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ORIGINAL ARTICLE

Validation of the Oral Health Screening Questionnaire in Predicting Serious Periodontitis among Adult Filipinos with Type 2 Diabetes Mellitus

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Abstract

Background. Periodontitis affects more than half of patients with diabetes. In resource poor areas in the Philippines, access to routine dental visits may be difficult and thus, a selective approach might be needed to identify those who need dental evaluation and management. An easy-to-administer oral health self-report questionnaire was developed in order to predict serious (moderate to severe) periodontitis.

Objective. The study aims to determine the validity of the Oral Health Screening Questionnaire for Persons with Diabetes (OHSQPD) in estimating the prevalence of serious periodontitis.

Methodology. A cross-sectional criterion-referenced study of 175 participants with T2DM were included in the study. They were asked to answer the questionnaire and then made to undergo a full dental examination to identify the presence and severity of periodontitis. The validity of the questionnaire was assessed by determining the sensitivity, specificity, positive predictive value, negative predictive value and area under the receiver-operating curve (AUROC) with the dental examination as the gold standard.

Results. Using the questionnaire, the prevalence of serious periodontitis was 61% (106) based on an optimal cut-off score of ≥12. At this score, the questionnaire yielded a sensitivity of 80.4% and a specificity of 70.6%, with an AUROC of 0.83.

Conclusion. The OHSQPD is a valid tool in detecting serious periodontitis.

Key words: questionnaire, type 2 diabetes mellitus, periodontitis, Filipino, oral health

INTRODUCTION

The estimated global prevalence of diabetes is 8.8%, with the majority living in low to middle income countries.[1] In 2013, the prevalence of diabetes in the Philippines among adults 20 years and above was at 5.4% and is increasing.[2] Persons with diabetes are predisposed to chronic infections and inflammation of the oral tissues, including periodontal diseases, which cause substantial oral functional disability.[3] Periodontitis has been considered as the sixth complication of diabetes.[4] It is a complex disease with numerous causal risk factors (including diabetes), characterized by the loss of connective tissues within the periodontium and the destruction of alveolar bone support.[5]

Recently, much has been published about periodontitis and its relationship with diabetes and vice-versa. In diabetes, the production of advanced glycated end-products (AGEs), which activate host cells such as monocytes/macrophages and endothelial cells, may lead to the release of pro-inflammatory cytokines and proteases which damage the gingival tissues and cause resorption of alveolar bone.[6] Studies have identified that the risk of periodontitis was 3 to 4 times higher in people with diabetes.[5,7] Susceptibility to periodontitis is increased with poor glycemic control and more severe forms of periodontitis are observed in those with poorly controlled diabetes.[5,8,9] The prevalence of periodontitis among Filipinos with type 2 diabetes mellitus (T2DM), 35 years old and above is observed to be as high as 68-94%.[10,11]

There is convincing evidence that there is a bidirectional association between periodontitis and diabetes.[6,7] Diabetes and periodontal disease share a common pathway in inflammation resulting in increased levels of

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inflammatory mediators that can further increase insulin resistance.[12] Periodontal infection increases systemic inflammation by contributing to the cycle of hyperglycemia and AGEs binding accumulation thus the tendency for increasing the risk of developing diabetes or further increasing glycated hemoglobin (A1c) levels.[7] An improvement in glycemic control has been shown with early detection and treatment of periodontitis in both controlled and uncontrolled diabetes.[13-16]

Although prevalent, periodontitis is generally hidden, thus there is a need for routine oral evaluation in persons with diabetes.[7] While local and international guidelines recommend routine clinical screening and early referrals to dentistry, oral health awareness is lacking in the Philippines.[17] There is also a lack of access to public health care and the majority pay a larger out-of-pocket share.[1] Persons with diabetes have a higher utilization of dental procedures and may benefit from increased frequency of prophylactic services.[18] However, they are hesitant to see the dentist and probable reasons for not consulting is the cost of dental treatment as medications alone account for much of the patient's budget.[17] Thus, there is a need to develop strategies to promote prevention and control of periodontitis in settings were income is limited.

