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Use of Multi-Response Logistic Regression to Determine the Factors Affecting the Radiation Values of Light-Curing Units in Private Dental Clinics in Erbil

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Abstract

This study aims to determine the exposure of dentists to radiation resulting from the use of light therapy units and to assess their risk and impact on dental clinics . This study was conducted in private dental clinics in the city of Erbil in northern Iraq. Surveys were conducted to collect information about light-curing units. The results were analysed using the multi-response logistic regression to determine the factors affecting the radiation values of light-curing units. The results of the study showed that five major variables have a major effect by radiation. This is shown with a value of $P \leq 0.05$. Typical treatment times with radiant light, with a typical number of daily restorations, may exceed the risk limits for blue light reflected on eyes. This is given that the responding dentists did not protect their eyes with enough blue light .Technology in dentistry requires the operator to have knowledge of basic technical specifications and the safe use of devices and tools routinely used in dental treatment.

Keywords: The radiance values, light-curing units and dental offices, multi-response logistic regression..

استخدام الانحدار اللوجستي متعدد الاستجابة لتحديد العوامل المؤثرة في القيم الإشعاعية لوحدات المعالجة بالضوء في عيادات الأسنان الخاصة في أربيل

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الخلاصة

تهدف هذه الدراسة إلى مدى تعرض أطباء الأسنان للاشعاع للاستخدام العملي لوحدات المعالجة بالضوء وتأثير خصائصها وخصائصها التقنية بالإضافة إلى وعيهم بالسلامة من هذا الإشعاع. أجريت هذه الدراسة في عيادات الأسنان الخاصة في مدينة أربيل شمال العراق. تم إجراء المسوحات وجمع المعلومات حول وحدات

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المعالجة بالضوء باستخدام مقياس إشعاع. تم تحليل النتائج باستخدام الانحدار اللوجستي متعدد الاستجابة لتحديد العوامل المؤثرة في قيم الإشعاع لوحدات المعالجة بالضوء وأظهرت نتائج الدراسة أن خمسة متغيرات رئيسية لها تأثير كبير على الإشعاع وهذا موضح بقيمة P 0.05 . قد تتجاوز أوقات العلاج النموذجية بالضوء المشع ، إلى جانب العدد المعتاد من الترميمات اليومية ، حدود مخاطر الضوء الأزرق المنعكس على العينين. هذا أمر مقلق ، نظرًا لأن أطباء الأسنان المستجيبين لم يحموا عيونهم بما يكفي من الضوء الأزرق. بسبب الاعتماد اليوم على التكنولوجيا الحديثة في طب الأسنان ، يجب أن يكون طبيب الاسنان على دراية بالمواصفات الفنية الأساسية بالإضافة إلى التشغيل الآمن للأجهزة والأدوات شائعة الاستخدام.

1. Introduction

Background radiation is a measure of the level of radiation present in the environment at a particular location which is not due to deliberate introduction of radiation sources. The energy of the radiation increases from left to right as the frequency rises. The equivalent dose (or effective dose) is the radiation dose to tissues taking into consideration the different biological effects due to the different types of radiation. For beta and gamma radiation, the dose equivalents equal the absorbed dose. Conversely, the dose equivalent is greater than the absorbed dose for alpha and neutron radiation, because these types of radiation are more harmful to the human body. Units of equivalent dose are the roentgen equivalent man (rem) and the sievert (Sv). Biological equivalent dose are commonly measured in 1/1000th of a rem (known as a millirem or mrem[1,2,3].

The use of light sources for treatment has become essential everywhere and these sources can be considered a major part of the equipment in every dental clinic. A large number of dental research and clinical treatments depend on the use of compound resin and light devices used in dental treatment. To achieve good mechanical properties of the composites included in the light-treated resins, the material must receive sufficient energy and appropriate wavelengths [4,5, 6].

