Comparison of Oral Health-Related Quality of Life in Partial and Complete Denture Wearers: A Propensity Score Analysis

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Abstract

Background: Dentures, both partial and complete, have been shown to have the same impact on one's quality of life. Due to the impossibility of randomization in these studies, they are prone to selection bias. This study aimed to compare the effect of partial and complete dentures on oral health-related quality of life (OHRQoL) by propensity score to overcome selection bias.

Methods: This is a cross-sectional descriptive-analytic study. A total of 1376 people participated in this study. Age, sex, marital status, education level, smoking, smoking opium and its derivatives, and dental visit was collected by a checklist. OHRQoL was measured by the OHIP-14 questionnaire. The generalized boosted model was used to estimate the propensity score. Missing data were imputed using multiple imputations with mixed models. The assumptions of multivariable regression analysis and propensity score method were first examined, and then the quality of life related to oral health was compared between the two groups.

Results: The regression model's assumptions were not verified due to high skewness and collinearity. The results of the normality test ($P < 0.001$) and goodness fit test ($P < 0.001$) revealed that the regression model did not fit the data. The propensity score method reduced at least 76% of the bias resulting from the distribution difference between the confounding variables and was used for analysis. In the regression and propensity score method, the results showed that the total OHIP-14 score of the complete prosthesis group was higher than the partial prosthesis group at 3.92 (95% CI = (2.18,5.65)) and 3.64 (95% CI = (1.93,4.53)), respectively. This difference was clinically and statistically significant ($P < 0.001$). In addition, there is a significant difference in the two groups based on propensity in all seven areas ($P < 0.001$). But there is no significant difference in the regression adjustment of the Functional limitation of the two groups ($P = 0.035$).

Conclusion: The propensity score has fewer assumptions than the regression method and may be more reliable for OHIP scores. The propensity score analysis revealed that despite the costs and repair issues associated with partial dentures, complete denture wearers have lower OHRQoL than partial denture wearers.

Keywords: Oral health-related quality of life, Partial dentures, Complete dentures, Propensity score

Introduction

Untreated decayed teeth are a significant cause of tooth loss and are the most common disease in the world (1).

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↑What is "already known" in this topic:
There are few studies that partial and complete dentures impact on oral health-related quality of life (OHRQoL). Because, these studies are prone to selection bias due to the impossibility of randomization. Regression analysis has been commonly used to control for confounding variables in these studies, but it relies on strong assumptions and may not be suitable for highly skewed and collinear data.

→What this article adds:
This study adds to the existing literature by comparing the effect of partial and complete dentures on OHRQoL using propensity score analysis, which is less reliant on assumptions and more suitable for highly skewed and collinear data. The results suggest that complete denture wearers have lower OHRQoL than partial denture wearers, despite the costs and repair issues associated with partial dentures. The study highlights the importance of using appropriate statistical methods to control for confounding variables in studies of OHRQoL.

There are strong pieces of evidence that socioeconomic factor is a significant factor in tooth extraction (2). Dentures and dental implants are treatments for missing natural teeth. There is strong evidence that denture type affects the lip force, maximum bit force, and masticatory performance (3, 4).

There is a piece of evidence that indicates the complete and partial denture wearer's satisfaction and quality of life are not different (3). Studies on the OHRQoL in people using complete or partial teeth are observational, and most of them measured the clinical efficacy of the treatments rather than effectiveness (3, 4). The propensity score method is a powerful method to modify and eliminate the confounding effect of variables in observational studies. In the absence of unmeasured confounder variables, the measured effect by propensity score method is marginal in a randomized clinical trial (5). In addition, the performance of propensity score-based can be measured (6). These features have led to the superiority of this method over regression methods.

Oral health-related quality of life(OHRQoL), as a well-known outcome of the prosthesis fabrication of clinical research, is defined as the effect of oral conditions on physical health, social life, and positive feelings about oral and facial conditions (7). OHRQoL of people using partial and complete dentures is associated with their oral health (8). It is also associated with age, the number of teeth left, anterior tooth replacement, and denture arch placement (9). The patient's OHRQoL that is treated by a partial or complete denture, is significantly affected by the patient's educational level, socio-economic status, medical conditions, and smoking habits (10). People's satisfaction with dentures is also related to denture quality (11).