Untreated serious periodontitis (moderate to severe periodontitis) is associated with tooth loss and progression of pocket depths.[19] In those who underwent periodontal treatment, an initial pocket probe depth (PPD) range of 4-6 mm was a risk factor for tooth loss.[20,21] It is also recognized that due to untreated or inadequately controlled serious periodontitis, the systemic inflammatory burden may also be increased.[22]

The Centers for Disease Control and Prevention (CDC) in collaboration with the American Academy of Periodontology (AAP) has formulated self-report questionnaires that appear to be promising in predicting the prevalence and severity of periodontitis among the adult population.[23-25] These validated self-reported oral health questions were translated into Filipino and together with other relevant oral health, medical and demographic variables; multivariate logistic regression analyses were done to determine predictors of serious periodontitis.[11] Predictors of serious periodontitis among adult Filipinos with diabetes were low education status, tooth loss >6, poor gum health, history of loose teeth and poor tooth appearance. With these, revised questions in English as well a Filipino version and a scoring system predictive for serious periodontitis were formulated.

Currently, this questionnaire has not been validated and there are no other validated clinical oral health screening questionnaires available locally. The validation of such a questionnaire would be useful in our setting in which resources are limited and thus would lessen the costs of screening. This paper aims to do the following:

1. To determine the validity of the Oral Health Screening Questionnaire for Persons with Diabetes in estimating the prevalence of serious periodontitis.
2. To compute the cut off value for the Oral Health Screening Questionnaire for Persons with Diabetes that is most predictive for serious periodontitis using a receiver operator curve (ROC).

METHODOLOGY

Design/Setting

This is a cross-sectional criterion referenced study that was conducted at the tertiary outpatient clinics of the University of the Philippines - Philippine General Hospital (UP-PGH). The study was reviewed by the University of the Philippines Manila Research Ethics Board (UPMREB) Panel prior to commencement. The study participants were recruited consecutively from September 2015 – January 2016.

Study sample

Using Epi Info version 7, the minimum sample size requirement was estimated to be at least 138 based on an estimated sensitivity of 90% (unpublished data) by Lo et al., alpha (α) = 5%, and a margin of error = 5%.[11] The computed 138 minimum sample size was increased to 173 accounting for possible 20% non-response.

Selection Criteria

Inclusion Criteria
1. Adult (Age ≥35 years) Filipino diagnosed with type 2 diabetes mellitus for at least 1 year. Diagnosis of type 2 diabetes was based on the American Diabetes Association criteria as follows:[26]
    *   Fasting Blood Sugar (FBS) ≥126 mg/dl on 2 determinations;
    *   Symptoms of hyperglycemia and Random Blood Sugar (RBS) ≥200 mg/dl;
    *   2-hour plasma glucose ≥200 mg/dl after a 75 grams Oral Glucose Tolerance Test (OGTT);
    *   Standardized A1c ≥6.5%
2. Dentulous persons with ≥6 teeth present
3. Recent A1c result done within the past 3 months
4. Able to read, comprehend and respond to the series of questions
5. Willing to undergo a dental examination

Exclusion Criteria
1. Patients with heart murmurs that would require antibiotics prior to dental examination

Withdrawal Criteria
1. Inclusion is voluntary. Withdrawal is allowed should the patient decide to stop participating even if consent was already given.

Materials and Methods

The Oral Health Screening Questionnaire for Persons with Diabetes (OHSQPD) was used in this study (Appendix A). The questionnaire is composed of 5 questions that pertain to (Q1) low education status, (Q2) tooth loss >6, (Q3) poor gum health, (Q4) presence of loose teeth and (Q5) poor tooth appearance and a scoring system designed to predict serious periodontitis (Appendix B). It is self-reported with all questions answerable by YES or NO answers.

Participants included in the study were provided with an overview of the study and once eligibility status was determined, they were given the written informed consent and contact information was obtained. Information regarding gender, age, anthropometrics, smoking status, education level, duration of diabetes, frequency and last dental examination, co-morbidities, and A1c level were gathered. Socio-demographic and medical variables were collected using a standard data collection form (Appendix C).

