

ORIGINAL ARTICLE

Factors Influencing Anxiety Levels During Dental Radiographic Examination Among Dental Students

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ABSTRACT

Introduction: Dental anxiety was found to be related to the radiographic procedure and can be influenced by sociodemographic characteristics of patients such as age, gender, level of education, and provoking factors such as past dental examination experience. Evaluating the anxiety regarding dental radiographic examination could be beneficial in ensuring the procedure's continuance. This study aimed to measure the radiology knowledge among dental students and its association with anxiety due to dental radiographic examination. **Methods:** A cross-sectional study was conducted to collect the data using a questionnaire packet that included a knowledge and anxiety questionnaire, demographic data, and information about the experience of dental radiographic examination. A total sampling of 1st and 2nd year undergraduate and clerkship dental students at the Faculty of Dentistry, Universitas Gadjah Mada, Indonesia was selected based on inclusion and exclusion criteria. Anxiety-related factors were assessed using descriptive statistics and multiple linear regression conducted with STATA 15.1. **Results:** Results showed that knowledge and anxiety were negatively correlated but the correlation was not statistically significant. Gender, radiographic technique, and presence/absence of a companion during the examination were not correlated with anxiety. Meanwhile, the anxiety level was negatively and significantly correlated with age and examination frequency ($p < 0.05$). Multiple linear regression results showed strong evidence that age and examination frequency were the main factors for predicting anxiety. **Conclusion:** Although age, radiographic examination frequency, and educational level are significant bivariate predictors of anxiety, subsequent regression analysis indicated that only age and radiographic examination frequency influence anxiety.

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INTRODUCTION

Anxiety is an emotional condition that allows people to survive in the face of a threat (1). This condition can be considered a disorder when the individual's defense mechanism is abnormally regulated, resulting in an excessive response. Anxiety can strike at any time, including during a dental and oral examination, commonly referred to as dental anxiety. Dental anxiety is caused by a feeling of stress in response to dental treatment due to specific or non-specific factors (2,3).

Dental procedures can cause anxiety and fear in

patients, making it difficult to maintain good oral health. Patients' fear and perception of pain increase because of stress, thus reducing their ability to cooperate with the treatment (1). The procedures that use a drill or needle seem to cause the most anxiety. More people report experiencing pain after invasive procedures like subgingival scaling, deep probing, fillings, extractions, and root canal therapy (4). Dental anxiety is relatively common in developing countries with prevalence ranging from 4% to 20%. The prevalence of dental anxiety in Indonesia reaches 22% (5) and is affected by a combination of factors, including age, gender, dental experience, environment, ethnicity, culture, parental anxiety, psychological condition, education, and socioeconomic status (6,7).

The study showed that the older the patient, the lowest the anxiety level will be. Age is related to experience

and the aging process itself. Adult individuals have a good coping mechanism that allow them to be more able to control themselves against a threat (8-10). Anxiety is more experienced by women than men. This is because men are considered to have a stronger mentality in the face of a threat to themselves. Women tend to respond more when facing dangerous threats to themselves as they are physically weaker (8-11).

Oral health knowledge influences health-related behavior. Dental students have lower levels of dental anxiety than students from other majors such as medicine, engineering, or art (12,13). The high level of dental anxiety among non-dental university students is due to the lack of adequate dental health education. Yildirim et al (11) stated that a person’s awareness of dental issues increases with his/her education level, leading to less dental anxiety. The link between a person’s education and socioeconomic status is controversial. A person with low socioeconomic status and education level is likely to experience dental anxiety (7). However, some studies did not find any link between education and dental anxiety (7,18,14).

Another study discovered that dental x-rays are second of the most feared treatments in dental therapy, just behind injections (15). The use of dental x-rays during treatment increases anxiety levels (15,16). The negative stimulus embodied by x-rays is due to the discomfort induced by the film placed in the mouth and the patient’s fear of being exposed to ionizing radiation (15,17). Dental anxiety has been widely studied; however, knowledge regarding anxiety caused by dental radiographic examinations is lacking.

