Comparing self-reported and clinically diagnosed dental treatment needs in the Canadian population

Farmer, Julie ; Ramraj, Chantel; Azarpazhooh, Amir; Dempster, Laura; Ravaghi, Vahid; Quiñoneza, Carlos

DOI:
10.1111/jphd.12205

Comparing self-reported and clinically diagnosed unmet dental treatment needs using a nationally representative survey

J. Farmer, BSc (Hons), RDH, MSc [1]; C. Ramraj, BSc (Hons), MSc, PhD(c)[2]; A. Azarpazhooh, DDS, MSc, PhD, FRCD(C)[1,3]; L. Dempster, BScD, MSc, PhD[1]; V. Ravaghi, DDS, MSc, PhD[4]; C. Quiñonez, DMD, MSc, PhD, FRCD(C)[1]

1 Faculty of Dentistry, University of Toronto, Toronto, Canada
2 Dalla Lana School of Public Health, University of Toronto, Toronto, Canada
3 Department of Dentistry, Mount Sinai Hospital, Toronto, Canada
4 School of Dentistry, University of Birmingham, Birmingham, UK

Keywords
self-reports; dental health surveys; dental treatment needs; clinical oral health status; diagnostic accuracy.

Correspondence
Julie W. Farmer, University of Toronto, Faculty of Dentistry Discipline Dental Public Health, 124 Edward Street, Room 521A, Toronto, ON, Canada. Tel.: (416) 979-4900 ext 4489; Fax: (416) 979 4936; e-mail: julie.farmer@mail.utoronto.ca. Julie Farmer, Laura Dempster, Amir Azarpazhooh, and Carlos Quiñonez are with the Faculty of Dentistry, University of Toronto. Chantel Ramraj is with the Dalla Lana School of Public Health, University of Toronto. Amir Azarpazhooh is with the Department of Dentistry, Mount Sinai Hospital. Vahid Ravaghi is with the School of Dentistry, University of Birmingham.

Received: 3/22/2016; accepted: 12/22/2016.

doi: 10.1111/jphd.12205

Journal of Public Health Dentistry **00** (2017) 00–00

Abstract

Objectives: To describe the validity and diagnostic accuracy of self-reported data compared with clinically assessed data for the ascertainment of clinical dental treatment needs in the Canadian population.
Methods: A secondary analysis of data from the Canadian Health Measures Survey (2007-2009) was undertaken. Clinical treatment needs were classified into preventive and diagnostic, restorative, endodontic, periodontic, surgical, and orthodontic categories. Sensitivity, specificity, positive and negative predictive values (NPVs), kappa statistics and likelihood ratios (LR) were calculated to compare self-reported and clinically determined needs. Survey weights were applied to generate nationally representative findings of the Canadian population.
Results: Generally across most dental need categories, agreement between self-reported and clinically-determined dental need was found to be moderate to poor (kappa <0.6). For most needs, self-reported data was found to be highly specific (>90 percent) but not very sensitive. Low positive (<60 percent) and high NPVs (>80 percent) revealed that self-reported information was found to be more precise in reassuring when most dental needs were not present, opposed to confirming needs that were required. High positive LRs were obtained for endodontic ($+LR = 12.15$) and orthodontic needs ($+LR = 14.82$), indicating good diagnostic accuracy of positive self-report for these outcomes.
Conclusions: Our findings suggest that in general, self-reports are poor estimates for normative dental treatment needs but do have some merit in confirming non-needs. Exceptionally, self-reports do have suitable diagnostic accuracy for predicting orthodontic and endodontic needs.

Introduction

Monitoring population-level trends in oral health is important for informing policy on the level of oral disease and degree of inequality within societies. This is commonly assessed through surveillance measures and periodic surveys, where data is collected through self-reports and/or through clinical examination. Self-reports of oral health status and treatment needs are often utilized due to their convenience and low cost; however, they have been found to be heavily influenced by personal beliefs, cultural background, and social, educational, and environmental factors (1). To ensure the accurate assessment of clinical treatment needs of individuals within a society, it is essential to understand the level of accuracy of self-reports on predicting normative needs.