The participants answered the OHSQPD (Appendix A) and were then referred to a dentist (co-investigator), who was unaware of the answers for a formal dental and periodontal evaluation. The participants answered the OHSQPD (Appendix A) and were then referred to a dentist (co-investigator), who was unaware of the answers for a formal dental and periodontal evaluation. The basic elements from the NHANES III protocol were used for the full-mouth periodontal examination.[27,28] The dentist reported variables relating to the measurement of periodontal supporting tissues such as attachment loss, probing depth and furcation involvement. This was done using a color-banded probe graduated at 2, 4, 6, 8, 10, and 12 mm. Measurements were carried out on six sites per tooth (mesio-buccal, buccal, distobuccal, mesio-lingual, lingual, disto-lingual, mesiofacial, mid-facial, and disto-facial) for all teeth (excluding 3rd molars). The number of lost teeth was also documented during the examination. Periodontal examination results were recorded using a separate Dental Sheet (Appendix D).

Participants were classified according to the severity of periodontal disease based on the criteria used in the NHANES III.[28] Periodontitis was defined as a disease state in which there is an active destruction of the periodontal supporting tissues as evidenced by the presence of at least 3 mm probing depth and periodontal attachment loss at the same site. It is classified as follows:

- Severe periodontitis: 1) two or more teeth (or 30% or more of the teeth examined) having ≥5 mm probing depth, or 2) four or more teeth (or 60% or more of the teeth examined) having ≥4 mm probing depth, or 3) one or more posterior teeth with grade II furcation involvement.
- Moderate Periodontitis: 1) one or more teeth with ≥5 mm probing depth, or 2) two or more teeth (or 30% or more of the teeth examined) having ≥4 mm probing

depth, or 3) one or more posterior teeth with grade I furcation involvement and accompanied by ≥3 mm probing depth.
- Mild periodontitis: 1) one or more teeth with ≥3 mm probing depth, or 2) one or more posterior teeth with grade I furcation involvement.
- No periodontitis: participants with 6 or more teeth present who did not fulfill any of the above criteria.

In this study, serious periodontal disease was considered for participants fulfilling the criteria for moderate to severe periodontitis.[11,29] Results of the periodontal evaluation were given to the participant. Intervention and follow-up were advised accordingly to ensure proper treatment of periodontitis.

Data analysis

Data analysis was done using the software Stata SE version 13. Quantitative variables were summarized as mean and standard deviation, while qualitative variables were tabulated as frequency and percentages. All responses on the oral health questionnaire were recorded according to the proposed scoring system (Appendix B).

The optimal cut-off value for detecting serious periodontitis was determined using a ROC. The value was determined using the point in which the sum of the sensitivity and specificity was highest.

The validity of the questionnaire in predicting serious periodontitis was assessed by determining its sensitivity, specificity, positive predictive value and negative predictive value (95% confidence interval) with the results of the full dental and periodontal examination as gold standard. The area under the receiver-operating curve (AUROC) (95% confidence interval) was computed to determine if the test is able to correctly classify those with and without the disease.

RESULTS

A total of 401 participants were consecutively seen in the UP-PGH outpatient clinics. One hundred seventy-seven (177) participants were not enrolled due to the exclusion criteria. The most common reason for exclusion was due to having fewer than 6 teeth left on examination. This accounted for 53% (93) of the excluded participants. Other leading reasons for exclusion were the 26% (47) who did not give consent and 16% (28) who had no recent A1c results. Figure 1 shows a flow diagram of the derivation of the participants available for the study.

