

# Validity of a questionnaire in estimating restorative treatment need among young adults

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**Objective:** There are no verified anamnestic sets of questions for assessing restorative treatment need. Finnish conscripts responded to a computer-based questionnaire on oral health during their oral health screening in 2011. This study compared the outcomes of the screening and the questionnaire concerning restorative treatment need with the aim of finding and validating a set of questions with the best association between the two methods. **Clinical setting:** The study group comprised 8,566 conscripts. Of 50 original questions, 22 questions were chosen for closer analysis. The generalised linear mixed model was used to calculate the OR values (95%CI) for each of these questions, using restorative treatment need at individual level as the response variable. Questions with the best association ( $Q_1$ – $Q_{10}$ ) were selected for the final set; the inclusion criterion was  $p < 0.05$ . The area under curve (AUC) value was calculated for the sum function of these 10 questions. **Results:** Among the final set of 10 questions, the OR values varied between 1.12 and 4.61. The AUC value was 0.75. By increasing the number of positive responses to 8 questions, the odds for restorative treatment need were OR 69.27 and increased to infinity with 10 questions. **Conclusions:** A selected set of questions together with clinical screening, or even alone, can be a valid instrument for screening people for restorative treatment need. The method is particularly useful in large populations. This statistical method might identify appropriate sets of questions for different contexts.

**Key words:** dental restoration, permanent, dental caries, questionnaire, self-report, screening, Finland, conscripts

## Introduction

Anamnestic questionnaires are widely used in clinical practice to gain background information for treatment planning and dental care. In addition to questions about general health, medication and previous oral health care, the questionnaires usually include questions about oral symptoms. However, so far the questionnaires are not systematically used or even designed to be used as a diagnostic tool to screen or confirm treatment need. Levin *et al.* (2013) were the first to study questionnaires from this perspective in their research into a questionnaire detecting restorative treatment need. They found a good association between responses to oral health questions and treatment need. However, they reported a need for further studies using various background factors and study groups. Unaware of that study we designed and conducted the present study with a similar aim during the same time period.

Dental caries is a disease affecting most people in the industrialised and particularly in the developing world. Multidisciplinary factors associated with dental caries have been described, for example, by Selwitz *et al.* (2007) in their article. The effect of different factors on restorative treatment need varies on the basis of their intensity and individual response. No conclusion about the exclusive factors at population level can be made based on the literature alone. Furthermore, these studies investigate only individual or some variables without aiming to find combinations of questions having the

best association with caries experience or restorative treatment need.

In the Finnish Defence Forces, an oral screening method created by Ankkuriniemi (1980) is used for determining oral treatment need, including assessment of restorative, periodontal and mucous membrane treatment need. In 2011, the oral health of 13,819 conscripts born 1990 to 1992 was screened based on the WHO criteria (1997) for epidemiological dental caries studies. Among other data, their restorative treatment need was registered. Only about one fifth were found to have DMFT=0 and almost half (45%) needed restorative treatment. The conscripts' mean DMFT value was 4.1, sd 4.2 (Tanner *et al.*, 2013).

In addition to the screening, the participants answered a computer-based questionnaire about their socioeconomic background, dietary and oral hygiene habits, dental attendance, and treatment history. Originally developed at the University of Oulu for children in upper comprehensive schools, the questionnaire was revised for conscripts (Anttonen *et al.*, 2012) and validated in other studies (Anttonen *et al.*, 2008; 2011; 2012). The questionnaire's individual questions can be analysed separately or as summed scores. The association between the summed scores and demineralisation of the teeth has also been established (Anttonen *et al.*, 2008; 2011).

The aim of this study was to find an anamnestic set of questions which would have the best association with restorative treatment need at an individual level established on the basis of oral screening of young adults.

The hypothesis was that a limited set of questions can be established on the basis of statistical analyses, and the outcome of these questions can predict the results of the clinical screening for restorative treatment need.

## Material and methods

During the screening for restorative treatment need, the dentists used the WHO criteria (WHO, 1997) for epidemiological dental caries studies and the Defence Forces' protocol for registering restorative treatment need (scores 3, 4 and 5 indicating restorative treatment need or DT; whether the cause was a primary or secondary caries lesion or the tooth needed endodontics or extraction) (Anttonen *et al.*, 2012). The screening protocol has been detailed in earlier studies (Kämpfi *et al.*, 2013; Tanner *et al.*, 2013)

The dentists performing the screenings were trained and calibrated at two sessions in November 2010 and June 2011. They were advised to take BW radiographs to support screening if they found at least one lesion having penetrated into dentin (Anttonen *et al.*, 2012). The inter-examiner agreement of the dentists performing the oral examination was ICC=0.73 (range 0.32-0.85) before the January survey and ICC=0.71 (range 0.58- 0.86) before the July survey. The intra-examiner agreement was ICC=0.72 (range 0.28-0.94) across the November and June samples.

