Saudi Dental Journal (2020) **32**, 382–389

King Saud University

Saudi Dental Journal

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ORIGINAL ARTICLE

Dental Caries Experience and Oral Health Related Quality of Life in Working Adults

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Received 20 August 2019; revised 10 November 2019; accepted 11 November 2019
Available online 20 November 2019

KEYWORDS

Quality of Life;
Working Adults;
Dental Public Health;
Dental Caries;
DMFS

Abstract *Objective:* To evaluate effect of dental caries experience and untreated dental decay on Oral Health-Related Quality of Life (OHRQoL) in working adults.

Methods: The clinical records of 160 patients were reviewed. Dental health indicators were derived from individual tooth- and surface-level data allowing for calculating the number of decayed surfaces (D), number of decayed missed filled surfaces (DMFS), and significant caries (SiC) indices. A questionnaire was administered to verify demographic factors and OHRQoL. The questionnaire was administered via face-to-face interview, for patients in the hospital; or via telephone interview, for those who could not complete it during their hospital visit. Models were developed using multivariable linear regression to predict total OHIP-14 scores and examine the simultaneous association of independent and outcome variables. The model was adjusted for age, gender, and nationality..

Results: Physical limitation and psychological discomfort were the most frequent impacted domains, affecting 17.1% and 7.5% of subjects, respectively. Painful aching was the most frequent item to have any impact, affecting 64.4% of the subjects. The results of multivariable analysis indicated that the SiC score could statistically significantly predict the Oral Health Impact Profile (OHIP) score, $P = 0.0003$. In the linear regression model, for participants with DMFS equal to or higher than the SiC, on average, OHIP scores were almost 10 points higher than for participants with DMFS below the SiC.

Conclusion: The more the dental decay the higher the impact on OHRQoL. From a dental public health perspective, using OHRQoL as a need assessment tool, along with dental clinical indicator, can be helpful in planning and targeting public health programs for the most in-need adult populations.

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

https://doi.org/10.1016/j.sdentj.2019.11.003

Clinical Significance: This study identified that patients with severe dental caries report poorer OHRQoL. Clinicians should be aware of impacts that dental decay may have on OHRQoL, including physical, psychological concerns, and pain.

1. Introduction

Oral diseases such as dental decay, periodontitis, and gingivitis are estimated to affect 3.47 billion people worldwide and are the most common non-fatal cause for disability (Charlson et al., 2018). Equally important to objective methods of oral health assessment completed by dentists is the patient subjective evaluation of his or her treatment needs and clinical outcome (Allen, 2003; Sischo and Broder, 2011). The theory of oral health-related quality of life (OHRQoL) adopts patient-centered outcome instruments to quantify the impact of oral health on daily activities in terms of a patient's social, psychological, and functional well-being (Locker and Allen, 2007). Historically, several psychometric tools have been established to evaluate OHRQoL. The Oral Health Impact Profile (OHIP) is commonly used to quantify OHRQoL (Allen, 2003). The OHIP-14 includes 14 items, which are founded on Locker's theoretical model for measuring oral health (Allen, 2003; Locker, 1988; Slade, 1997). These components represent the consequences of oral diseases and the harmful effect they have on OHRQoL. The validity and reliability of OHIP-14 have been shown in many studies, and the instrument has been translated into several languages, including Russian (Al Habashneh et al., 2012).