Previous studies that have examined the consistency between self-reports and normative needs have found that self-reports often provide different assessments and values from those of clinically determined standards (1-5). For

example, Liu and colleagues (2010) examined data from the 1999-2000 and 2001-2002 waves of the US National Health and Nutrition Examination Survey (NHANES) and found that patients are less likely to adequately assess their periodontal status and the presence of caries, than they are to assess their number of teeth, restorations, and the presence of fixed and removable prosthetics (1). This is congruent with previous work by Gilbert and Nuttall (1999), which concluded that individuals are usually unable to report signs and symptoms related to their periodontal conditions (5).

Aside from self-reports on periodontal and dental caries status, orthodontic need and treatment history (1,3,4,6-15), few studies have explored variations in consistencies in self-reported and normative treatment needs between different treatment categories, such as preventive, restorative, endodontic, and surgical needs (1,6,11,14). While comparisons of socio-dental and normative approaches on treatment needs have been assessed (3,4,13-15), a comparison of the accuracy of self-reports on estimating their unmet clinical dental conditions by different of treatment categories has been seldom explored (1). Understanding the level of diagnostic accuracy of self-reports on estimating the presence of unmet dental conditions provides insight into individuals' understanding of oral health and disease which could influence their oral health behaviors and dental care utilization patterns. However, the extent to which individuals can accurately diagnose their unmet clinical treatment needs or oral health conditions and whether this varies by treatment category remains unclear. As such, the objective of this study was to assess the level of agreement and diagnostic accuracy of self-reported data on the ascertainment of clinically diagnosed unmet clinical treatment needs in the Canadian population.

Methods

Study design and sample

This study used data from the Canadian Health Measures Survey (CHMS), Cycle 1 Household and Clinic Questionnaires. The CHMS collected health measures from approximately 5,600 people, which statistically represents 97 percent of the Canadian population between 6 and 79 years of age. This consisted of those living in privately occupied dwellings in the ten provinces and the three territories. Those excluded from the survey included persons living on Indian Reserves or Crown lands, residents of institutions, full-time members of the Canadian Forces and residents of certain remote regions (16). For this study, the sample of those reporting unmet clinical treatment needs included those of all ages, therefore covering children, adolescents, young adults and older adults.

Data collection

Data collection for the CHMS was conducted by Statistics Canada between March 2007 and February 2009. First, a personal interview using a computer-assisted interviewing method was employed and second, a visit to a mobile examination centre was required for the direct clinical measure of oral health. For the household interview, the interviewer randomly selected one or two respondents and conducted a health interview lasting about 45 to 60 minutes. Thirty-four specific oral health questions were asked that gathered data related to oral health such as oral symptoms, dental care habits and source of funds to pay for dental care. Additionally, relevant sections of the interview gathered information on socio-demographic information (16).

Clinical dental examinations were performed in mobile examination centers. The Department of National Defence supplied 12 dentist-examiners for the two-year collection period who were calibrated to World Health Organization standards by a gold standard trainer. Inspections of all clinic staff and on all components of the examination were performed at regular intervals to provide a direct assessment of protocol adherence, communication with participants, overall data collection quality and operation of the clinic (16).

During the oral examination, the dentist used an explorer and mirror to assess the condition of the teeth, gums, and tongue of every eligible participant. The treatment needs of the participant was also assessed (assuming there were no financial barriers) and ranked according to urgency (16). Specific criteria were used to appropriately classify each type of treatment need into categories (preventive and diagnostic, restorative, surgical, periodontic, endodontic, and orthodontic), as outlined in Tables 1 and 2. Prior to the clinical examination by the dental-examiner, each respondent was asked if they thought they had any untreated dental conditions and if so, which condition(s) they thought they had (Table 1), forming the self-reported data for this study.

Data was accessed from Statistics Canada's Research Data Centre (RDC) in Toronto. The RDC operates through a partnership with the Social Sciences and Humanities Research Council (SSHRC), Canadian Institutes of Health Research (CIHR), Canada Foundation for Innovation (CFI) and a consortium of universities across the country including the University of Toronto.