This study aimed to compare the OHRQoL of individuals with partial and complete dentures and estimate the population-average effect of using partial and complete dentures on OHRQoL.

Methods

This study is a cross-sectional descriptive-analytic study. It was a part of the Kerman Coronary Artery Disease Risk Factors study. In the study's first phase, a cluster sample was selected from four sections based on the map (250 city codes were randomly selected from each section). By sending an invitation letter to cooperate through the postal code, 6000 people participated in the first phase of the Kerman Heart Cohort. During the second phase, from 2014 to 2019, another 4000 people added to the study. The sample of this study was the participants in the Kerman Coronary Artery Disease Risk Factors study who used complete or partial teeth. All Kerman residents at the time of the Kerman Cohort Study were qualified to take part in the investigation. People who refused to participate in the research were not included. A total of 1376 people participated in this study.

This study was conducted as a research project. The Ethical Review Board approved the study's protocol of Kerman University of Medical Sciences under the code (IR.KMU.REC.1399.647). The research process and its objectives were explained to the participants, and the written informed consent was signed by the subject. The questionnaires were anonymous, and the subjects were assured about the confidentiality of the data.

The data was collected with questionnaires of the study in two parts. The first part deals with demographic information and the personal characteristics of individuals. The demographic variable was age, sex, marital status, education level, smoking, smoking opium and its derivatives, and dental visit.

The second part of the questionnaire was the Persian version of the OHIP-14 questionnaire. This questionnaire measures the OHRQoL in seven areas: functional limitation, physical pain, psychological discomfort, social disability, psychological disability, physical disability, and handicap. The validity of the OHIP-14 questionnaire led to Cronbach's alpha of 0.85, and the reliability was calculated by the test-retest method, which led to an ICC coefficient of 0.88 (12). The answers are scored 0 to 4 for each question. The score of each domain is obtained from the sum of the question's domain. The higher scores indicate the lower OHRQoL.

Multiple regression methods and propensity score matching methods for data analysis were nominated. Before using any method, its assumptions and goodness were examined. The goodness fit test and Shapiro-Wilks method were used to assess the regression method. Although the multiple regression model did not fit well, its results are presented here for comparison.

The generalized boosted model was recommended for propensity score estimation. Generalized boosted models are based on the combination of a large number of models that have weak predictive power. In this method, the error of the model at each step is modeled and added to the new model to the model of the previous step (13). In this study, the propensity score of participants is estimated based on the variables of age, sex, marital status, level of education, smoking, smoking opium and its derivatives, and dental visit, then matched according to the nearest propensity score method without replacement.

In order to evaluate the matching performance, the standardized bias (SB), and the percentage of bias reduction (PBR) are calculated (14). The one-to-one nearest neighborhood matching algorithm with a caliper (0.25×standard deviation of propensity scores) is used to match participants with a complete denture to the participants with a partial denture (14). For more robustness of the results, the bootstrapped method is used to obtain the 95 percent confidence intervals (95%CI) for the difference in scores obtained. All calculations are performed using R software and Twang and gbm R's package.

Three variables of age, opium use, and dental visits had missing data. The number of missing data for a dental visit last year, age, and opium consumption status were 82, 1, and 1, respectively. To estimate the effect of treatment by regression and propensity score model, thousands of data sets were created using multiple imputation methods. Models were fitted to each of these thousands of data sets.

The Wilcoxon test is used to test the quality of life score of match groups. In addition, the quality of life score of the two groups was compared with Wald's test and confi-

dence interval in the multivariable regression model. The significance level was set at 0.05.

Results

A total of 1376 people participated in this study. 74.6% of participants had partial teeth, and 25.4% of people had complete teeth. 59.4% of the participants in the study were female, and 40.6% were male. Their mean age was 59.9 ± 10.86. Most people were married, and their educational level was less than a diploma. The prevalence of current opium consumption among participants was 29.5%, and currently smoking among them was 15.7%. Descriptive statistics of covariates are given in Table 1. The covariate's distribution of complete and partial groups is pre-