Researchers reported that young adults have lower OHRQoL than older adults, although oral diseases increase with age (Dahl et al., 2011; Sanders et al., 2009; Slade and Sanders, 2011). The factors that impact self-reported oral health are not well understood, but it has been suggested that oral diseases have a negative impact on self-reported oral health, and that this impact is worse at younger ages (Slade and Sanders, 2011). Several researchers evaluated OHRQoL in young adult subjects in Australia (Brennan and Spencer, 2009), Tanzania (Masalu and Astrøm, 2002), Japan (Yamane-Takeuchi et al., 2016), Malaysia (Masood et al., 2013), Sweden (Oscarson et al., 2007), Korea (Choi et al., 2015), and Saudi Arabia (Bahammam and Fareed, 2019). To summarize, OHRQoL in young adults was affected by education (Masalu and Astrøm, 2002; Masood et al., 2013), negative life experience (Brennan and Spencer, 2009), pain (Yamane-Takeuchi et al., 2016), and self-reported oral health (Masalu and Astrøm, 2002; Yamane-Takeuchi et al., 2016). The impact of clinical conditions (e.g., dental decay, edentulism, and periodontitis) on OHRQoL is inconsistent, with some researchers reporting no association (Lu et al., 2014; Oscarson et al., 2007) and other researchers reporting that poor clinically assessed oral health is associated with inferior OHRQoL (Choi et al., 2015; Masalu and Astrøm, 2002; Yamane-Takeuchi et al., 2016).

Many studies were conducted in Saudi Arabia to quantify the impact of malocclusion, general anesthesia, periodontitis, complete denture, full mouth rehabilitation, previous dental experience, and fear among children and guardians of autistic children on OHRQoL (AlBaker, 2013; Alghamdi et al., 2017; Baghdadi and Muhajarine, 2015; Baghdadi, 2014; Bahammam and Fareed, 2019; Dawoodbhoy et al., 2013; El-Meligy et al., 2016; Hassan and Amin, 2010; Merdad and El-Housseiny, 2017; Pani et al., 2013), but no study has been conducted to address the effect of dental decay or caries experience on the OHRQoL of adults in Saudi Arabia.

Good health, including oral health, enhances quality of life, which in turn empowers people to participate in all activities, improves workforce productivity, and increases the capacity for learning. Therefore, the aim of this study was to evaluate the effect of dental caries experience and untreated dental decay on OHRQoL in working adults

2. Methods

2.1. Study design

This is a cross-sectional study in which subjects were clinically examined to calculate their dental caries experience, and then subjects completed the OHIP-14 questionnaire, to quantify OHRQoL.

2.2. Setting

This study was conducted in a dental teaching hospital in Makkah city, Saudi Arabia. The study was conducted between November 2018 and April 2019.

2.3. Participants

This was a convenience sample of patients visiting the dental teaching hospital. However, patients were selected if they had at least 20 teeth and were from 18 to 60 years of age.

2.4. Variables

The OHRQoL (the outcome) was evaluated using the Arabic OHIP-14 or English OHIP-14 version for non-Arabic subjects. OHIP-14 was calculated by summing responses over all 14 items, ranging from 0 to 56, and was used as an indication for the severity of the impact on OHRQoL—the higher the score the more the negative impact.

Dental health indicators (predictors) were derived from individual tooth- and surface-level data allowing for calculating number of decayed surfaces (D), number of decayed missed filled surfaces (DMFS), and significant caries (SiC) indices.

2.5. Data sources and measurement

A questionnaire was administered to verify demographic factors (i.e., age, gender, and nationality) and to quantify

OHRQoL. The questionnaire was administered via face-to-face interview for patients in the hospital, or via telephone interview for those who could not complete it during their visit to the hospital. For each of the 14 items in the OHIP-14, responses were coded as "never = 0", "hardly ever = 1", "occasionally = 2", "fairly often = 3", and "very often = 4". Both interviews, face-to-face and telephone, were done using a script developed for the study. The face-to-face interviews were done by the examining dentist, whereas the telephone interviews were done by the principal investigator.

At the dental teaching hospital, during the registration process, each patient receives a full comprehensive dental examination by a trained dentist using a dental mirror, explorer, and orthopantomogram (OPG) radiographs. To overcome any uncertainties, bitewing radiographs are taken as needed. Full-mouth examinations include examination of all teeth and surfaces for decayed, missing, and filled teeth, or pulpal involvement. The examinations also included an assessment of pain, swelling, abscess, and oral pathology. The principal investigator reviewed the dental clinical records of 160 patients to calculate SiC, DMFS, and D. The SiC, the primary predictor in this study, was calculated by selecting the one third of the sample with the highest caries score; then, the mean DMFS for this subgroup constituted the SiC index value (Bratthall, 2000).

