001
Gender: male (%)	47.8 (1.3)	51.9 (1.6)	41.5 (2.1)	40.9 (4.3)	0.0025
Education > 10 years (%)	64.2 (1.8)	62 (2.2)	22.4 (2.2)	17.5 (2.6)	<0.0001
Income: lower quartile (%)	11.5 (1)	16.9 (1.5)	45 (2.9)	48.7 (3.9)	<0.0001
Marital status with spouse (%)	88.6 (0.9)	84.9 (1.6)	68.4 (2.3)	66.1 (3.4)	<0.0001
Current smoker (%)	19.3 (1.3)	22.9 (1.9)	17.4 (2)	17.3 (3.4)	0.1909
Heavy drinker (%)	19.4 (1.2)	21.4 (1.6)	13.3 (2.1)	12.9 (2.8)	0.0104
Physical activity (%)	15.6 (1)	16.5 (1.6)	11.1 (1.5)	12.1 (2.4)	0.0871
Body mass index ≥25kg/m^2 (%)	35.4 (1.5)	37.3 (1.9)	33.1 (2.4)	42.3 (4.7)	0.2566
Diabetes (%)	9.7 (0.9)	11.7 (1.3)	24.5 (2.4)	20.7 (2.8)	<0.0001
Hypertension (%)	33.1 (1.6)	36.3 (2.2)	57.9 (2.3)	61.4 (3.8)	<0.0001
Periodontitis (%)	26 (1.5)	40.8 (2.2)	34.6 (3.1)	54.2 (4)	<0.0001
Caries in permanent teeth (%)	89.9 (0.9)	94 (1)	82.7 (2.6)	91.6 (2.1)	<0.0001
Mastication problem					<0.0001
uncomfortable	15.3 (1.2)	35.6 (1.8)	48.5 (2.2)	67.9 (3.7)	
fair	15.6 (1.3)	19.1 (1.5)	19 (1.9)	12.7 (2.5)	
comfortable	69.1 (1.6)	45.3 (1.8)	32.6 (2.6)	19.4 (2.9)	
Speaking problem					<0.0001
uncomfortable	4.7 (0.6)	9.9 (1.2)	31.7 (2.8)	40.6 (3.4)	
fair	9 (0.9)	14.8 (1.4)	21 (2)	18 (3)	
comfortable	86.2 (1)	75.3 (1.7)	47.3 (2.6)	41.4 (3.4)	
Self-perceived oral health status					<0.0001
healthy	17.6 (1.2)	6.7 (0.9)	14.7 (2.1)	5.2 (1.4)	
fair	46.6 (1.7)	31.2 (2.1)	27.1 (2.7)	10.3 (1.9)	
unhealthy	35.8 (1.6)	62.1 (2.1)	58.2 (2.9)	84.5 (2.5)	
Use of oral health services	24.5 (1.3)	30.5 (1.7)	11.9 (1.7)	13.1 (3.0)	<0.0001
Daily tooth brushing frequency					0.1711
0	13.1 (1.1)	12.5 (1.3)	16.4 (2)	19.7 (2.6)	
1	27.1 (1.2)	27.2 (1.9)	28.8 (2.2)	23.1 (3.2)	
2	33.4 (1.4)	35.9 (1.9)	34.1 (2.3)	32.9 (4.1)	
3	26.4 (1.4)	24.4 (1.5)	20.7 (2.1)	24.4 (3.5)	
Use of oral hygiene devices	46 (1.6)	45.1 (2)	23.7 (2.4)	24.3 (3.3)	<0.0001
Total number of remaining teeth	26.3 ± 0.1	25.8 ± 0.1	9.2 ± 0.4	12 ± 0.4	<0.0001
Total number of occluding pairs	12.5 ± 0.1	12 ± 0.1	2.2 ± 0.1	2.9 ± 0.2	<0.0001
EuroQol visual analog scale	75.6 ± 0.5	72.3 ± 0.7	66.5 ± 1.1	64.9 ± 1.8	<0.0001
EuroQol 5-dimension index	0.95 ± 0.0	0.93 ± 0.0	0.88 ± 0.0	0.85 ± 0.0	<0.0001

Data are presented as the mean ± standard error, or proportions (standard error).