Data analysis

The CHMS is a sample survey, meaning that each participant represents many other Canadians not included in the survey. In order for the results of this study to be representative of the population, unique weights were assigned to each participant that corresponded to the number of people represented by that participant in the population as a whole. To account for the complex sampling design, in addition to survey

Table 1 Clinic Questions and Protocol Used to Identify Unmet Self-Reported and Clinical Treatment Needs

Clinic survey questionnaire	Clinic examination protocol

• OHQ_Q11. Do you think you have any untreated dental conditions?
  • Yes
  • No
• OHQ_Q12. What untreated dental condition(s) do you think you have?
  • Preventive
  • Filings
  • Temporomandibular joint disorder (TMD)
  • Surgery
  • Periodontics
  • Esthetics
  • Endodontics
  • Orthodontics
  • Soft tissue
  • Prosthetics – partial or full denture
  • Prosthetics – implant, bridge or crown
	• OHE_N53. Record the treatment currently needed by the respondent
	  • No treatment needed
	  • Prevention
	  • Filings
	  • Temporomandibular joint disorder (TMD)
	  • Surgery
	  • Periodontics
	  • Esthetics
	  • Endodontics
	  • Orthodontics
	  • Soft tissue
	  • Other – Specify (insert treatment to a maximum of 80 characters)

weights (provided by Statistics Canada), bootstrap weights were also applied prior to the statistical analysis to obtain reliable estimates representative of the Canadian population.

Along with the dental-examiner's evaluation of treatment need, which was considered the gold standard for obtaining normative needs in this study, self-reported measures were summarized in a conventional two-by-two (2×2) table (Table 3). First, Cohen's (unweighted) kappa coefficient was computed to obtain the level of agreement between clinically derived and self-reported unmet treatment need for each treatment type. Second, sensitivity, specificity, positive and negative predictive values (NPVs) were calculated to further test the concordance between self-reported and clinically determined needs. To provide additional information on the diagnostic accuracy of self-reports in reporting clinically derived treatment needs, positive and negative likelihood ratios (LR) were computed. Using Table 3 as a template, treatment-specific tables (not shown) were constructed for having a perceived unmet need (yes/no) and having a clinical need (yes/no), in general.

Table 2 Criteria Used to Assess Each Treatment Type*

Description	Examples
Preventive and diagnostic	Examination; prophylaxis; fluoride; sealant; radiographs
Restorative	Fillings for restoration of carious lesions
Surgical	†
Periodontic	Scaling; root planning; periodontal surgery
Endodontic	Root canal therapy
Orthodontic	Under treatment, requiring orthodontic care as defined

*Adapted from The Oral Health Needs Assessment took kit provided by Health. Canada: http://www.fptdwg.ca/ohnat/index.php
†Not specified.

In cell "A" those who correctly diagnosed their treatment need (as determined by the gold standard) were entered. Their assessments were positive for having self-reported need and accurate for the treatment need, making them "true positives." In cell "B" those who said they had the treatment need but were inaccurate according to the gold standard were entered. These individuals wrongly diagnosed the type of treatment they needed, making them "false positives." In cell "C" those who were clinically diagnosed as having the treatment need but did not correctly predict it, were entered. These individuals were incorrect in labeling themselves healthy (not requiring the treatment), making them "false negatives." Lastly, in cell "D" those who were clinically diagnosed as healthy (not having the treatment need) and correctly perceived no need for that treatment were entered. On both accounts, these people were accurate in saying they were healthy and were also clinically found to be healthy, making them "true negatives."

Cohen's (unweighted) kappa coefficient was used to determine the overall level of agreement between two types of tests or assessments. Values for Cohen's kappa coefficient range from 0.0 to 1.0, where cut off values indicate poor (<0.20), fair (0.21-0.40), moderate (0.41-0.60), good (0.61-0.80), and almost perfect (>0.81) agreement (17). To calculate the kappa coefficient the proportion of observed agreement (P_O)

Table 3 Example of 2×2 Table Constructed to Calculate Sensitivity, Specificity, Positive and Negative Predictive Value

		Clinically determined need (gold standard)	
		Yes	No
Self-reported need	Yes	A (true positive)	B (false positive)
	No	C (false negative)	D (true negative)

Table 4 Comparing Self-Reported Versus Clinically Determined Treatment Needs Using Sensitivity and Specificity with 95% Confidence Intervals (*n* = 29,149,991)