There are different types of light treatment sources, including plasma, tungsten halogen quartz, laser, and light-emitting diode modules. These light treatment sources differ in price which is considered one of the influencing factors when purchasing new sources of light therapy. The intensity of the light produced by these devices refers to the radiation emitted for each part of the resin compound and to the surrounding areas [7,8].The value of incident radiation, expressed in watt /cm^2, is the total radiation energy(Watt) supplied by light source to treat an area of known dimensions (cm^2).This energy can reflect the average value over the total surface area and does not take into account the irregularity of the light produced at the tip of the light sources. Dentists also need to know the wavelength of the light emitted by these sources, to make these modules compatible with a wide range of optical devices, the wavelength of light must be matched with its ability to be absorbed by different materials [9,10]. LED modules (light emitting diode) include a wide range of wavelengths, which are located in the violet area of visible light,

2. Materials and Methods

This study was conducted in private dental clinics in the city of Erbil in northern Iraq. A total of 55 private dental clinics were chosen by systematic random sampling. Private dental clinics were visited, and the consent of the dentists of private clinics was obtained after knowing the rationale and purpose of the study. A table was designed to record information about light-curing units. Information were collected related to the following: age (years), type and intensity of the unit in (mW/cm^2) , the unit's most recent maintenance date, the

approximate number of times the unit is used during a day, the exposure time for each treatment period in second and the radiation dose from the unit (for both LED and Quartz-Tungsten Halogen (QTH) using radiometric specifications (1PC XH-901 dosage rate: 0.01 μ Sv/h to 150 mSv/h), the dosage rate was recorded three times from each LED unit and the average dosage was determined, also three measurements were recorded for each QTH unit and the average dosage was determined. The ordinal logistic regression procedure, or PLUM (**Pol**ytomous **U**niversal **M**odel), is an extension of the general linear model to ordinal categorical data. This procedure makes use of a general class of models to allow the analysis of the relationship between a polytomous ordinal dependent variable (consists of more than two categories) and a set of predictors (independent variables).
The multiple logistic models take the form: [11]

$$P_i = \frac{e^{\beta_0+\beta_1 X_{1i}+\beta_2 X_{2i}+\cdots+\beta_k X_{ki}}}{1+e^{\beta_0+\beta_1 X_{1i}+\beta_2 X_{2i}+\cdots+\beta_k X_{ki}}} \qquad i = 1,2,\dots,n \qquad \dots\dots\dots(1)$$

Where: P_i is the dependent variable (probability of event) such that $0 \leq P_i \leq 1$
$\beta_0, \beta_1, \beta_2, \cdots, \beta_k$: are the model parameters
$X_{1i}, X_{2i}, \cdots, X_{ki}$: are the independent variables
e : is the base of natural log, such that $e = 2.718$
Equation 1 can be written as:

$$\frac{P_i}{1-P_i} = e^{\beta_0+\beta_1 X_{1i}+\beta_2 X_{2i}+\cdots+\beta_k X_{ki}} \qquad \dots\dots\dots(2)$$

The quantity $\frac{P_i}{1-P_i}$ is called the odds ratio (OR). Taking the natural log ($\log_e$) for both sides of Equation 2 results in [11,12]:

$$Logit = Log_e(Odds) = Log_e\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki}. \dots\dots(3)$$

"Logit" is a linear combination of independent variables. In our study, "logit" represents the dependent variable which is the radiation rate, and we have six independent variables with 55 observations, so equation 3 becomes:

$$Logit = Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \beta_6 X_{6i} \qquad \dots\dots(4)$$

Where: Y : equivalent dose rate ($\mu Sv/h$), the dependent (response) variable which takes four values (0.16, 0.18, 0.20 and 0.22).
X_1: Age of unit (years), the 1st independent variable which consists of three categories (< 1, 1 – 3 and > 3).
X_2: Type of unit, the 2nd independent variable which consists of two categories (LED and QTH).
X_3: Intensity of unit (mw/cm^2), the 3rd independent variable which consists of three categories (<300, 300 – 900 and 900 – 1500).
X_4: Last maintenance date of unit (months), the 4th independent variable which consists of four categories (no , < 12 , 12 – 24 and > 24).
X_5: Daily number of times the unit is being used, the 5th independent variable which consists of three categories (<4, 4 – 8 and > 8).
X_6: Exposure time per treatment period (seconds), the 6th independent variable which takes four values (10, 20, 30 and 40).

It is clear that the multiple logistic regression model (Equation 4) refers to the regression model that considers logit as dependent variable; the amount of change is calculated in the logarithm of the weighting factor of the dependent variable and not in the dependent variable itself as is the case in linear regression analysis[13,14].

3. Results and Discussion

A total of 55 readings were recorded about the emitted radiation rate from the used light-curing units in private dentists clinics in Erbil as dependent (response) variable and six other independent (predictors) variables as shown in Table 1.