Of the 224 enrolled, 49 (22%) did not undergo the full dental examination so that the final data set for analysis included a total of 175 participants. The mean age of the participants was 55.9±8.3 years old (range 36-74) of which 120 (69%) were females. One hundred twenty-six (72%) did not reach or finish college. The mean BMI and A1c were
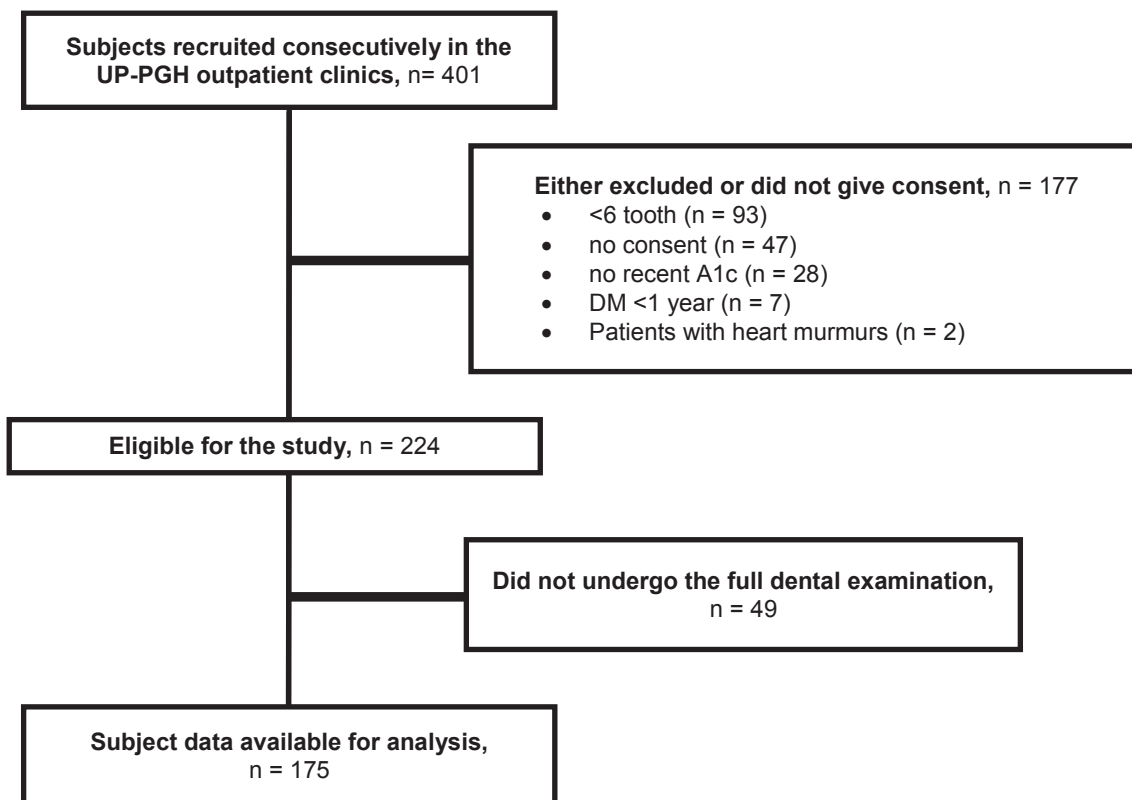
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Figure 1. Flow diagram of the derivation of participants.
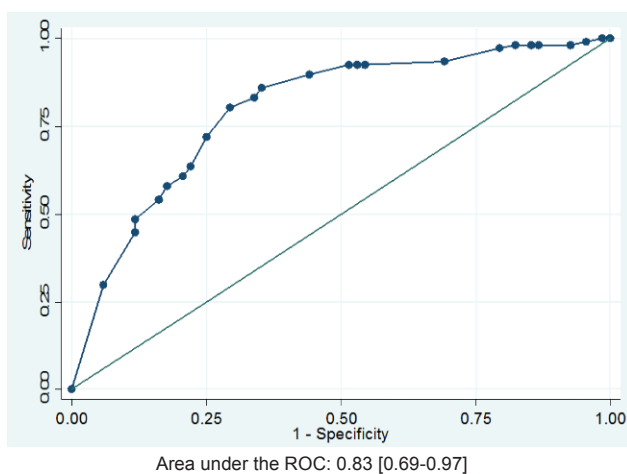

Area under the ROC: 0.83 [0.69-0.97]

Figure 2. Area under the Receiver Operating Curve (AUROC) for identifying serious periodontitis using the self-reported Oral Health Questionnaire, N =175.