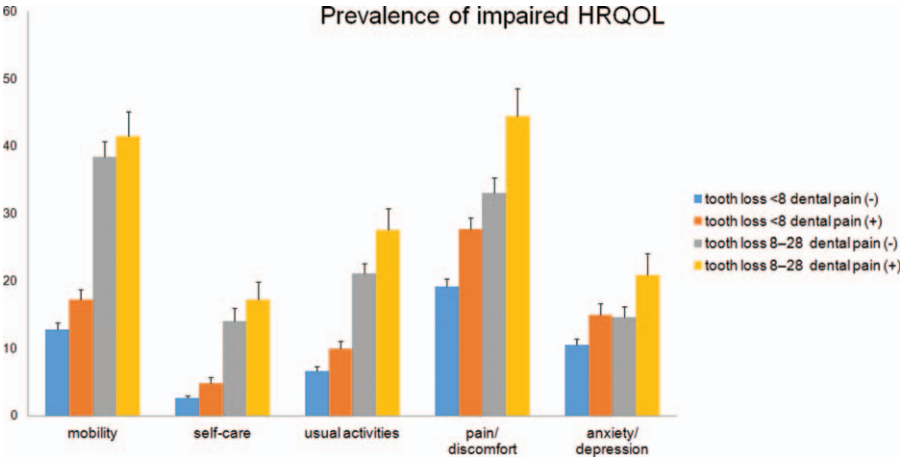

Figure 1. Prevalence of impaired health-related quality of life according to four subgroups based on tooth loss and dental pain. Percentage of subjects who responded "some or extreme problems" in each dimension of the EQ-5D (mobility, $P < 0.0001$; self-care, $P < 0.0001$; usual activity, $P < 0.0001$; pain/discomfort, $P < 0.0001$; anxiety/depression $P = 0.0004$). Bars represent standard error.

and the tooth loss up to 8 teeth without dental pain group showed the lowest level of impaired HRQOL (mobility, $P < 0.0001$; self-care, $P < 0.0001$; usual activity, $P < 0.0001$; pain/discomfort, $P < 0.0001$; and anxiety/depression, $P = 0.0004$). All 4 subgroups showed higher level of impaired HRQOL in pain/discomfort dimension than other dimensions of EQ-5D (Fig. 1).

We analyzed the 4 subgroups according to age. The proportion of both groups without dental pain (tooth loss of up to 8 teeth without dental pain group and tooth loss of 8 to 28 teeth without dental pain group) decreased significantly from the younger age to older age group. Although the proportion of both groups with dental pain (tooth loss of up to 8 teeth with dental pain group and tooth loss of 8 to 28 teeth with dental pain group) increased significantly with age (Fig. 2, P for trend <0.0001).

We analyzed the EQ-5D index and EQ-VAS by the number of remaining teeth. The EQ-5D index and EQ-VAS were low when the remaining number of teeth was less than 5, and were high when the remaining number of teeth was more than 20. The EQ-5D and EQ-VAS levels increased linearly increasing number of remaining teeth (Fig. 3).

3.3. Multivariable analyses for the associations between the EQ-5D and dental pain and tooth loss

After adjustment for sociodemographic factors such as age and gender (model 1), the ORs of the EQ-5D increased according to the following order, tooth loss of up to 8 teeth without dental pain, tooth loss of up to 8 with dental pain, and tooth loss of 8 to 28 teeth with dental pain. After adjusting for BMI, current smokers, heavy drinkers, physical activity (model 2), the trend of ORs were same. However, the ORs of tooth loss of 8 to 28 teeth without dental pain group did not significantly increase. Adding other factors such as lower quartile income, education level, diabetes and hypertension (model 3), the ORs (95% confidence