2.6. Bias

DMF indices have an intrinsic disadvantage related to the 'M' factor of the index used. Subjects may not be able to recall whether the missing teeth or portions of teeth resulted from dental decay or another reason such as a broken filling. This is called recall bias, and it can make the results unreliable (Broadbent and Thomson, 2005). To account for this potential bias, sub-analyses were conducted using the decayed (D) component of the DMFS and by calculating the SiC from D scores only. These new variables were then used as primary predictors in two separate linear regression models.

To reduce information bias, an interview script was developed, and all interviewers followed the script during the interviews.

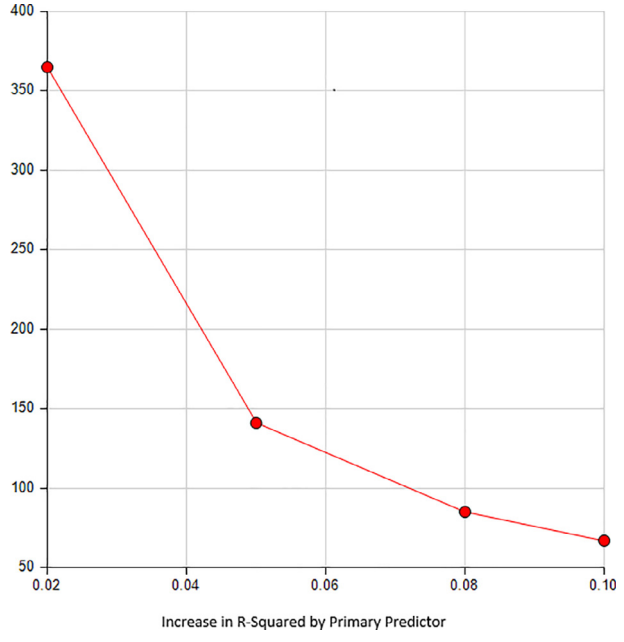

Fig. 1 Sample size and power analysis (Power = 0.9, Alpha = 0.05).

2.7. Study size

A sample size of 85 participants achieves 90% power to detect an R-squared value of 0.08 attributed to one independent variable using an F test with a significance level (alpha) of 0.05. The variables tested are adjusted for an additional six independent variables with an R-squared value of 0.29 (Fig. 1) (Cohen, 1988).

2.8. Statistical methods

The demographic characteristics and OHRQoL profiles were summarized using descriptive statistics. For inferential statistics, a model was developed using multivariable linear regression to predict total OHIP-14 scores and examine the simultaneous association of independent and outcome variables. The model was adjusted for age, gender, and nationality. To determine which additional variables to be adjusted for, the purposeful selection method was used (Bursac et al., 2008). All statistics were computed using STATA software (version14.1; Stata, College Station, TX). All statistical tests were two-tailed and interpreted at the 0.05 significance level.

2.9. Ethical considerations

The study protocol was approved by the institutional review board (IRB). All patients signed a consent during the registration procedure stating that their unidentified information can be used for research purposes. Consequently, patients' national ID, name, dental record number, and date of birth were removed, producing unidentified and untraceable data.

3. Results

Of the 160 records reviewed, 146 were included in final analyses and 14 were excluded due to missing data. Of these records, 85% were below the SiC. The mean participant age was 31.7 (SD ± 14.3) years; the mean age for the below the SiC group was 29.3 years, whereas it was 46 years for the equal to or above the SiC group. Females constituted 51% of the subjects, and 42% were Saudis (Table 1).

The overall mean of OHIP score was 12.7 points (SD ± 10.5); the mean OHIP score for the below SiC group was 11.3 points, whereas it was 21.1 points for the equal to or above SiC group. For those with a history of previous extraction, the mean OHIP score was 14.9 points (SD ± 11.1). For those for whom the chief complaint was pain, the mean OHIP score was 15.3 points (SD ± 11.6). For those for whom the chief complaint was to restore their teeth, the mean OHIP score was 12.4 points (SD ± 9.6) (Table 1).

The overall OHIP score ranged from 0 to 50 point(s). Physical limitation and psychological discomfort were the most

Table 1 Participant characteristics.