Table 1. Distribution of participants according to socio-demographic and clinical characteristics. Philippine General Hospital, Manila, N=175

Characteristics	(N = 175)
Gender (Female)	120 (69%)
Mean age ± SD (years)	55.86±8.34
Mean A1c ± SD (%)	7.43±1.65
Mean BMI ± SD (kg/m^2)	25.74±4.00
Mean lost tooth ± SD	12.92±6.97
Smoking history	28 (16%)
Educational attainment (High school or lower)	126 (72%)
Hypertension	132 (75%)
Dyslipidemia	127 (73%)
Dental visits per year (<1)	152 (87%)
Duration of diabetes ± SD (years)	9.03±7.67

25.7±4.0 kg/m^2 and 7.4±1.7% respectively with a mean duration of diabetes of 9.0±7.7 years. The majority of participants (87%) had no annual dental visits with a mean tooth loss on examination of 12.9±7.0. Only a minority of the participants were smokers or had ever smoked 28 (16%). Hypertension and dyslipidemia were the frequent co-morbidities observed. A summary of the distribution of the socio-demographic and clinical characteristics of the 175 participants included in the study is seen in Table 1.

Overall, 93% (162) of the participants had periodontitis, while the prevalence of serious periodontitis (moderate and severe) was 61% (107). The prevalence of mild, moderate, and severe periodontitis were 7.5% (13), 31% (55) and 54% (94) respectively. Only 7.5% (13) had no periodontitis on examination.

The optimal cut-off value for detecting serious periodontitis based on study criteria determined using the ROC was 12 (see Figure 2). With this cut-off score, the estimated prevalence of serious periodontitis was also 61% (106). The distribution of participants according to the oral health scores, seriousness of periodontitis, and the validity characteristics of the self-report questionnaire are seen in Tables 2 and 3. The questionnaire yielded a sensitivity [95% CI] of 80.4% [72.9-87.9] and a specificity [95% CI] of 70.6 [59.8-81.4]. Positive and negative predictive values were 81.0% [72.6-89.1] and 70% [58.7-80.4] respectively. The area under the receiver operating curve (AUROC) [95% CI] was 0.83 [0.69-0.97] (Figure 2).

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Table 2. Distribution of the participants according to the oral health score and seriousness of periodontitis

Oral Health Score	Serious periodontitis	Absent / Mild periodontitis	Total
≥12	86	20	106
<12	21	48	69
Total	107	68	175

Table 3. Validity characteristics of the Oral Health Screening Questionnaire for Diabetics at a derived cut-off score of 12

Performance measures	Result in % [Confidence Interval]
Sensitivity	80.4% [72.9-87.9]
Specificity	70.6% [59.8-81.4]
PPV	81.0% [72.63-89.10]
NPV	70.0% [58.7-80.43]

Note: Positive predictive value (PPV), Negative predictive value (NPV)

Table 4. Distribution of the participants according to the oral health score and seriousness of periodontitis

Study	Sensitivity	Specificity	Area under the ROC curve [95% CI]
Current Study	**0.80**	**0.71**	**0.83 [0.69-0.97]**
Khader Y 2015 [30]	0.61	0.83	0.77 [0.71, 0.82]
Zhan Y 2014 [31]	0.81	0.74	0.84 [0.82–0.86]
Lai H 2015 [32]	0.68	0.62	0.70 [0.67–0.74]

DISCUSSION

Periodontitis is a complication of diabetes and it causes a significant burden. There is still a lack of a certain degree of awareness regarding oral health and its relationship with diabetes. It is clear that routine oral health care in adults with diabetes is uncommon, as 152 (87%) of the participants had no regular dental visits.

While a full dental and periodontal examination remains the standard of care for persons with diabetes, it comes at a cost. Oral health is an important element of diabetes care and will contribute to the improvement in glycemic control.[15] Self-report measures can offer a practical alternative for periodontal disease evaluation. The OHSQPD was inexpensive and easy to administer in the outpatient setting. The importance of validating the questionnaire then, is to identify persons with diabetes having serious periodontitis who will potentially require urgent dental evaluation and treatment.

One hundred sixty two (93%) participants had periodontitis while more than half (107 or 61%) of the population had serious periodontitis. This prevalence of periodontitis based on the full dental and periodontal examination is similar to what was reported by Lo et. al., and this may be due to the similar population characteristics such as a lower level of education and poorer oral health care.[11]

The reported prevalence of serious periodontitis was 61% based on the OHSQPD when using the optimal cut-off score of 12, with a sensitivity of 80.4% and a specificity of 70.6%. The test had a good discriminating ability for detecting serious periodontitis based on the AUROC value.