A computer-based questionnaire of 50 questions was made available to the conscripts to complete while waiting their turn for the oral screening (Anttonen *et al.*, 2012). Given the strict time limits set for Defence Forces' screening protocols not all conscripts had an opportunity to answer and none underwent oral screening twice or answered the questionnaire twice.

After the pilot study in 2010, the questionnaire was revised according to the issues raised. All persons in charge were also given structured instructions how to advise respondents if they needed clarification about specific questions. Three laptop computers were delivered to each garrison (altogether more than 40 computers) for answering the questionnaire.

Answering the questionnaire was voluntary, and by answering it, the conscripts gave their consent to use their personal military records. The medical trainees in the military service aided the conscripts with any ICT problems concerning the questionnaire. After the field survey, the medical trainees delivered the USB memory sticks with the data to the dentist in charge of the garrison, who then forwarded them for preparation of data (JP) and further analysis.

From the original set of questions 22 were chosen by consensus of the authors for closer analysis (Table 1). Consensus was reached after a careful consideration of the questions' clinical relevance with some of the questions being the same as those used by Levin *et al.* (2013). The responses to the 22 questions were dichotomised for further analyses (Table 1). Code 0 was given to any favourable response or a protective factor concerning restorative treatment need and code 1 to the opposite situation.

Wisdom teeth were excluded from all analyses. A multilevel analysis was applied to the data using gen-

eralised linear mixed models with a logit link function. The binary outcome variable was restorative treatment need (yes/no according to the screening) at individual and tooth level. The garrison or the examiner was considered as a random effect. Odds ratio (OR) values were first calculated using the generalised linear mixed model for the 22 selected questions ( $Q_{1-22}$ ). Among them the ten questions with the highest OR values ( $p < 0.05$ ) were chosen for the final set of questions ( $Q_{1-10}$ ). The OR values were recalculated using the generalised linear mixed model to meet both high OR value and  $p < 0.05$  criteria. The accuracy of the screening was investigated by calculating the AUC (area under curve) values. All analyses used the SPSS v18.0 software and R software (v2.15.1 patched, www.R-project.org).

Screening data were collected from the archived Finnish Defence Forces' records with permission. For identification, ID codes were created for all the conscripts. The key for the IDs and patient records is kept in the Defence Forces' archive. The main research plan was evaluated by the Ethical Committee of the Northern Ostrobothnia Hospital District, which gave its consent on 30 March 2010. The Centre for the Military Medicine of the Finnish Defence Forces gave its permission for the study in June 2010 (AG14218/23.6.2010).

## Results

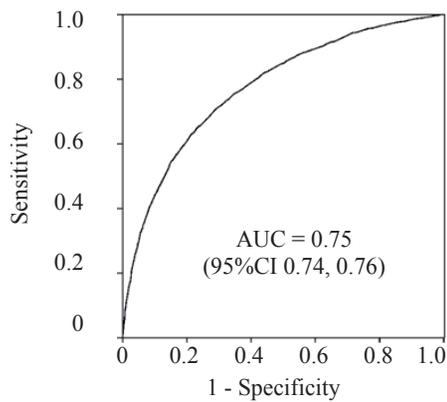
Of the 13,819 (13,564 men and 255 women) conscripts screened, 8,566 (62%) had time to answer the questionnaire and 37 of these left one or more questions unanswered, leaving 8,529 for inclusion in the analysis. The education level of the conscripts was: 9.8% basic education, 44.0% vocational education, 3.7% vocational education with general upper secondary education curriculum, 41.0% general upper secondary education or general upper secondary education curriculum, 0.2% university of applied sciences, 0.7% university, and 0.5% other. The mean DMFT value of the respondents was slightly higher than for all those screened (4.27 and 4.25, respectively). About 47% of the respondents had restorative treatment need (DT 1.50, sd 2.59); with about 80% having the DMFT > 0; these figures are similar for the screened group.

Table 1 shows the distribution of the responses to the 22 questions and the association between the responses and restorative treatment need (DT > 0). The 10 most predictive questions ( $Q_1-Q_{10}$ ) out of the 22 questions ( $Q_1-Q_{22}$ ) are presented in Table 2. For them, the OR values varied between 1.12 (95%CI 1.01, 1.23) and 4.61 (95%CI 4.16, 5.11). Of the questions, the question  $Q_1$ , 'Do you think you need dental treatment?', had the highest odds for restorative treatment need (Table 1).