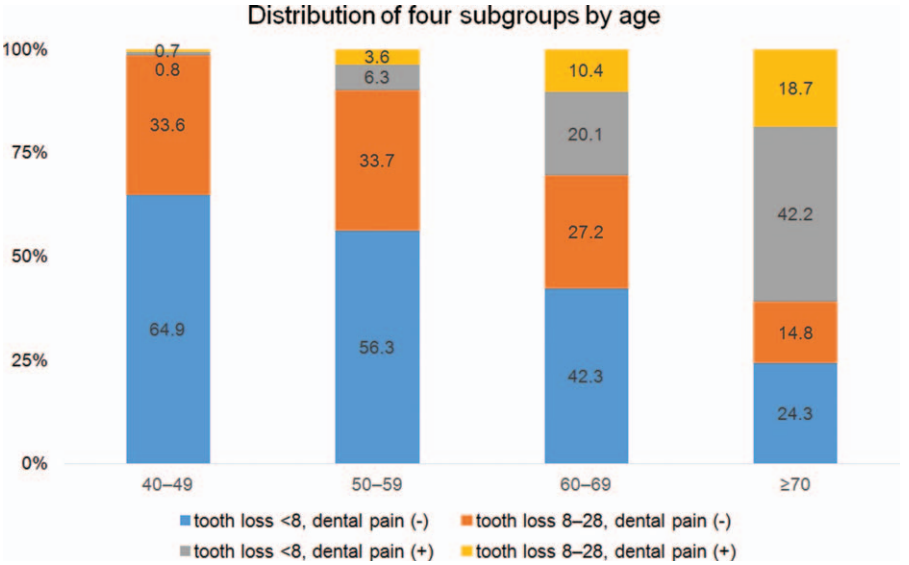

Figure 2. The distribution of the four subgroups according to age groups (P for trend <0.001).

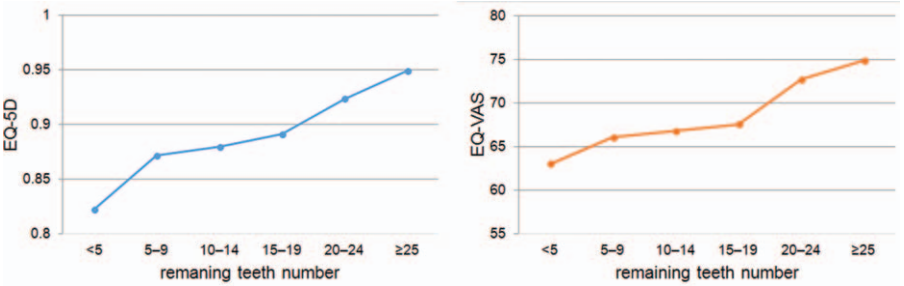

Figure 3. The EQ-VAS and EQ-5D index according to the number of remaining teeth (*P* for trend < 0.001).

interval) of mobility, self-case, usual activity, pain/discomfort, and anxiety/depression were 1.93 (1.32–2.84), 1.90 (1.25–2.90), 1.46 (0.88–2.43), 1.48 (0.88–2.49), and 1.46 (0.85–2.51) in tooth loss of 8 to 28 teeth with dental pain group (Table 2).

4. Discussion

The purpose of this study was to investigate the association between tooth loss and dental pain with HRQOL using a well characterized, nationally representative, population-based study. In this study, we found that subjects with tooth loss and dental pain appear to have a greater risk in HRQOL than those who simply have tooth loss or dental pain. HRQOL is more closely associated with dental pain than with tooth loss.

In this cohort, the tooth loss of 8 to 28 teeth with dental pain group showed a higher proportion of subjects who responded "some or extreme problems" in all 5 dimensions of the EQ-5D than the other 3 groups by univariate analysis (Fig. 1). Subjects with dental pain regardless of tooth loss numbers were older that those without dental pain (Fig. 2). The older age group generally had more comorbidities and other risk factors; therefore, these conditions might also be associated the much poorer HRQOL in older subjects with dental pain than in younger subjects. However, after adjusting for age and gender, the tooth loss of 8 to 28 teeth groups also showed increased levels in all 5 dimensions of HRQOL (Table 2, model 1). In a previous study, Steele et al[6] found that age and tooth loss had independent effects on HRQOL. In this study, HRQOL in the tooth loss of 8 to 28 teeth with dental pain group was significantly impaired compared with that in the tooth loss of up to 8 teeth with no dental pain group. However, using multiple logistic regression analyses after adjusting for comorbidities, there was no significant effect of the tooth loss of 8 to 28 teeth without dental pain group in all 5 dimensions of HRQOL (Table 2, model 3). Our data indicate that HRQOL is more closely related with dental pain than with tooth loss.

The parameter of "number of lost teeth" has been thought to be the most important predictor for assessing the HRQOL. For example, the variable of missing teeth number was significantly associated with the HRQOL scores independent of gender, age,

Table 2

Adjusted odd ratios and 95% confidence intervals for health-related quality of life (*n* = 21,836,566; weighted).