One of the subjects in the dentistry curriculum is radiology. Dental radiographic examinations should be more well-accepted as a result of personal radiology knowledge. Therefore, the present study examined the degree of radiology knowledge among dental students according to their education level and its association with anxiety due to dental radiographic examination. Additionally, we explored differences in the degree of anxiety according to gender, radiographic technique, presence/absence of a companion during examination, age, and examination frequency.

MATERIALS AND METHODS

Sample selection and data collection process

This is a cross-sectional study design with a total sampling of 1st and 2nd year undergraduate and clerkship dental students in the Faculty of Dentistry, Universitas Gadjah Mada, Indonesia. The data were collected from 9th to 28th September 2021 in the Faculty of Dentistry, Universitas Gadjah Mada, Indonesia. Dental students were chosen because the radiology education curriculum was required to measure their knowledge. The inclusion criteria of the students were as follows:

- a) 1st year students, before the lecture,
- b) 2nd year students, right after the lecture including basic radiation physic and biology, radiation protection, radiography, radiological interpretation and
- c) clerkship students (clinical training), before graduation.

From the total sampling of 405 students of 1st and 2nd year undergraduate and clerkship dental students, forty students refused to participate and 10 students took an academic leave, therefore they were excluded. A total of 355 students who met the criteria filled out the knowledge questionnaire. Among the respondents, only 183 who had previous radiographic examination experience were directed to fill out the questionnaire about anxiety. A flow chart of the sample selection and data collection process was presented in Figure 1. The questionnaire was electronically based, and distributed online through Google Forms by Line and WhatsApp social media platforms.

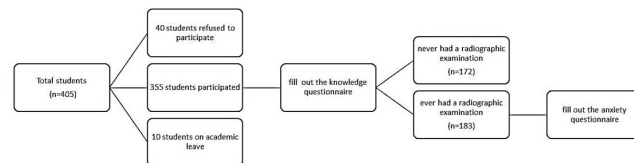


Figure 1: Flow chart

Questionnaire

The questionnaire was divided into three sections. The first section was used to collect data regarding the gender, age, educational level, and previous dental radiography experience, including frequency, radiography technique, and presence/absence of a companion. The second section was a modified questionnaire from Srivastava et al.(19) and was pilot tested, composed of 12 multiple-choice questions to measure the level of understanding related to radiation risk and protection. Each question was allocated 1 mark for the correct response and 0 marks for the wrong answer. The third section involved the self-evaluation of anxiety levels and was modified from the hierarchic anxiety questionnaire (HAF) by Juhren. (18) The anxiety questionnaire was adjusted to the respondent’s feelings toward dental radiographic examinations. The modified HAF consists of 13 questions, each with five possible responses scored on a 5-point scale ranging from 1 to 5, with 1 indicating “calm” and 5 indicating “fearful.” The overall maximum score is 65. The final anxiety assessment was given by the sum of the score for each question: less than 13 points-no anxiety; 14–26 points-low anxiety, 27–39 points-moderate anxiety, 40–52 points-high anxiety, and 53–65 points-severe anxiety with phobia tendency. All questionnaires were written in Bahasa Indonesia, and a pilot test was performed to determine their content clarity. To reduce information bias, the questions were tested for validity and reliability in 30 subjects within the groups. The Cronbach’s alpha showed 0.706 and 0.918 for the knowledge and anxiety questionnaires, respectively. In addition, in

the questionnaire there was contact information of the researcher for the subjects who had questions regarding the content of the questionnaire.

Statistical Analysis

Data were analyzed using STATA software version 15.1 (Stata Corp., College Station, TX, USA). Sociodemographic data were subjected to univariable data analysis and presented in the form of frequency, percentage, mean, and standard deviation. Bivariable analysis was carried out using Wilcoxon rank-sum (Mann-Whitney) test and Kruskal Wallis test to assess the difference in the mean scores of knowledges and anxiety on each characteristic, followed by Tukey's Post Hoc test to compare the differences between groups characteristics. The correlation between knowledge and anxiety was analyzed using Spearman rank correlation. The relationship between anxiety and its correlated factors was analyzed by multiple linear regressions. A significance level of $p < 0.05$ and a 95% confidence interval (CI) were established for all analyses.