Table 1. Distribution of covariates in complete and partial groups

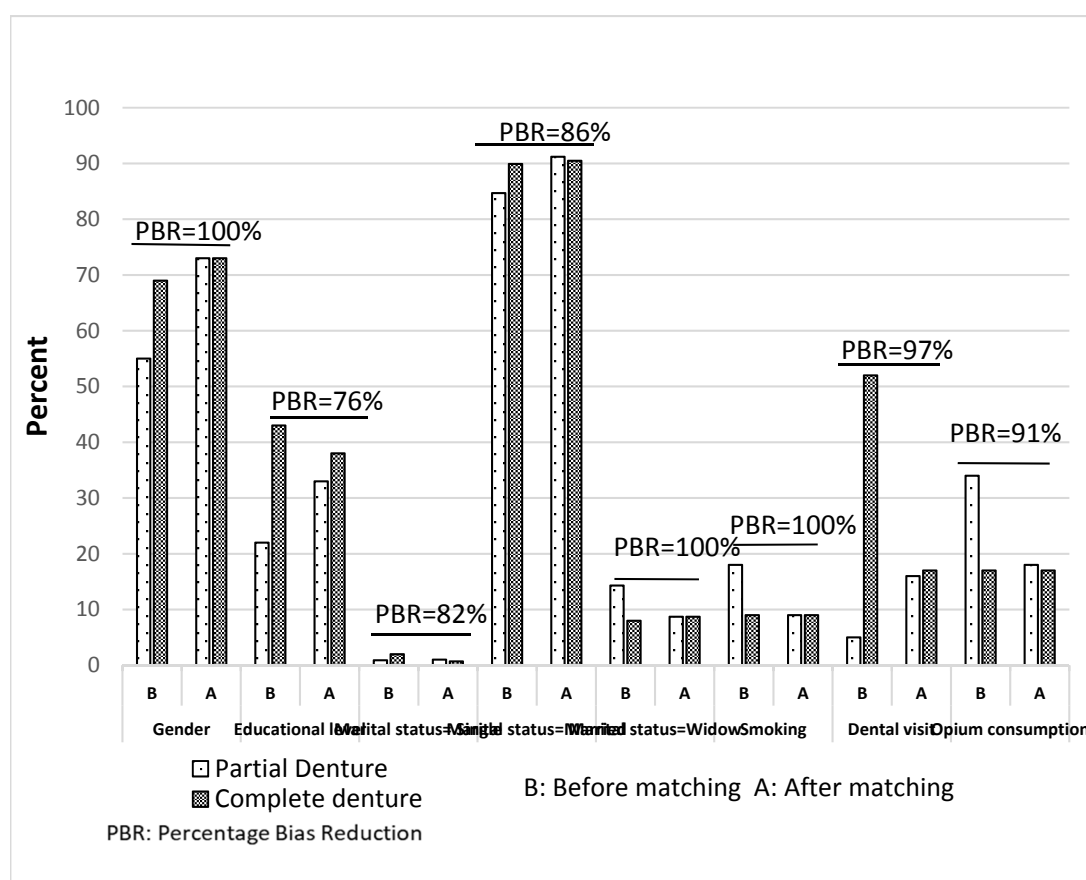| Variable	Partial denture	Complete denture	*P*-value
Gender N (%)			
Men	452 (80.9%)	107 (19.1%)	<0.001
Women	574 (70.3%)	243 (29.7%)	
Education level N (%)			
Below diploma	794 (80.8%)	189 (19.2%)	<0.001
Diploma and above	232 (59%)	161 (41%)	
Marital status N (%)			
Single	9 (50%)	9 (50%)	<0.001
Married	871 (73.7%)	311 (26.3%)	
Widow	146 (83%)	30 (17%)	
Smoking status N (%)			
Yes, I smoke	184 (85.2%)	32 (14.8%)	<0.001
No, I don't smoke	842 (72.6%)	318 (27.4%)	
Dental visit in last year N (%)			
I didn't visit last year	945 (86.9%)	142 (13.1%)	<0.001
I visit last year	51 (24.6%)	156 (75.4%)	
Opium consumption N (%)			
I don't used	679 (70%)	291 (30%)	<0.001
I use or I was ex-user	346 (85.4%)	59 (14.6%)	
Age Mean (Sd)	62.17 (9.7)	53.27 (11.2)	<0.001

Figure 1. Covariate balance performance of propensity score matching method

Table 2. The effect of partial and complete dentures on oral health-related quality of life by propensity score matching analysis and multivariable regression analysis