Categorical Variables	OHIP score		Age	
	Mean	SD	Mean	SD
Significant Caries Index (SiC)				
Below SiC (85%)	11.3	10.1	29.3	12.8
Equal or above SiC (14%)	21.1	9.2	46	14.8
Gender				
Female (51%)	12.9	10.6	29.7	12.8
Male (48%)	12.5	10.4	33.9	15.5
Nationality				
Not Saudi (57%)	11.6	9.3	31	12.9
Saudi (42%)	14.1	11.8	32.7	16.1
Chief Complaint				
Pain (35%)	15.3	11.6	30.8	12.4
Restorative or Prosthetic (54%)	12.4	9.6	33.5	15.5
Other (9%)	4.5	6.2	24.9	12.2
Past Extraction				
No (43%)	9.8	8.9	25.3	9.9
Yes (56%)	14.9	11.1	36.6	15.2
Total (100%)	12.7	10.5	31.7	14.3

Table 2 Oral health impact profile of sample.

Dimension	Item	Never		Hardly ever		Occasionally		Fairly often		Very often	
		n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Functional Limitation	Speaking Problems	88	60.3	27	18.5	13	8.9	15	10.2	3	2.1
	Taste Problems	82	56.2	26	17.8	19	13	12	8.2	7	4.8
Physical Limitation	Painful Aching	52	35.6	21	14.4	39	26.7	27	18.5	7	4.8
	Discomfort when Eating	54	37	22	15.1	26	17.8	26	17.8	18	12.3
Psychological Discomfort	Anxious	67	45.8	27	18.5	29	19.9	16	11	7	4.8
	Tense	68	46.7	30	20.5	34	23.3	10	6.8	4	2.7
Physical Disability	Unsatisfactory Diet	87	59.6	26	17.8	17	11.6	14	9.6	2	1.4
	Interrupted Meals	92	63	20	13.7	20	13.7	12	8.2	2	1.4
Psychological Disability	Difficult to Relax	63	43.2	35	23.9	32	21.9	14	9.6	2	1.4
	Embarrassed	63	43.2	30	20.5	29	19.9	19	13	5	3.4
Social Disability	Irritable with People	76	52.1	40	27.4	16	11	10	6.8	4	2.7
	Difficulty in Daily Activities	95	65.1	28	19.1	14	9.6	7	4.8	2	1.4
Handicap	Less Satisfying Life	101	69.2	18	12.3	15	10.3	10	6.8	2	1.4
	Unable to Function	114	78.08	17	11.64	7	4.8	7	4.8	1	0.68

Table 3 Results from multivariable linear regression with SiC as dependent variable.

Predictor	Coefficient	SE	P-value	95% C.I.
Significant Caries index				
Below SiC (reference)				
Equal or higher than SiC	9.97	3.25	0.0031	(3.49–16.45)
Chief Complaint				
Cosmetic (reference)				
Pain	9.57	4.34	0.0310	(0.9–18.23)
Restorative or prosthesis	10.51	4.10	0.0126	(2.33–18.7)

Results are adjusted for age, gender, nationality, history of previous extraction, and history of orthodontic treatment.

frequently impacted domains, affecting 17.1% and 7.5% of subjects, respectively. Painful aching was the most frequent item to have any impact, affecting 64.4% of the subjects; whereas an inability to perform daily tasks was the least frequent item to have any impact, affecting 21.9% of the subjects (Table 2).

The results of multivariable analysis investigating the simultaneous association between OHIP score (as a dependent variable) and SiC index (as a primary predictor) while adjusting for age, gender, nationality, type of chief complaint, history of previous extraction, and history of orthodontic treatment are summarized in Table 3. In this linear regression model, it was estimated that the SiC score could statistically significantly predict the OHIP score, P = 0.0003.

In the linear regression model, for participants with DMFS equal to or higher than the SiC index, on average, OHIP scores were almost 10 points higher than for participants with a DMFS less than the SiC index while adjusting for age, gender, nationality, type of chief complaint, history of previous extraction, and history of orthodontic treatment (Table 3).