Table 1: Research Data

Unit No.	Radiation rate $\mu Sv/h$	Unit age (years)	Unit type	Unit intensity (mw/cm^2)	Unit last maintenance date (months)	Unit daily used times number	Exposure time/ treatment period (seconds)
1	0.16	1-3	LED	900-1500	no	> 8	20
2	0.16	1-3	LED	900-1500	no	< 4	20
3	0.16	1-3	LED	900-1500	no	< 4	30
4	0.16	< 1	LED	< 300	no	< 4	40
5	0.16	1-3	QTH	< 300	no	< 4	30
6	0.16	> 3	LED	300-900	> 24	< 4	20
7	0.16	> 3	QTH	< 300	> 24	< 4	40
8	0.16	1-3	QTH	< 300	no	4-8	20
9	0.22	> 3	LED	300-900	> 24	4-8	20
10	0.18	1-3	LED	900-1500	no	> 8	10
11	0.18	1-3	LED	900-1500	no	4-8	40
12	0.18	1-3	LED	900-1500	no	> 8	40
13	0.18	1-3	LED	900-1500	no	4-8	30
14	0.16	> 3	QTH	< 300	> 24	4-8	30
15	0.18	1-3	LED	300-900	no	> 8	30
16	0.18	< 1	LED	< 300	no	> 8	30
17	0.18	1-3	LED	900-1500	no	4-8	40
18	0.18	1-3	LED	900-1500	no	< 4	20
19	0.18	1-3	LED	900-1500	no	< 4	10
20	0.18	1-3	LED	900-1500	no	< 4	40
21	0.18	1-3	LED	900-1500	no	< 4	40
22	0.18	1-3	LED	900-1500	no	< 4	30
23	0.18	1-3	LED	300-900	no	< 4	40
24	0.18	> 3	QTH	< 300	> 24	4-8	40

25	0.18	> 3	LED	300-900	> 24	4-8	20
26	0.18	1-3	LED	300-900	12-24	> 8	20
27	0.18	1-3	LED	300-900	12-24	> 8	40
28	0.18	1-3	LED	300-900	12-24	4-8	30
29	0.20	< 1	LED	300-900	12-24	4-8	40
30	0.20	1-3	LED	300-900	12-24	> 8	40
31	0.20	1-3	LED	300-900	12-24	4-8	40
32	0.20	1-3	LED	300-900	12-24	4-8	20
33	0.18	> 3	QTH	900-1500	> 24	4-8	40
34	0.18	> 3	LED	300-900	> 24	> 8	40
35	0.20	1-3	LED	300-900	12-24	4-8	40
36	0.20	1-3	LED	300-900	12-24	> 8	10
37	0.20	1-3	LED	300-900	12-24	> 8	40
38	0.20	< 1	LED	300-900	no	4-8	30
39	0.20	1-3	LED	300-900	12-24	4-8	30
40	0.20	1-3	LED	300-900	12-24	4-8	30
41	0.20	1-3	LED	300-900	12-24	> 8	40
42	0.22	1-3	LED	300-900	12-24	4-8	40
43	0.22	1-3	LED	300-900	no	4-8	10
44	0.18	> 3	QTH	300-900	> 24	4-8	30
45	0.18	> 3	LED	300-900	> 24	4-8	40
46	0.22	< 1	LED	< 300	no	4-8	40
47	0.18	> 3	LED	300-900	no	> 8	30
48	0.22	< 1	LED	300-900	no	4-8	30
49	0.22	1-3	LED	300-900	no	4-8	10
50	0.18	> 3	LED	300-900	no	> 8	30
51	0.22	1-3	LED	300-900	no	4-8	30
52	0.18	> 3	LED	300-900	> 24	4-8	30
53	0.22	1-3	LED	300-900	no	> 8	40
54	0.20	> 3	QTH	300-900	> 24	4-8	40
55	0.22	1-3	LED	300-900	no	> 8	30

Multiple Ordinal logistic regression models were fitted based on the data displayed in Table 1 using SPSS-software version 26 with ordinal outcomes (ordered logit) link function specification. The model is fit through the procedure of maximum likelihood estimation. The quality of the model was verified by calculating overall measures of fit, and there are several

important measures that help in evaluating the final model of the data, like: differences, coefficient of determination, goodness of fit test, likelihood ratio test, ROC analysis in addition to classification tables. The model was fitted to the data in Table 2.
The equivalent dose rate from the light-curing units used includes four categories: 0.16 µSv/h, 0.18 µSv/h, 0.20 µSv/h and 0.22 µSv/h with light-curing units ratios of 16.4%, 45.5%, 21.8% and 16.4%, respectively.