Ethical clearance

The study was carried out in strict conformity with ethical norms, including the World Medical Association's Helsinki Declaration and approved by Research Ethics Committee, Faculty of Dentistry, Universitas Gadjah Mada No. 00760/KKEP/FGK-UGM/EC/2021.

RESULTS

A total of 355 dental students responded to the questionnaire as provided in Table I. The majority of the respondents were females (86.5%) and from the age group 17–20 years (70.7%). Data distribution by educational level showed that most of the respondents were 1st-year students (36.9%). Among the respondents, 51.5% ($n = 183$) had received radiographic examinations, and the rest had not received any radiographic examination and did not proceed to answer the next question about examination experience. Of one hundred eighty-three respondents who had received a radiographic examination, most of them were examined once (40.98%), had experienced extraoral radiographic examination (53.6%), and were accompanied during the process (56.8%). Those respondents proceed to a questionnaire about anxiety toward radiographic examinations. The majority of the students had low anxiety levels toward dental radiographic examinations (44.51%) followed by no anxiety (40.11%) as listed in Table I.

The comparison of each variable based on the knowledge score on radiation risk and protection is reflected in Table II. Significant differences in knowledge level were observed among all observation groups ($p < 0.01$), except for knowledge score on radiation risk and protection comparison between males and females. The anxiety levels differed significantly within radiographic

Table 1: Demographic data and radiographic examination experiences

Demographic data	n (%)
n total =355	
Gender	
Male	48 (13.5)
Female	307 (86.5)
Age	
17-20	251 (70.7)
21-24	93 (26.2)
25-28	11 (3.1)
Educational level	
1 st year	131 (36.9)
2 nd year	120 (33.8)
Clerkship	104 (29.3)
Radiographic examination experience	
Ever	183 (51.5)
Never	172 (48.5)
n total =183	
Radiographic examination experience frequency	
1	75 (40.98)
2	61 (33.33)
3	20 (10.93)
>3	27 (14.75)
Radiography technique	
Intraoral	17 (9.3)
Extraoral	98 (53.6)
Both	68 (37.2)
Presence of companion	
Yes	104 (56.8)
No	46 (25.1)
Both	33 (18.0)

Table II: Comparison of knowledge score on radiation risk and protection between demographic data and radiographic examination experience (n=355)

Demographic data	Knowledge score				
	Observation	Rank sum	Statistic test	d.f.	p-value
Gender					
Male	48	8173	-0.564 ^z	1	0.57 ^a
Female	307	55017			
Age					
17-20	251	38165	54.94 ^x	2	<0.001 ^{b****}
21-24	93	22509			
25-28	11	2515			
Educational level					
1st-year	131	11414	164.44 ^x	2	<0.001 ^{b****}
2nd-year	120	26751			
Clerkship	104	25025			
Radiographic examination experience					
Ever	183	37289.5	4.9 ^x	1	<0.0001 ^{a****}
Never	172	25900.5			

^a: determined using a Wilcoxon rank-sum (Mann-whitney) Test

^b: determined using Kruskal Wallis test

^x: chi-square value

^z: mann-whitney value

d.f.: degree of freedom

****: statistically significant $p < 0.001$

****: statistically significant $p < 0.0001$

examination frequency only ($p < 0.05$) as shown in Table III. The highest anxiety level scores were from the respondents who had their first examination.