4. Discussion

4.1. Main findings

On average, the OHIP scores were almost 10 points higher for participants with DMFS equal or higher than SiC index value compared with those with DMFS less than SiC. Physical limitation and psychological discomfort were the most frequently impacted domains, affecting 17.1% and 7.5% of subjects, respectively. Painful aching was the most frequent item to have any impact, affecting 64.4% of the subjects.

4.2. Data interpretations and comparisons with previous studies

The severity (average OHIP-14 score) of low OHRQoL in subjects in the present study (12.7) is similar to that reported in an Indian study (13.4) (Acharya and Sangam, 2008) and in Spanish adults (11) (Montero-Martin et al., 2009). On the contrary, a Greek study found a mean OHIP-14 score of 15 in adults (Papagiannopoulou et al., 2012), whereas a Hong Kong study reported a mean OHIP-14 score of 6.3 in young adults (Lu et al., 2014). Direct comparison of the aforementioned findings with this study must be done with care. Assessment of quality of life, as well as OHRQoL, depends on subject's prospects and experience, which differ according to socioeconomic, social, demographic, psychological, and other cultural factors (Carr et al., 2001). Therefore, a subject with poor oral health and poor expectations may not see himself or herself to have poor OHRQoL and may consequently report themselves as being satisfied. On the other hand, subjects who have excellent oral health and high expectations may report low OHRQoL and describe themselves as being disappointed (Carr et al., 2001; Locker and Gibson, 2005). For instance, in this study, nationality was significantly related to OHIP-14 score. Saudi participants, on average, reported higher OHIP scores compared with non-Saudi participants.

Nonetheless, in the current study, the biggest driver of low OHRQoL was the OHIP-14 dimension of physical pain, which is in agreement with all the previously mentioned studies and others (Acharya and Sangam, 2008; Batista et al., 2014; Dahl et al., 2011; Lu et al., 2014; Montero-Martin et al., 2009; Papagiannopoulou et al., 2012). Consequently, it may be assumed that a similar pattern of OHRQoL occurs in adults across different nations.

Regarding the main predictor, clinical caries experience, it was found that subjects with high DMFT/DMFS scores believed that they truly had poor OHRQoL. In contrast, a Chinese study (Lu et al., 2014), and a Swedish study (Oscarson et al., 2007), did not find any association between dental caries (DMFT) and OHRQoL. Nevertheless, these findings were in line with those of other studies (Batista et al., 2014; Masalu and Astrøm, 2002; Yamane-Takeuchi et al., 2016). Currently, the mechanism of the association between OHRQoL and dental caries experience is unknown (Yamane-Takeuchi et al., 2016). However, since that physical pain was the most frequently reported dimension of OHIO-14 and the mean DMFT of 12.4, it may be safe to assume that dental caries in this study was probably associated with oral/-dental pain. Dental health professionals and public health programs should target their efforts toward prevention to decrease dental/oral pain and DMFT and improve OHRQoL.

Using SiC can provide better results when used with skewed caries distribution; but, if used alone, it can lead to lack of information about a significant segment of the population (Campus et al., 2003). In an effort to address this concern, several sub-analyses were conducted to probe the robustness of the results to potential under representation of the studied sample. In separate regression, the linear regression model was re-fitted with the DMFS scores as the primary predictor (model 1 in Table 4). However, the results did not vary in any way that altered the interpretation of the impact of dental decay on OHRQoL.

In several studies including a systematic review, tooth loss was found to significantly impact OHRQoL (Gerritsen et al., 2010; Sanders et al., 2009; Steele et al., 2004). In addition, DMF indices have an inherent drawback related to the 'M' component of the index used. Participants may not be able to recall whether the missing tooth or portion of tooth was due to dental decay or another reason such as a large broken filling, which is called recall bias (Broadbent and Thomson, 2005). Therefore, to address these potential biases, sub-analyses were conducted using the decayed (D) component of DMFS (model 2 in Table 4), and the SiC was calculated from D scores only (model 3 in Table 4). These new variables were used as primary predictors in two separate linear regression models. Nevertheless, the findings from these models did not alter the interpretations of previously mentioned models in this study (Table 4).