OHIP-14 Domains	Partial denture	Complete denture	Denture Effect[1] (95%CI)	Denture Effect[2] (95%CI)
	Mean(sd)	Mean(sd)		
Functional limitation	2.98 (1.29)	3.03 (1.34)	0.27 (0.01,0.52)	0.15 (-0.05,0.35)
Physical pain	3.7 (1.88)	4.11 (1.8)	0.64 (0.28,0.99)	0.42 (0.13,0.71)
Psychological discomfort	4.14 (1.67)	4.71 (1.93)	0.69 (0.33,1.05)	0.45 (0.18,0.73)
Social disability	3.11 (1.67)	3.53 (1.94)	0.67 (0.33,1.04)	0.56 (0.28,0.83)
Psychological disability	2.87 (1.37)	3.68 (1.79)	0.80 (0.33,1.02)	0.77 (0.54,0.81)
Physical disability	2.67 (1.17)	3.31 (1.54)	0.59 (0.46,1.12)	0.57 (0.37,0.76)
Handicap	2.41 (1.07)	2.65 (1.22)	0.27 (0.31,0.86)	0.28 (0.12,0.47)
TOTAL SCORE	21.87 (8.13)	24.97 (9.07)	3.92 (2.18,5.65)	3.64 (1.91,4.55)

[1] Effect =Mean of Complete Denture group - Mean of Partial Denture group by propensity score method

[2] Effect =Mean of Complete Denture group - Mean of Partial Denture group by multivariable regression analysis

sented in the comparison of distributions, which shows that all covariates have different distributions across the groups (Table 1).

The OHIP score had a highly right-skewed distribution (Skewness Coefficient= 1.98). The regression model failed to fit the data adequately. The normality test ($P <$ 0.001) and goodness fit test ($P <$ 0.001) showed that the regression model does not fit well with the data ($R^2 =$ 0.067).

The PMS procedure is used to balance the distributions in groups. Finally, 210 match case was constructed based on the sample. Figure 1 represents the performance of the matching procedure except for the age variable. The PBR index revealed that the matching procedure removed biases at least 76 percent, and the distribution of covariates is the same across the match groups. Also, the mean age after matching in the partial and complete denture groups was 56.09 ± 8.7 and 55.22 ± 10.5. The PBR index for age was 89 percent. Therefore, the PMS adjustment procedure has controlled at least 89% of the imbalance between the variables of the two research groups.

In the regression and propensity score method, the results showed that the total OHIP-14 score of the complete prosthesis group was higher than the partial prosthesis group at 3.92 (95% CI = (2.18,5.65)) and 3.64 (95% CI = (1.93,4.53)), respectively. It means that people with complete dentures have lower OHRQol than people with partial dentures. This result is statistically and clinically significant. In addition, there is a significant difference in the two groups based on propensity in all seven areas ($P <$ 0.001). But there is no significant difference in the regression adjustment of the Functional limitation of the two groups ($P = 0.035$) (Table 2).

Discussion

The multiple regression method did not fit because of the OHIP score data skewness. The propensity score matching represented good performance in covariate adjustment. After propensity score matching adjustment, It revealed that the OHRQoL of complete denture wearers was lower than partial denture wearers in all seven domains of the OHIP-14 questionnaire. Complete denture wearers had a lower quality of life than partial denture wearers in the psychological disability, social disability, and psychological discomfort domain. It reveals that discomfort and embarrassment among people using a com-

plete denture are more than among partial denture wearers.

In the oral health quality of life literature, many studies have shown that the questionnaire scores are right-skewed. This issue arises because the coding ranges from 0 to 4 (or 1 to 5), and in some of the questionnaire questions, participants select a choice that leads to the codes 0 and 1. Therefore, the sum of scores is close to zero. This contradicts the assumptions of the normality of the multiple regression model and may lead to inaccurate estimates. This study demonstrated that using trend scores can easily overcome this problem.

This study showed that people with complete dentures have a lower quality of life than people with partial dentures. The Comparison of OHRQoL between partial and complete denture wearers in South Korea on 4250 elderly people by Bae et al. showed that people with complete dentures generally have a lower OHRQoL than people with a partial denture. However, the sample size of their study was considerable, but the questionnaire's total score was not significantly different between the two denture groups (15). This result contradicts the results of our study. They used multiple regression for their analysis and did not adjust the effect of other variables such as age and sex, in their model. In addition, a 49-item questionnaire was used. Therefore, the difference between the results of the two studies can be justified.