The sensitivity of the sum variable ( $Q_{sum}$ ) of the questions increased with the increasing number of questions from  $Q_1$  to  $Q_{10}$  (Table 3). According to the summed variable, eight questions ( $Q_{sum}=8$ ) comprised explicit inclusion criteria for those needing restorative treatment (DT > 0) (sensitivity 1.00, specificity 0.02). On the other hand, practically every one of those whose responses all favoured oral health (i.e. summed variable = 0) had no restorative treatment need (sensitivity 0.05, specificity 0.99). The odds for restorative treatment need increased

**Table 1.** Distribution of responses (n=8,529 in all cases) to questions (Q<sub>1</sub>-Q<sub>22</sub>) and distribution considering the restorative treatment need (DT>0) of the respondents. Q<sub>1</sub>- Q<sub>10</sub> belonged in the final set of question.

<i>Questions and Responses</i>		<i>Respondents</i>	<i>DT&gt;0</i>
		<i>%</i>	<i>%</i>
Q <sub>1</sub>	Do you think you need dental treatment?		
	No	59.4	31.0
	Yes	40.6	71.0
Q <sub>2</sub>	Have you had your teeth restored?		
	No	24.5	24.3
	Yes	75.5	54.7
Q <sub>3</sub>	Your education?		
	University, General upper secondary, Vocational with general upper secondary	45.6	36.7
	Vocational, Basic education, Other	54.3	56.3
Q <sub>4</sub>	How often do you brush your teeth?		
	Every day or almost every day, Sometimes during the week	89.3	45.0
	Never or almost never	10.7	66.0
Q <sub>5</sub>	Do you smoke?		
	No	60.6	40.2
	Yes	39.4	58.1
Q <sub>6</sub>	Do you find visiting a dentist scary?		
	Not at all	66.8	41.8
	A little, Very much	33.2	58.2
Q <sub>7</sub>	How long ago did you visit an oral hygienist or a dentist?		
	<1 year, 1-2 years	81.6	45.0
	3-4 years or more, I don't remember	18.4	57.2
Q <sub>8</sub>	Do you skip brushing because you feel tired or you don't feel like brushing?		
	Never or almost never	45.7	39.6
	Every day or almost every day, Sometimes during the week	54.3	53.7
Q <sub>9</sub>	Did you visit the dentist last time because of toothache?		
	No	86.3	45.3
	Yes	13.7	59.5
Q <sub>10</sub>	How many € do you spend weekly on snacks (products like fizzy drinks and sweets)?		
	0-5 euros	44.9	42.4
	>6 euros	55.1	51.2
Q <sub>11</sub>	Your mother's education?		
	University, General upper secondary, Vocational with general upper secondary	38.4	40.7
	Vocational, Basic education, Other	61.6	51.3
Q <sub>12</sub>	Do you use an electronic toothbrush?		
	Every day or almost every day, Sometimes during the week	20.5	43.1
	Never or almost never	79.5	48.3
Q <sub>13</sub>	Have you had individual oral hygiene lessons?		
	Yes	37.2	47.8
	No	62.8	46.9
Q <sub>14</sub>	Do you use sucrose chewing gum?		
	No	92.3	46.8
	Yes	7.7	52.3
Q <sub>15</sub>	Do you have a chronic illness requiring regular medication?		
	No	92.1	47.2
	Yes	7.9	47.9
Q <sub>16</sub>	During past 6 months how often have you exercised or done sports?		
	1-2 times per week or more	78.2	45.2
	1-2 times per month, Never	21.8	54.8
Q <sub>17</sub>	Your father's education?		
	University, General upper secondary, Vocational with general upper secondary	30.2	39.9
	Vocational, Basic education, Other	69.8	50.4
Q <sub>18</sub>	Do you use sports drinks?		
	Never or almost never	76.8	46.9
	Every day or almost every day, Sometimes during the week	23.2	48.2
Q <sub>19</sub>	Have you had teeth extracted?		
	No	66.4	46.3
	Yes	33.6	49.0
Q <sub>20</sub>	Do you have any dental symptoms/toothache?		
	No	85.3	44.1
	Yes	14.7	65.6
Q <sub>21</sub>	Do you use energy drinks?		
	Never or almost never	51.0	43.1
	Every day or almost every day, Sometimes during the week	49.0	51.6
Q <sub>22</sub>	Do you use xylitol chewing gum?		
	Yes	88.2	47.1
	No	11.8	48.4



**Figure 1.** Receiver operating characteristic and area under curve value for the generalised linear mixed model of the association between restorative treatment need ( $DT>0$ ) and values for the summed variable of the chosen ten questions,  $Q_1-Q_{10}$