Spearman Rank was used to identify the correlation between two assessed domains in Tables II and III: knowledge score on radiation risk and protection and anxiety level. The correlation results in Figure 2

Table III: Comparison of anxiety score between demographic data and radiographic examination experience (n=183)

Demographic data	Anxiety score				
	Observation	Rank sum	Statistic test	d.f.	p-value
Gender					
Male	20	1415	-1.93 ^z	1	0.053 ^a
Female	162	15238			
Age					
17-20	84	8398.5	4.33 ^x	2	0.11 ^b
21-24	87	7311			
25-28	11	943.5			
Educational level					
1st-year	37	3417.5	5.8 ^x	2	0.055 ^b
2nd-year	47	4981			
Clerkship	98	8254.5			
Radiographic examination experience frequency					
1	74	7819.5	10.2 ^x	3	0.017 ^{b*}
2	61	5180.5			
3	20	1565			
>3	27	2088			
Radiography technique					
Intraoral	17	1600.5	3.94 ^x	2	0.14 ^b
Extraoral	97	9484			
Both	68	5568.5			
Presence of companion					
Yes	103		0.44 ^x	2	0.8 ^b
No	46				
Both	33				

^a: determined using a Wilcoxon rank-sum (Mann-whitney) Test

^b: determined using Kruskal Wallis test

^x: chi-square value

^z: mann-whitney value

d.f.: degree of freedom

^{*}: statistically significant p<0.05

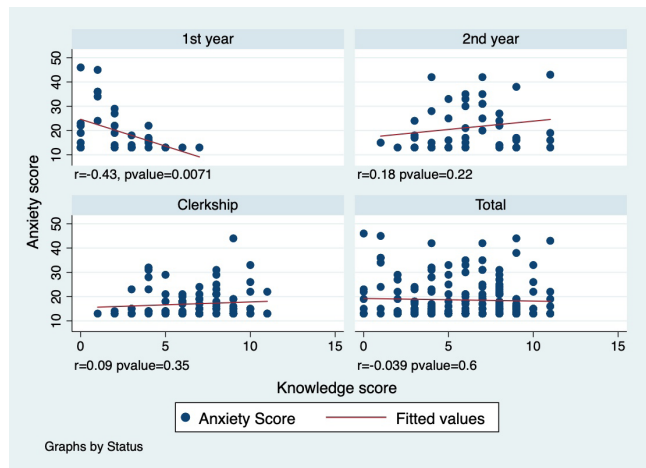


Figure 2: Correlation between dental radiology knowledge score on radiation risk and protection and anxiety levels

indicated a negative correlation between knowledge score on radiation risk and protections and anxiety levels. Therefore, increasing the knowledge score on radiation risk and protection will reduce anxiety by 0.039 points. However, this correlation had no statistical significance. Table IV shows the simple linear regression analysis results to analyze which group was associated with anxiety levels. Age, educational level, and examination frequency were all significant predictors (p <0.05) of anxiety levels among the respondents. Age reduced anxiety by 5.7 points, thus contributing 3.5% to

Table IV: Simple bivariate regression analysis for the variables predicting the anxiety level (n=183)

Variables	Coefficient	Constant	R ² /adjusted R ²	p-value
Age	-5.7	30.73	0.035	0.011 [*]
<i>Educational level</i>				
1 st year	ref	19.48	0.04	0.0065 [*]
2 nd year	1.76			0.292
Clerkship	-2.45			0.097
Radiographic examination experience frequency	-1.74	22.10	0.055	0.001 [*]
<i>Radiography technique</i>				
Intraoral	ref	20.65	0.0189	0.06
Extraoral	-1.2			0.55
Both	-3.7			0.07
<i>Presence of companion</i>				
Yes	ref	19.38	0.002	0.30
No	-2.05			0.14
Both	-1.31			0.39

Coeff: Coefficient regression/ slope

Constant: constant of regression equation

R²: Coefficient of determination

Adjusted R²: Adjusted Coefficient of determination

^{*}: statistically significant p<0.05

^{**}: statistically significant p<0.01

^{***}: statistically significant p<0.001

predicting anxiety levels. The educational level had a 4% effect on anxiety: a high educational level was associated with low anxiety. Examination frequency, which showed a negative correlation with anxiety, contributed 5.5% more to anxiety than other variables. Therefore, frequent examination will reduce anxiety by 1.74 points. Radiographic technique and presence/absence of a companion during the examination were not associated with anxiety.