Currently, there are no studies that used self-report questionnaires to detect periodontitis among persons with diabetes, however when compared to other self-reported periodontal disease scales that predicted periodontitis in those without diabetes, the questionnaire had comparable sensitivity and specificity.[30-32] The validity characteristics of these self-reported periodontal disease scales for detecting serious periodontitis are seen in Table 4.

As the study is done in a tertiary referral center, the questionnaire might perform differently in the community setting. Limitations stem from the setting of the study and are due to the educational and language barriers that may be encountered. Validity therefore may be dependent on the specific population characteristics. These population characteristics may affect the comprehensibility of the self-report questions hence may influence participant responses. The participants included in this study are also relatively older and already with established diabetes for almost ten years; thus, the sensitivity and specificity of the questionnaire in detecting serious periodontitis may be different in younger populations with a shorter duration of diabetes. Further evaluation is needed to determine the performance of the questionnaire in the community setting.

CONCLUSION

The Oral Health Screening Questionnaire for Persons with Diabetes is a valid tool with good sensitivity, specificity and predictive value for detecting serious periodontitis. In can potentially become an invaluable tool in settings in which routine and clinical oral examination for all diabetics is not feasible.

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APPENDIX

Appendix A. The Oral Health Screening Questionnaire for persons with diabetes

Oral Health Questions	Response
1. What is your highest educational attainment?	☐ High school or lower ☐ College or higher
2. How many teeth did you lose?	☐ ≥6 ☐ <6
3. Overall, how would you rate the health of your teeth and gums?	☐ Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor
4. Have you ever had any teeth that became loose on their own, without an injury? (not baby teeth)	☐ Yes ☐ No
5. During the past 3 months, have you noticed that you have a tooth that doesn't look right?	☐ Yes ☐ No
Total Score	

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Appendix B. The recommended Oral Health Questionnaire and the scoring system predictive of serious periodontitis

Oral Health Questions	Response	Score
1. What is your highest educational attainment?	High school or lower	+ 3
	College or higher	0
2. How many teeth did you lose?	≥6	+ 4
	<6	0
3. Overall, how would you rate the health of your teeth and gums?	Excellent	- 5
	Very Good	- 4
	Good	- 3
	Fair	- 2
	Poor	- 1
4. Have you ever had any teeth that became loose on their own, without an injury? (not baby teeth)	Yes	+ 7
	No	0
5. During the past 3 months, have you noticed that you have a tooth that doesn't look right?	Yes	+ 7
	No	0
Total Score		

Appendix C. Patient data sheet

Part 1: General Data
Participant's Code: _____   Date Examined: _____
Age: _____   Civil Status: ☐ S ☐ M ☐ W
Sex: ☐ Male   ☐ Female
Education Attainment: ☐ High school or lower   ☐ College or higher
Occupation: _____ Family Monthly Income (Pesos): _____
Part 2: Medical History
Smoking history: ☐ Smoker (___ pack ___ years) ☐ Non-smoker
Comorbidities:
☐ Hypertension   ☐ Dyslipidemia
☐ Bronchial Asthma   ☐ Autoimmune disease
☐ Liver disease   ☐ Renal disease
☐ Cardiac disease   ☐ Others (specify)
Date of diagnosis with diabetes: _____
Date of last dental visit: _____
Number of dental visits per year: _____
Part 3: Clinical Data
BP: _____   Wt (kg): _____   Ht (cm): _____   BMI: _____ (kg/m^2)
Pertinent Physical Examination Findings:
_____
_____
_____
Part 4: Laboratory Data
A1c within the last 3 months: _____

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Appendix D. Dental sheet

Patient Number: _____

<p align="center">Periodontal Examination</p>

Total Number of Teeth Present: _____   Total Number of Teeth Lost: _____
Periodontitis: _____ Present   _____ Absent
Severity of Periodontitis: _____ Mild   _____ Moderate   _____ Severe
Other Findings: _____
Recommendation: _____
Assessed By: _____

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