**Table 2.** Odds Ratio (OR) and confidence interval (95%CI) values from the generalised linear mixed model of the association between the restorative treatment need ( $DT>0$ ) and questions  $Q_1-Q_{10}$

Question in the final set	OR	95%CI	p
$Q_1$	4.61	4.16, 5.11	<0.001
$Q_2$	2.79	2.46, 3.16	<0.001
$Q_3$	1.60	1.44, 1.78	<0.001
$Q_4$	1.50	1.26, 1.78	<0.001
$Q_5$	1.39	1.25, 1.55	<0.001
$Q_6$	1.41	1.27, 1.57	<0.001
$Q_7$	1.38	1.21, 1.57	<0.001
$Q_8$	1.20	1.08, 1.33	<0.001
$Q_9$	1.18	1.02, 1.38	0.02
$Q_{10}$	1.12	1.01, 1.23	0.03

with increasing value of the summed variable (Table 3). When the explanatory weight of the generalised linear mixed model was taken in account, the AUC value for the entire question set  $Q_1-Q_{10}$ , the most predictive set of questions, was 0.75 (Figure 1).

## Discussion

According to the present study, a questionnaire with statistically chosen questions correlates well with the outcome of clinical screening for restorative treatment need. Screening a large population using this type of a questionnaire can therefore be considered a valid method for finding the individuals in need of restorative treatment. At the individual level, responses to specific questions provide a useful tool for planning individual caries control programmes.

The study group here is unique because military service is mandatory to all Finnish males, with full variation of sociodemographic variables, after turning 18 years. Those with physical or mental illnesses are exempted from the service. Four in five in each male age cohort enter the military service. Therefore all groups in the society, despite their background and socioeconomic status, are represented. Health examination is obligatory for conscripts during the first week of the service and includes oral screening precluding any dropout for that part of the data collection. In addition, the study group is large enough for drawing reliable conclusions.

The participants were called in for examination in groups and were given only limited time. The conscripts entered the clinical screening room in alphabetical order. While waiting their turn, they answered the questionnaire, assisted technically by medical trainees. No problems were reported by the staff or medical trainees concerning the questionnaire or the protocol. The original questionnaire with 50 questions took approximately 11 minutes per conscript to answer (Anttonen *et al.*, 2012). Consequently, a set of 10 questions should only take a couple of minutes to complete. The three computers at each garrison for

**Table 3.** Odds ratios and 95%CI values from the generalised linear mixed model on the association between the restorative treatment need ( $DT >0$ ) and values of sum variables of the final ten questions and probability profile for each variable.

$Q_{sum}$	OR	95%CI	p	Valid percent (%)	$DT=0$ (n)	$DT>0$ (n)	Total (n)	Sensitivity	Specificity
0	1			3.0	222	31	253	0.05	0.99
1	1.72	1.12, 2.63	0.01	8.2	568	130	698	0.18	0.96
2	2.86	1.92, 4.27	<0.01	13.4	823	317	1,140	0.36	0.88
3	4.01	2.71, 5.95	<0.01	18.3	1,014	548	1,562	0.58	0.75
4	6.47	4.37, 9.59	<0.01	18.2	831	719	1,550	0.77	0.57
5	10.22	6.89, 15.17	<0.01	16.5	603	803	1,406	0.90	0.37
6	20.10	13.42, 30.11	<0.01	12.0	285	742	1,027	0.97	0.18
7	29.35	19.09, 45.11	<0.01	6.8	123	458	581	0.99	0.07
8	69.27	39.40, 121.78	<0.01	2.9	25	219	244	1.00	0.02
9	79.13	31.24, 200.42	<0.01	0.8	6	59	65	1.00	0.00
10	$\infty$	0.00, $\infty$	0.94	0.0	0	3	3	1.00	0.00
Total				100.0	4,500	4,029	8,529		

answering the questionnaire were not enough, and only two thirds (59.8%) had time to respond to every question. Oral health of the questionnaire completers matches well that of all the conscripts. Therefore, the selection bias due to unavailability of time to complete the questionnaire can be considered only minimal.