	Proportion with unmet need	Kappa coefficient	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)	+ LR	− LR
Having a self-perceived need and clinical need	32.83 [32.81-32.85]	0.344 [0.344-0.345]	56.1 [56.1-56.2]	78.3 [78.3-78.3]	55.8 [55.8-55.9]	78.5 [78.5-78.5]	2.59 [2.58-2.59]	0.560 [0.560-0.561]
Preventive and diagnostic	13.74 [13.73-13.75]	0.234 [0.233-0.235]	25.1 [25.1-25.2]	93.8 [93.8-93.9]	53.4 [53.3-53.5]	81.6 [81.6-81.6]	4.05 [4.05-4.08]	0.798 [0.797-0.799]
Restorations	20.41 [20.40-20.42]	0.371 [0.370-0.371]	78.2 [78.1-78.2]	61.8 [61.8-61.9]	55.5 [55.5-55.6]	82.3 [82.3-82.4]	2.05 [2.04-2.05]	0.353 [0.352-0.353]
Surgery	7.44 [7.43-7.45]	0.469 [0.468-0.470]	53.6 [53.6-53.7]	91.7 [91.6-91.8]	58.5 [58.4-58.6]	90.1 [90.1-90.2]	6.48 [6.47-6.50]	0.506 [0.505-0.506]
Periodontics	5.07 [5.06-5.08]	0.189 [0.188-0.190]	28.8 [28.7-28.9]	92.1 [92.0-92.1]	23.5 [23.4-23.6]	93.8 [93.7-93.8]	3.65 [3.61-3.64]	0.774 [0.773-0.775]
Endodontics	1.95 [1.94-1.96]	0.424 [0.423-0.426]	54.8 [54.7-55.0]	95.5 [95.4-95.5]	39.4 [39.3-39.5]	97.5 [97.5-97.6]	12.15 [12.10-12.20]	0.473 [0.471-0.474]
Orthodontics	20.80 [20.79-20.81]	0.412 [0.411-0.414]	72.6 [72.4-72.8]	95.1 [95.1-95.2]	31.3 [31.1-31.4]	99.1 [99.1-99.2]	14.82 [14.73-14.84]	0.288 [0.286-0.290]

and proportion of expected agreement (P_E) was obtained from the 2 × 2 table, and subsequently calculated using methods described elsewhere (13).

In our analysis, sensitivity referred to the proportion of people who correctly diagnosed their unmet clinical treatment need (17). Specificity is defined as the proportion of people without the disease who have a negative test and refers to the proportion of people who correctly diagnosed that they did not have a clinical treatment need (17). A highly sensitive test will rarely miss people with the disease, whereas a highly specific test will rarely misclassify people as having the disease when they do not (17).

A positive predictive value (PPV) is the probability of disease in a patient with a positive test result (17). This tells us how accurate self-reported treatment needs are, as a diagnostic tool, in confirming clinical treatment needs. NPV is the probability of not having the disease when the test result is negative (17), which describes the accuracy of self-reported information, as a diagnostic tool, in reassuring those who do not have a clinical treatment need.

Likelihood ratios were calculated to determine the diagnostic practicality of using self-reported measures as a proxy measure of true clinical need. They express the extent to which a self-reported result is to be found in people with the condition, compared to those without the condition (17). Positive LR of 10 or greater or negative LR of 0.10 or less are considered to provide strong evidence that the diagnostic test (self-reports) is a good indicator unmet treatment need (17,18).

All of the relevant variables used in this study were imported into Statistical Package for the Social Sciences (SPSS) for Windows from the original CHMS Wave 1 master data file. Household and mobile examination centre data were merged via a unique personal identifier assigned to each participant. The SPSS data file containing all of the variables of interest was then imported into STATA for Windows for data analysis. All cases where participants were not clinically examined (n = 18) were excluded from the analysis.

Results

The prevalence of each treatment type required by the Canadian population through clinical examination are shown in Table 4. Approximately 32.8 percent of Canadians had at least one unmet treatment need. Most of the population had an orthodontic (20.8 percent), restorative (20.4 percent), and preventive and diagnostic (13.7 percent) care need.