Table V shows the three significant predictors of anxiety levels, i.e., age, educational level, and radiographic examination frequency used to develop multiple linear regression models. Model 1 shows age as the single predictor of anxiety. According to bivariate regression analysis, age was negatively correlated with anxiety. Model 2 combines age and educational level to predict anxiety. In this model, age and educational level were positively correlated with anxiety, but the correlation was not statistically significant. Model 3 predicts anxiety based on age, educational level, and radiographic examination frequency. In this model, radiographic examination frequency was significantly negatively correlated with anxiety. Regardless of age or educational level, increasing radiographic examination frequency will reduce anxiety by 1.275 points. Model 4 has the combination of educational level and radiographic examination frequency as a predictor of anxiety. Examination frequency continued to have a significant negative correlation with anxiety, but educational level has no significant correlation. Model 5 predicts anxiety only with variable radiographic examination frequency. This variable still showed a significant negative correlation with anxiety. For the last Model 6, variable radiographic examination frequency is combined with age. Both variables showed significant negative correlations with anxiety. Model 6 contains variables

Table V: Regression models predicting anxiety (n=183)

	Anxiety score					
	Model 1 Coeff SE	Model 2 Coeff SE	Model 3 Coeff SE	Model 4 Coeff SE	Model 5 Coeff SE	Model 6 Coeff SE
Age	-0.574* (0.224)	0.0994 (0.547)	0.205 (0.544)			-1.254* (0.514)
<i>Educational level</i>						
1 st year		Ref	Ref	Ref		
2 nd year		1.692 (1.731)	1.588 (1.715)	1.746 (1.659)		
Clerkship		-2.957 (3.129)	-2.264 (3.116)	-1.248 (1.567)		
<i>Radiographic examination frequency</i>			-1.275* (0.602)	-1.255* (0.598)	-1.743** (0.534)	-11.6* (4.910)
<i>Age # Radiographic examination experience Frequency</i>						0.469* (0.224)
Constant	30.73*** (4.770)	17.68 (10.03)	17.65 (9.931)	21.35*** (1.527)	22.11*** (1.208)	47.95*** (10.68)
N	183	183	183	183	183	183
Adjusted R-squared	0.030	0.039	0.057	0.062	0.051	0.071
AIC	1260.5	1260.7	12581	1256.3	1256.5	1254.5
BIC	1266.9	1273.5	1274.2	1269.1	1262.9	1267.3

Coeff: Coefficient regression/ slope

SE: Standard error

N: observation

Adjusted R-squared: Adjusted Coefficient of determination

AIC: Akaike Information Criterion

BIC: Bayesian Information Criterion

*: statistically significant p<0.05

**: statistically significant p<0.01

***: statistically significant p<0.001

that can predict anxiety with statistical significance and consistently reduce the anxiety score.

DISCUSSION

To the best of our knowledge, this study is the first to examine the factors influencing the anxiety toward dental radiographic examinations among dental students. Some factors such as knowledge, age, gender, and dental radiographic examination experience were analyzed. Clerkship students received higher mean dental radiology knowledge score on radiation risk and protections than 1st- and 2nd-year students. Good education gives students access to health information and can partly account for this result. In the Faculty of Dentistry, National University, Indonesia, a 26-hour series of radiology courses and 20-hour basic practical training are delivered in the 2nd year lectures. A 60-hour clinical training is given to clerkship students. Therefore, 1st year students who have not received radiology lectures showed the lowest knowledge score on radiation risk and protection about radiology. These results are in concordance with a previous study, which stated that clerkship students have the highest dental radiology knowledge, followed by 4th and 3rd year undergraduate students (19,20). This finding indicated that dental students with a high level of education have high dental radiology knowledge. Therefore, to raise the public's awareness about dental radiography, it is feasible to educate everyone about x-rays to the level of a dental student.