A study conducted in different provenance of Iran on people with partial dentures showed that partial denture wearers had low OHRQoL. Physical disability and physical pain had the lowest score, and more than 20% of people have expressed discomfort in eating (16). A similar study in Sudan showed that most functional limitations, and Psychological disabilities and minor problems are related to disabilities and social disabilities (4). However, the study did not have a comparative group. In this study, the lowest quality of life in the two groups was related to psychological disabilities and physical pain. It shows that people with partial and complete dentures had the most problems in these areas.

Our data showed that people with complete dentures had lower quality of life than people with partial denture functional limitation and physical disability domain. In line with our study, a clinical study showed that people with a partial denture had a higher quality of life than complete dentures (10). Also, the study showed that par-

tial denture wearers needed more visits to repair their dentures, and partial denture wearers reported ill-fitting RDPs and inflammation of the oral mucosa complications. Despite higher complications and repairs of the denture, partial denture wearers have higher OHRQoL.

The results indicate that the use of partial and complete dentures depends on the age of individuals. Also, the data showed that age was a confounding factor. Previous literature confirmed that the OHRQoL of denture wearers depends on age (2, 9, 16, 17). The age effect can be explained by the fact that the number of missing teeth increases with age and the chances of using a complete denture increase. Therefore, people of different ages have different expectations of the appearance and function of their teeth. Then it is reasonable that compare a forty-year-old with a complete denture with a forty-year-old with a partial denture.

There is a piece of evidence that indicates that the OHRQoL of denture wearers depends on Oral Health (9). The dental visit variable was considered the indicator of our study's oral health status. However, the dental visit variable depends on oral health and the importance of individuals to oral health. But one can still expect to visit a dentist last year due to oral disease in many cases. The data showed that this variable was a confounding factor.

The patient's education level, smoking, and opium had the confounding effect in this study. The results showed that the distribution of these variables varies according to the type of denture. It showed that the OHRQoL of partial and complete denture wearers is significantly affected by the patient's level of education, socio-economic status, medical conditions, smoking, and smoking habits (9). Therefore, adjustment of these variables has probably led to lower bias.

In our study, the assumptions of the regression model were not met, yet it produced results similar to those obtained with the propensity score method. However, it is important to note that these findings may not be generalizable to other settings. Several studies have demonstrated that neither method is superior when their underlying assumptions are valid. Marten et al. reported that the propensity score method outperformed regression in investigating the impact of blood pressure medications on the risk of a heart attack when the number of confounders was high (18). Similarly, Amoah et al. found that the propensity score method was superior to regression in evaluating the treatment of Gram-negative bloodstream infections (19). Nonetheless, Roberts et al. found that both methods produced comparable effect sizes and significance levels when examining the impact of maintenance treatment on COPD (20).

In this study, the type of partial dentures and their connection to adjacent teeth, and their location were not recorded. It can be expected that if these items are measured, the results of our study will be different. We suggest that the effect of this variable be measured for future studies. It has been shown that the quality of dentures (partial or complete) affects OHRQoL (21). Due to the budget limitation, we could not measure these factors. Therefore, the quality and duration of using dentures are suggested to be

investigated in future studies.

Conclusion

The type of denture is essential in compensating for the effects of missing teeth on the quality of life of people. Despite the results of previous studies, it was shown that with proper control of partial denture selection, users of complete dentures experience a lower quality of life than users of partial dentures.

Ethics Approval and Consent

The research process and its objectives were explained to the participants then the informed consent was signed by the subject or the subject's parents/legally authorized representative before the beginning of the project. The questionnaires were anonymous, and the subjects were reassured about the confidentiality of the data.

Conflict of Interests

The authors declare that they have no competing interests.