Table 4 also shows the kappa coefficients, sensitivity, specificity, PPV, NPV, and LRs for each treatment need. These results indicate poor agreement (<0.20) between clinical and self-reported periodontal needs, fair agreement (0.21-0.40) for prevention and restorative needs, and moderate agreement (0.41-0.60) for surgery, endodontic, and orthodontic needs. From the sensitivity and specificity analyses, only 56

percent of Canadians who had a clinical treatment need perceived a need for it, while 78 percent of people who reported not having any needs correctly had no need for treatment. As a test for predicting clinical treatment need, self-reported information had high specificity but low sensitivity for most treatment types. As a result of its low sensitivity (especially for prevention and periodontics), self-reports were found to be poor at detecting all of the people who did require treatment and tended to miss the people who reported not needing treatment but actually did need it (i.e., produced a large number of false negative results).

For predictive values, higher NPV than PPV were observed for each category. Therefore, a person who reported not requiring periodontal treatment had a 94 percent chance of not requiring it, while a person who reported needing periodontal treatment only had a 24 percent chance of actually needing it. Overall, especially for needs such as endodontic and orthodontics, if a person reported they did not require treatment, then they had a very high chance of not needing it.

Nearly all self-reports exhibited small changes in pretest to posttest probability of needing or not needing treatment as indicated by positive LR less than 5 and negative LR greater than 0.2 (Table 4). The high positive LR for self-reported orthodontic ($+LR = 12.15$) and endodontic ($+LR = 14.82$) treatment needs represent large shifts from pretest to posttest probability, indicating good diagnostic accuracy for these measures. Overall, self-reports for orthodontics ($-LR = 0.288$) and restorations ($-LR = 0.353$) had the lowest negative LR, indicating somewhat adequate diagnostic accuracy of negative self-reports for these treatment types.

Discussion

The objective of this study was to compare the agreement between self-reported and clinically evaluated dental needs; and significant discrepancies were found between the two, varying in magnitude by type of treatment. The findings reveal that for predicting unmet clinical dental needs, self-reports for most treatment types had high specificity and low sensitivity. In other words, for most dental outcomes, self-reports were found to be poor at detecting individuals that required treatment, but were accurate in identifying those who did not require treatment. Our general findings of low PPVs and high NPVs echo similar results, demonstrating that self-reports are more precise in reassuring what needs people do not require as opposed to confirming what needs they do require. And finally, adequate diagnostic accuracy for a positive self-report of endodontic and orthodontic need was found by assessing LR.

This study demonstrates that the accuracy to which a self-reported dental needs can be correctly predicted varies by each treatment type. For example, for periodontal treatment, the probability of a person requiring this treatment following a positive response for needing it was very low. This finding is consistent with the previously mentioned studies that found that individuals are usually unable to assess their periodontal status (1,2,5,6). Chronic and slow-progressing conditions, such as periodontal disease and dental caries, often go unnoticed by the general population (2,19). Ab-Murat and colleagues found that among those with a normatively derived periodontal condition less than 10 percent reported having an oral impact related to their condition (13). Less than 5 percent of the Canadian population exhibit moderate or severe attachment loss or periodontal pockets greater than 4 mm (16). This low prevalence of moderate to severe periodontal disease, which may be accompanied by tooth mobility or other oral impacts on daily living, may explain why individuals were less likely to accurately diagnose their periodontal needs. In addition, individual self-reports could also be influenced by the type and extent of oral health education acquired from dental providers; however, due to the lack of relevant variables, the effect of oral health promotion and education cannot be determined in the present analysis.

To complement PPVs and NPVs, our resulting LR provide further information on the diagnostic accuracy of each self-report in determining clinical treatment needs. High positive LR for orthodontic and endodontic treatment needs indicate that self-reports are good indicators of these particular needs. It is logical to assume that higher LR were expressed in these treatment groups because endodontic and orthodontic conditions requiring treatment may be accompanied with clinical signs or symptoms, functional impairments, or pain experienced by individuals. Conversely, signs and symptoms for other treatment types, such as preventive and diagnostic, restorative, and periodontics may be intermittent and potentially less prevalent. Also, as indicated by lower negative LR (less than 0.5), for not requiring orthodontic or restorative need, self-reports have moderately good diagnostic accuracy. This finding is consistent in literature with perceived orthodontic treatment need and normative need correlating well (4-9). As well, with permanent dentition and skeletal maturation in adulthood, awareness of orthodontic treatment needs may be better assessed in permanent compared to mixed and developing dentitions in adolescents; however, comparisons across age groups have been seldom explored (7-12).