Clerkship students were less anxious than 1st and 2nd year students due to their enhanced education, professional development, and clinical experience. These findings are similar to previous studies, which stated that dental anxiety decreases when the study advances (12,13). There are differences in the degree of dental anxiety between dental students with different levels of education. Because they were exposed to more dental treatments throughout their college years, senior dental students reported lower levels of dental anxiety than their junior counterparts (environmental habituation) (14).

Increasing knowledge score on radiation risk and protection also lowered the anxiety levels, but the value was not significant. This finding coincided with previous results (8,10,14). Nonetheless, other authors claimed that education has a significant impact on reducing dental anxiety and is inversely associated with anxiety levels (21,22). The difference might be due to the prior studies being conducted on a broad range of subjects from primary school students to university students. Meanwhile, the subjects in the present study were solely university students. Expanding the research population by involving subjects with low education levels is necessary to confirm the lack of relationship between educational level and anxiety.

The strengths of this study include the use of multiple linear regression models to examine in detail the relationship of various dependent variables that

influence the anxiety level, consisting of knowledge, age, and dental radiographic examination experience. According to the multiple regression model, only age and radiographic experience frequency showed the strongest and most consistent anxiety-related factors. Increased anxiety levels were observed in the 17-20 age group. Although the result is consistent with the trend indicated in published studies, variances still remained. The prevalence of dental anxiety was lower among adult patients. Anxiety can decrease with age because older participants have had more time for positive experiences to counteract negative ones (4,23). This phenomenon might result from the wide and intense psychological influence of several factors in this age group, eventually causing dread and dental anxiety. Practically, this study has implications for young people who are undergo dental radiography examination for the first time. They require more attention, for example the operator explains in detail the procedure that they are going to do.

The students' anxiety levels were reduced when they frequently underwent dental radiography examinations. This result is consistent with several study findings, which stated that patients who have no previous dental experience are more anxious than patients who visit the dentist frequently or on a regular basis (4). According to Jeddy et al (3) who studied patients receiving dental treatment, anxiety levels are similarly low in individuals who had received dental treatment more than three times. Furthermore, students who had negative dental experiences reported higher levels of dental anxiety than those who had good experiences. Thus, it is reasonable to conclude that positive experiences have the ability to alleviate dental anxiety (13). Costa et al (16) studied a particular biomarker of anxiety level in saliva and discovered that the synthesis of the enzyme alpha-amylase increases before a dental surgery. The patient may have no idea how the X-ray machine will work during his or her first radiographic examination.

As the first to assess the factors correlated with the anxiety toward dental radiographic examinations, this research suggested that age and radiographic examination frequency play a central role in influencing anxiety. However, some limitations must be addressed. First, the results cannot be considered representative of the entire nation because this research was conducted in a single institution and only with dental students. Second, multiple linear regression results showed that 7% of the anxiety level factors can be predicted by age and radiographic experience frequency; however, 93% of other factors cannot be predicted as a source of anxiety. Third, the number of men and women in the study participants is not equal because most of dental students are women. Therefore, we did not discuss the difference in anxiety levels between men and women. The alternative hypothesis is accepted since increasing age and radiographic examinations frequency have a substantial effect on the reduction of anxiety scores

among dental students who would be exposed. In summary, our study has provided the first evidence that age and radiographic examination frequency influence the anxiety toward dental radiographic examination in dental students. Future studies using samples from many colleges and a balanced proportion of men and women respondents must be conducted to enhance the results. In addition to knowledge, age, gender, and dental radiographic examination experience, other aspects must be considered to address the remaining factors related to anxiety. According to recent study, the level of anxiety during dental radiography examination was associated by age. Further research on anxiety during dental radiography examinations can be carried out to young people including elementary, junior high, and high school students.

CONCLUSION

Several factors believed to affect the anxiety of dentistry students have been investigated. In conclusion, age, educational level, and radiographic examination experiences all significantly affected knowledge scores of radiation risk and protection. Furthermore, there are significant differences in anxiety scores depending on the frequency of radiographic examination. The strongest factors associated with anxiety were age and the frequency of radiographic experience.

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