The set of questions was tested during a pilot study, and minimal revisions were needed. In addition, all the dentists in charge of the garrisons were instructed how to assist respondents, particularly in certain questions (Anttonen *et al.*, 2012). A consensus about selecting the 22 questions out of the 50 original questions was reached by the authors, which raises speculation about the relevance of the question set. The literature supports the use of most of the 22 questions (Armfield, 2013; Borenstein *et al.*, 2013; Cochrane *et al.*, 2012; de Carvalho *et al.*, 2013; Dodds, 2012; Isaksson *et al.*, 2013; Jafarian and Etebarian, 2013; Robinson *et al.*, 2005; Samec *et al.*, 2013). The association between the final set of 10 questions and restorative treatment need at individual level according to screening proved to be very good. The statistical validation of the questions for the final set of 10 questions can therefore be considered relevant and as a strength of this study. The set of 10 questions established in the present study or a set of any 10 questions could become a part of any existing anamnestic questionnaire.

Seven out of the ten most predicting questions concerned oral health behaviour, dental attendance and treatment history, attitudes, and dental fear, which is in line with the existing literature (Armfield, 2013; Borenstein *et al.*, 2013; de Carvalho *et al.*, 2013; Dodds, 2012; Isaksson *et al.*, 2013). In addition, association of frequent smoking with restorative treatment need (Holmén *et al.*, 2013) was reconfirmed. The well-known fact that an individual's education level affects general health and oral health (WHO, 2014) was also reconfirmed. The question concerning money spent weekly on snacks (sweets and fizzy drinks) is a new approach in association with restorative treatment need. This question could be relevant anywhere in the world. Levin *et al.* (2013) and the findings of this study both emphasise the value of a well-chosen set of questions during the check-up. Levin *et al.* (2013) investigated the validity of a set of dental questions in their preliminary study on Israeli conscripts. Their conclusion was that a simple and easy-to-use questionnaire is a good screening tool to identify high risk patients among large populations. Levin *et al.* (2013) ended up using a very similar set of questions with us, mainly focusing on the individual's oral health behaviour – both studies were accomplished during the same time period unaware of one other's existence.

It is very likely that the sets of questions, however, should be different for different age, gender and cultural groups. For example, females were a very small minority in our study group and it can be speculated if these questions would have similar odds for treatment need among them. Restorative treatment need at individual level was used here as the response variable; but the variable could, of course, be periodontitis, especially for older study groups. Further prospective studies using specific sets of questions would be valuable for further verification of the method.

The best combination of sensitivity and specificity values was achieved at the  $Q_{sum}$  value 4. This value can

be considered as a trigger point for referring the patient for a more detailed inspection. The higher the  $Q_{sum}$  value is, the more definitely the patient should be referred for a detailed inspection. As suggested in this study, a patient with any 8 predisposing responses for restorative treatment need in the final set of 10 questions most likely has restorative treatment need and should be referred for a thorough inspection without delay. On the other hand, if one gives only one or zero predisposing responses, an inspection may be postponed and the recall period can be more than one year. A prospective study on determining the length of the recall period on the basis of the questionnaire would be interesting and valuable. Alternating screening and thorough inspections at certain individual intervals might be sufficiently reliable.

It is open to discussion whether the outcome of the clinical screening was reliable in our study. All the examiners were experienced and familiar with screening oral health in the required manner. In addition, caries diagnostics were emphasised in the training sessions. The examiners were advised to take BW radiographs to support screening if they found at least one lesion having penetrated into dentin. One shortcoming in our study setting is that a sample of the screened conscripts could not be brought in for rescreening to gain information about the reproducibility of the examiners. Furthermore, the use of the gold standard was not possible in the clinical setting because the screenings were carried out simultaneously in different parts of the country in a single week. The calibration of the dentist was carried out by evaluating treatment need on the basis of photographs and extracted teeth. According to the results, the reproducibility of the screening dentists in terms of the inter-examiner and intra-examiner agreement was very good.

The questions did not aim to estimate actual treatment need at tooth level. Those individuals needing restorative treatment found on the basis of a screening and/or questionnaire should be referred for a thorough examination and treatment planning. Even if no restorative treatment need is detected, the individual treatment plan should always include caries control (i.e. checking for visual plaque, active and inactive initial caries lesions and presence of gingivitis). The patient is always entitled to be informed about his/her individual needs in self-care. The set of 10 questions introduced here can be most helpful in determining individual weaknesses and needs in terms of self-care, e.g. dietary habits and tooth brushing.

## Conclusion

Anamnestic questionnaires are already widely used in clinical practice, and they are simple and quick to carry out. Questions determining reliably the treatment need at individual level could easily be included in the questionnaires. A selected set of questions together with clinical screening, or even alone, can be a valid instrument for screening people with restorative treatment need. This method could be useful in screening restorative treatment need of large populations such as military conscripts but also in public health care. The present statistical methods can be used to find the right sets of questions for different contexts. Further studies are needed to validate sets

of questions for females and different age and cultural groups. Those studies also could have, for example, periodontal disease as a response variable.

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