	Tooth loss <8		Tooth loss 8–28		
	dental pain (−)	dental pain (+)	dental pain (−)	dental pain (+)	*P*-value
Model 1					
Mobility	1	1.42 (1.06–1.91)	1.32 (1.00–1.75)	1.72 (1.18–2.51)	0.0216
Self-care	1	1.41 (1.06–1.88)	1.32 (0.99–1.75)	1.67 (1.14–2.44)	0.0269
Usual activity	1	1.38 (0.10–1.90)	1.23 (0.89–1.71)	1.42 (0.91–2.22)	0.2027
Pain/discomfort	1	1.84 (1.12–3.05)	2.22 (1.39–3.54)	3.16 (1.93–5.17)	<0.0001
Anxiety/depression	1	1.78 (1.07–2.96)	2.12 (1.33–3.37)	2.9 (1.74–4.83)	0.0005
Model 2					
Mobility	1	1.94 (1.13–3.33)	2.24 (1.31–3.83)	3.14 (1.78–5.55)	0.0009
Self-care	1	1.55 (1.13–2.13)	1.37 (1.01–1.84)	2.19 (1.45–3.31)	0.0019
Usual activity	1	1.56 (1.14–2.12)	1.35 (0.99–1.83)	2.08 (1.38–3.13)	0.0029
Pain/discomfort	1	1.46 (1.01–2.10)	1.40 (0.97–2.01)	1.84 (1.14–2.95)	0.0486
Anxiety/depression	1	1.65 (1.32–2.07)	1.13 (0.86–1.49)	1.99 (1.35–2.94)	<0.0001
Model 3					
Mobility	1	1.64 (1.32–2.05)	1.15 (0.87–1.51)	1.93 (1.32–2.84)	<0.0001
Self-care	1	1.60 (1.27–2.01)	1.15 (0.84–1.57)	1.90 (1.25–2.90)	0.0001
Usual activity	1	1.52 (1.10–2.08)	0.91 (0.62–1.33)	1.46 (0.88–2.43)	0.0156
Pain/discomfort	1	1.54 (1.12–2.11)	0.90 (0.62–1.31)	1.48 (0.88–2.49)	0.01
Anxiety/depression	1	1.58 (1.10–2.27)	0.83 (0.53–1.29)	1.46 (0.85–2.51)	0.0096

Model 1 is adjusted for age and gender.

Model 2 is adjusted for age, gender, BMI, current-smoker, heavy-drinker, and physical activity.

Model 3 is adjusted for age, gender, BMI, current-smoker, heavy-drinker, physical activity, income, education, diabetes and hypertension.

and denture wearing in Japanese young and middle-aged adults.[20] However, in Sri Lanka older adults,[21] "wearing denture" and "having halitosis" were significant predictors of the HRQOL score, and only weak association was observed between the "number of missing teeth" and HRQOL. Recently, Batista el al[9] demonstrated that the HRQOL can be differently percepted even when the number of lost teeth was same. They showed the highest HRQOL score in "lost 13 to 31 teeth" group. However, "lost up to 12 teeth including any anterior teeth" group showed higher scores than "lost up to 12 posterior teeth" group. Therefore, they insisted that impact of tooth loss has to be evaluated quantitatively and qualitatively. Our study classified tooth loss into "tooth loss of up to 8 teeth" and "tooth loss of 8 to 28 teeth," and we found that the "tooth loss of 8 to 28 teeth" group had relatively lower level of HRQOL. The 20 or more remaining teeth threshold has been regarded as a functional dentition for some years. Because the subjects with 20 or more natural teeth were assumed to have a good masticate capability and nutritional intake.[22,23] Other studies have found that chewing ability was impaired in subject with less than 20 well-distributed teeth or 10 occluding pairs of teeth.[24,25]

Our study reflects that subjects with dental pain regardless of tooth loss experience more impaired HRQOL than subjects without dental pain (Fig. 1). Tooth loss has been considered as an important factor in global health and HRQOL;[9,10] however, dental pain had more important negative impact of HRQOL in this study. Furthermore, many patients with orofacial pain including dental pain are known to suffer from insomnia.[26] Therefore, dental pain should not be considered in isolation. Preventive and treatment approaches for reducing dental pain have positive effects on general health condition.

Some limitations have to be considered in a discussion about the results of this study. First, there is possibility of temporal relationship between dental pain and tooth loss with HRQOL because this study was cross-sectional survey. Second, this study was conducted by using self-reported questionnaires to report some data such as EQ-5D and dental pain. Third, self-reported dental pain was particularly subjective experience, and the duration and severity of dental pain were not known.

5. Conclusions

In conclusion, subjects with tooth loss and dental pain appear to have a greater risk of deterioration in their HRQOL than those who simply have tooth loss or dental pain. Dental pain compared with tooth loss has a strong association with HRQOL.

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