References

1. Kassebaum NJ, Smith AGC, Bernabe E, Fleming TD, Reynolds AE, Vos T, et al. Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990-2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. J Dent Res. 2017;96(4):380-7.
2. Saito M, Shimazaki Y, Fukai K, Furuta M, Aida J, Ando Y, et al. Risk factors for tooth loss in adult Japanese dental patients: 8020 Promotion Foundation Study. J Investig Clin Dent. 2019;10(2):e12392.
3. Ha JE, Heo YJ, Jin BH, Paik DI, Bae KH. The impact of the National Denture Service on oral health-related quality of life among poor elders. J Oral Rehabil. 2012;39(8):600-7.
4. Wahbi RH, Elamin EI. Impact of Removable Partial Denture on Quality-of-life of Sudanese Adults in Khartoum State. J Contemp Dent Pract. 2018;19(1):102-8.
5. Austin PC, Lee DS. The concept of the marginally matched subject in propensity-score matched analyses. Pharmacoepidemiol Drug Saf. 2009;18(6):469-82.
6. Hade EM, Lu B. Bias associated with using the estimated propensity score as a regression covariate. Stat Med. 2014;33(1):74-87.
7. Sischo L, Broder HL. Oral health-related quality of life: what, why, how, and future implications. J Dent Res. 2011;90(11):1264-70.
8. Gjengedal H, Berg E, Gronningsaeter AG, Dahl L, Malde MK, Boe OE, et al. The influence of relining or implant retaining existing mandibular dentures on health-related quality of life: a 2-year randomized study of dissatisfied edentulous patients. Int J Prosthodont. 2013;26(1):68-78.
9. De Kok IJ, Cooper LF, Guckes AD, McGraw K, Wright RF, Barrero CJ, et al. Factors Influencing Removable Partial Denture Patient-Reported Outcomes of Quality of Life and Satisfaction: A Systematic Review. J Prosthodont. 2017;26(1):5-18.
10. Celebic A, Persic S, Kovacic I, Bukovic D, Lesic N, Rener-Sitar K. Comparison of Three Prosthodontic Treatment Modalities for Patients with Periodontally Compromised Anterior Mandibular Teeth: A 2-year follow-up study. Acta Stomatol Croat. 2019;53(1):4-16.
11. Stober T, Danner D, Lehmann F, Seche AC, Rammelsberg P, Hassel

AJ. Association between patient satisfaction with complete dentures and oral health-related quality of life: two-year longitudinal assessment. Clin Oral Investig. 2012;16(1):313-8.

12. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997;25(4):284-90.

13. McCaffrey DF, Griffin BA, Almirall D, Slaughter ME, Ramchand R, Burgette LF. A tutorial on propensity score estimation for multiple treatments using generalized boosted models. Stat Med. 2013;32(19):3388-414.

14. Abadie A, Imbens GW. Matching on the Estimated Propensity Score. Econometrica. 2016;84(2):781-807.

15. Bae KH, Kim C, Paik DI, Kim JB. A comparison of oral health related quality of life between complete and partial removable denture-wearing older adults in Korea. J Oral Rehabil. 2006;33(5):317-22.

16. Shaghaghian S, Taghva M, Abduo J, Bagheri R. Oral health-related quality of life of removable partial denture wearers and related factors. J Oral Rehabil. 2015;42(1):40-8.

17. Ali Z, Baker S, Barabari P, Martin N. Efficacy of Removable Partial Denture Treatment: A Retrospective Oral Health-Related Quality of Life Evaluation. Eur J Prosthodont Restor Dent. 2017;25(2):101-7.

18. Martens EP, de Boer A, Pestman WR, Belitser SV, Stricker BH, Klungel OH. Comparing treatment effects after adjustment with multivariable Cox proportional hazards regression and propensity score methods. Pharmacoepidemiol Drug Saf. 2008;17(1):1-8.

19. Amoah J, Stuart EA, Cosgrove SE, Harris AD, Han JH, Lautenbach E, et al. Comparing Propensity Score Methods Versus Traditional Regression Analysis for the Evaluation of Observational Data: A Case Study Evaluating the Treatment of Gram-Negative Bloodstream Infections. Clin Infect Dis. 2020;71(9):e497-e505.

20. Roberts MH, Dalal AA. Clinical and economic outcomes in an observational study of COPD maintenance therapies: multivariable regression versus propensity score matching. Int J Chron Obstruct Pulmon Dis. 2012;7:221-33.

21. Al-Imam H, Ozhayat EB, Benetti AR, Pedersen AM, Gotfredsen K. Oral health-related quality of life and complications after treatment with partial removable dental prosthesis. J Oral Rehabil. 2016;43(1):23-30.