From a planning perspective, it is evident that self-reports should not replace clinically derived treatment needs in epidemiological surveys. We conclude that self-reports alone may underestimate clinical treatment needs of individuals, especially for preventive and periodontal needs. To complement these findings, future research should explore potential individual-level factors that may influence awareness of treatment needs; these may include factors pertaining to oral health literacy such as sociodemographic characteristics, dental utilization patterns, self-efficacy, and dental knowledge (20,21). For example, individuals who have a history of

clinical treatment for certain conditions or those who visit the dentist regularly may be better at predicting unmet treatment need. Although existing studies identify weak associations between dental utilization and oral health, differences in patterns of dental utilization (emergency versus routine), oral health literacy as well as other related factors, have not been explored (20).

While discrepancies were found between self-reports and unmet clinical treatment needs, these findings give rise to hypotheses on how individual perceptions of need may differ by treatment type. Although individuals were asked a direct question about the presence or absence of unmet dental conditions, individual perceptions are complex and can be influenced by ideologies on oral health and disease; all of which may be shaped by societal norms (22). For example, the preoccupation with self-image within North American societies coupled with functional impairments could influence an individual's perceived need for and reporting of unmet orthodontic needs (7,10,23). In addition, underreporting an unmet dental condition could be the result of past dental experiences, the extent and type knowledge on oral conditions acquired from dental providers or peers, or the perceived urgency of the condition, which can influence how individuals conceptualize oral health needs (22). Thus, pursuing these hypotheses through qualitative inquiry could provide a greater understanding of the social processes that influence self-reports (22). In addition, stratifications by socio-demographic factors and other influencing variables could provide more insight into how the level of agreement may change within different populations. Unfortunately, due to data release restrictions on small un-weighted samples, which were a result of the low prevalence of unmet dental needs in the Canadian population (16), further stratifications could not be incorporated.

This analysis had some shortcomings. For example, PPVs and NPVs are often influenced by the prevalence of the treatment need in the population, where low prevalence of conditions often lead to low PPVs and high NPVs and vice versa. As a result of only 34 percent of the population requiring clinical treatment, and of this, anywhere from 2 to 20 percent having each service need, the PPVs obtained were low and should be interpreted with caution. In addition, our analyses involved assessing the agreement and diagnostic accuracy between self-reports and clinical examinations that did not include radiographic assessments to confirm treatment needs. However, for the purposes of epidemiological surveys where radiographic assessment are rarely employed, our results have provided estimates on the diagnostic accuracy of self-reports on clinical treatment needs in this regard (24).

In conclusion, our findings suggest that self-reports provide poor assessments for clinical treatment needs for preventive and diagnostic, and periodontal conditions, but have suitable diagnostic accuracy for orthodontic and endodontic needs. Our results conclude that caution must be exercised when using self-reported measures to estimate true need in epidemiological surveys, as the findings may bias the true estimate of clinical treatment needs in the population.

Acknowledgments

The Population Health Improvement Research Network (PHIRN) of the Applied Health Research Network Initiative (AHRNI) of the Government of Ontario and the University of Toronto Open Fellowship (2010-2012) funded this research.