In this study, it was found that dental decay affected OHRQoL. On the contrary, Dahl and her colleagues reported that decayed teeth did not have an impact on OHRQoL (Dahl et al., 2011). This could be due to three reasons. First, the mean age of the sample of Dahl's study was 72.1 years compared to the mean age in this study of 31.7 years. Second, a very high portion of the sample in Dahl's study had less than 20 teeth (45%). Third, since dental decay is related to low education, the majority of the sample in Dahl's study had a high school education or less (83%); therefore, this might have decreased the variability in dental caries experience, leading to having no impact on OHRQoL in Dahl's study. On the other hand, findings from

Table 4 Sensitivity Analyses, all models adjusted for age, gender, and nationality.

Model No.	Primary	1	2	3	4
Outcome	Mean OHIP	Mean OHIP	Mean OHIP	Mean OHIP	Categorical OHIP
Predictor	DMFS_SiC	DMFS	D	D_SiC	DMFS_SiC
Coefficient	9.972	0.134	0.191	7.704	4.41*
P-value	0.003	0.01	0.015	0.015	0.009

* This is odds ratio from logistic regression.

this study concur with the findings of Batista and her colleagues (Batista et al., 2014).

Several instruments have been developed and validated to measure dental disease burden on OHRQoL. The Oral Health Impact Profile (OHIP) is one of the most popular instruments for measuring OHRQoL (Locker, 1995; Slade and Spencer, 1994). The OHIP has two validated versions, OHIP-49 and OHIP-14. The OHIP-14 was developed to quantify people's perceptions of the social impact of dental diseases on their well-being (Slade, 1997). The Arabic version of the OHIP-14 was validated in Jordan (Al Habashneh et al., 2012).

There is an argument that measuring quality of life in terms of mean scores is insufficient because they are meaningless and difficult to interpret without a meaningful benchmark. To standardize reporting and interpreting patient-based outcome measures, including quality of life measures, Tsakos et al. recommended using more than one method to analyze patient-based outcome measures (Tsakos et al., 2012). Following this recommendation, in the present study, a categorical outcome was created. The outcome was a yes/no indicator that coded as follows: fairly often and very often = yes; otherwise = no. A logistic regression model was fitted with the categorical outcome and SiC as primary predictor while adjusting for age, gender, and nationality. Additional variables were included using purposeful selection (Bursac et al., 2008). The findings agreed with the linear regression model, for participants with DMFS equal to or higher than the SiC index, on average, and the odds of having severe impact on OHIP scores were four times higher than for participants with DMFS less than the SiC index (OR = 4.41; P-value = 0.009), while adjusting for age, gender, and nationality (model 4 in Table 4).

4.3. Limitations of the study

Because of the cross-sectional study design, causal relationships in the association between the studied variables and OHRQoL cannot be determined. Only a convenience sample of subjects visiting the dental teaching hospital participated in the study, which limits the generalizability of the findings from the present study. Since dental care in the dental teaching hospital is offered free of charge, the dental caries experience may be overestimated due to the fact that most of the patients are from a low socio-economic background.

5. Conclusion

Dental decay affects the quality of life in adults. The more the dental decay, the higher the impact on OHRQoL. From dental public health perspective, using OHRQoL as an assessment tool, along with a dental clinical indicator, can be helpful in planning and targeting public health programs for the most in-need adult population. This can be critical for oral health care policy and have important implications for research. Dental health professionals and public health programs should target their efforts toward prevention to decrease dental/oral pain and DMFT and improve OHRQoL.

Statement of contribution

O.B. contributed to the design and implementation of the research, to the analysis of the results, and to the writing of the manuscript.

Ethical statement

The work described in this article have been carried out in accordance with *The Code of Ethics of the World Medical Association (Declaration of Helsinki)*.

CRediT authorship contribution statement

Omair M. Bukhari: Conceptualization, Data curation, Methodology, Project administration, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Many thanks to the dental records unit at UquDent.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2019.11.003.

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