References

1. Liu H, Maida CA, Spolsky VW, Shen J, Li H, Zhou X, Marcus M. Calibration of self-reported oral health to clinically determined standards. *Community Dent Oral Epidemiol.* 2010;**38**(6):527-39.
2. Vered Y, Sgan-Cohen HD. Self-perceived and clinically diagnosed dental and periodontal health status among young adults and their implications for epidemiological surveys. *BMC Oral Health.* 2003;**3**(1):3.
3. Srisilapanan P, Sheiham A. Assessing the difference between sociodental and normative approaches to assessing prosthetic dental treatment needs in dentate older people. *Gerodontology.* 2001;**18**(1):25-34.
4. Srisilapanan P, Korwanich N, Sheiham A. Assessing prosthodontic dental treatment needs in older adults in Thailand: normative vs. sociodental approaches. *Spec Care Dentist.* 2003;**23**(4):131-4.
5. Gilbert AD, Nuttall NM. Self-reporting of periodontal health status. *Br Dent J.* 1999;**186**(5):241-4.
6. Pitiphat W, Garcia RI, Douglass CW, Joshipura KJ. Validation of self-reported oral health measures. *J Public Health Dent.* 2002;**62**(2):122-8.
7. Ahmed B, Gilthorpe MS, Bedi R. Agreement between normative and perceived orthodontic need amongst deprived multiethnic school children in London. *Clin Orthod Res.* 2001;**4**(2):65-71.
8. Ajayi EO. Normative and self-perceived orthodontic treatment need in Nigerian school children. *Acta Odontol Scand.* 2015;**73**(5):364-7.
9. Bernabe E, Flores-Mir C. Normative and self-perceived orthodontic treatment need of a Peruvian university population. *Head Face Med.* 2006;**2**:22.
10. Chew MT, Aw AK. Appropriateness of orthodontic referrals: self-perceived and normative treatment needs of patients referred for orthodontic consultation. *Community Dent Oral Epidemiol.* 2002;**30**(6):449-54.
11. Hancock PA, Blinkhorn AS. A comparison of the perceived and normative needs for dental care in 12-year-old children in the northwest of England. *Community Dent Health.* 1996; **13**(2):81-5.

12. Kerosuo H, Al Enezi S, Kerosuo E, Abdulkarim E. Association between normative and self-perceived orthodontic treatment need among Arab high school students. *Am J Orthod Dentofacial Orthop.* 2004;**125**(3):373-8.
13. Ab-Murat N, Sheiham A, Tsakos G, Watt R. Periodontal treatment needs and workforce requirements: comparisons between the normative and sociodental approaches using different skill mix models. *Community Dent Oral Epidemiol.* 2015;**43**(2):106-15.
14. Ab-Murat N, Sheiham A, Watt R, Tsakos G. Treatment needs and skill mix workforce requirements for prosthodontic care: a comparison of estimates using normative and sociodental approaches. *BMC Oral Health.* 2015;**15**:36.
15. Gherunpong S, Tsakos G, Sheiham A. A sociodental approach to assessing dental needs of children: concept and models. *Int J Paediatr Dent.* 2006;**16**(2):81-8.
16. Health Canada. *Report on the Findings of the Oral Health Component of the Canadian Health Measures Survey 2007-2009.* Ottawa, ON: Health Canada; 2010.
17. Fletcher RH, Fletcher SW. *Clinical epidemiology: the essentials.* Baltimore (MD): Lippincott Williams & Wilkins; 2005.
18. Furukawa TS, Strauss SE, Bucher HC, Guyatt GH. Diagnostic tests. In: Guyatt G, Rennie D, Meade MO, Cook D, editors. *Users' guides to the medical literature: a manual for evidence-based clinical practice.* 2nd ed. New York, NY: McGraw Hill; 2008. p. 419-38.
19. Robinson PG, Nadanovsky P, Sheiham A. Can questionnaires replace clinical surveys to assess dental treatment needs of adults? *J Public Health Dent.* 1998;**58**(3):250-3.
20. Burgette JM, Lee JY, Baker AD, Vann WF, Jr. Is dental utilization associated with oral health literacy? *J Dent Res.* 2015;**95**:160-6.
21. Blizniuk A, Ueno M, Zaitsu T, Kawaguchi Y. Association of oral health literacy with oral health behaviour and oral health status in Belarus. *Commun Dent Health.* 2015;**32**(3):148-52.
22. Locker D, Maggirias J, Wexler E. What frames of reference underlie self-ratings of oral health?* *J Public Health Dent.* 2009;**69**(2):78-89.
23. Khalid A, Quinonez C. Straight, white teeth as a social prerogative. *Sociol Health Illn.* 2015;**37**(5):782-96.
24. Petersen PE, Baez RJ. *Oral health surveys: basic methods.* 3rd ed. Geneva: World Health Organization; 2013.