Table 2: Radiation rate status according to selected independent variables

Variables	N	Radiation rate $\mu Sv/h$				Chi-square	Degree of freedom df	P-value
		0.16	0.18	0.20	0.22			
X_1: Age of unit								
< 1 year	6 (10.9%)	16.7%	16.7%	33.3%	33.3%			
1 – 3 years	35 (63.6%)	14.3%	42.9%	25.7%	17.1%	6.337	6	0.387$^{n.s.}$
> 3 years	14 (25.5%)	21.4%	64.3%	7.1%	7.1%			
X_2:Type of unit								
LED	47 (85.5%)	10.6%	46.8%	23.4%	19.1%			
QTH	8 (15.5%)	50.0%	37.5%	12.5%	0.0%	8.508	3	0.037*
X_3: Intensity of unit								
< 300 mw/cm^2	8 (14.5%)	62.5%	25.0%	0.0%	12.5%			
300 – 900 mw/cm^2	33 (60.0%)	3.0%	36.4%	36.4%	24.2%	30.541	6	0.000**
900 – 1500 mw/cm^2	14 (25.5%)	21.4%	78.6%	0.0%	0.0%			
X_4: Last maintenance date of unit								
no	29 (52.7%)	20.7%	51.7%	3.4%	24.1%			
12 – 24 months	14 (25.5%)	0.0%	21.4%	71.4%	7.1%	29.186	6	0.000**
> 24 months	12 (21.8%)	25.0%	58.3%	8.3%	8.3%			
X_5: Daily used times number of unit								
< 4 times	12 (12.8%)	50.0%	50.0%	0%	0%			
4 – 8 times	27 (49.1%	7.4%	37.0%	29.6%	25.9%	18.572	6	0.005**
> 8 times	16 (29.1%)	6.3%	56.3%	25.0%	12.5%			
X_6: Exposure time per treatment period								
10 seconds	5 (9.1%)	0.0%	40.0%	20.0%	40.0%			
20 seconds	9 (16.4%)	44.4%	33.3%	11.1%	11.1%			
30 seconds	18 (32.7%)	16.7%	50.0%	16.7%	16.7%	9.913	9	0.358$^{n.s}$
40 seconds	23 (41.8%)	8.7%	47.8%	30.4%	13.0%			

n.s : not significant *** : significant at 5%** **** : significant at 1%**

The result of Table 2 reveals that 10.9% of the used light-curing units in private dentist's clinics are of age less than one year, 63.6% of the units are between 1 to 3 years old, and 25.5% of the units are older than 3 years. The result of chi-square (6.337) indicated that there is no significant association between the age of units and the radiation rates since the P-value (0.387) is greater than the level of significance α=0.05. The readings of radiation rate were taken from two types of light-curing units 85.5% of type LED and 15.5% of type QTH; the results revealed that there is a significant relationship at 0.05 significance level between the types of units and the radiation rates according to the P-value of chi-square test (0.037) which is less than α=0.05. The intensity of unit can be classified to three levels, 14.5% of radiation rates were recorded from units with intensity less than 300 mw/cm^2, 60.0% of readings were recorded from units with intensity between 300-900 mw/cm^2 and 25.5% of readings were recorded from units with intensity between 300-900 mw/cm^2. Table 2 shows that the radiation rate depends significantly on intensity of unit at 0.01 significance level according to the P-value of chi-square test (0.000) which is less than α=0.01. The readings of radiation rates are significantly affected by the last maintenance date of the light-curing units. Out of 55 units, 52.7 percent had no maintenance done, 25.5% of units were maintained during 12 to 24 months and 21.8% of units were maintained during more than 24 months. The analysis indicated a strong relationship between the radiation rates and the last maintenance date of units at α=0.01 significance level according to the P-value of chi-square test (0.000). The daily used number of the unit can be classified into three groups: 12.8% of the units were used less than 4 times a day, 49.1% of the units were used between 4 to 8 times a day and 29.1% of the units were used more than 8 times a day. The radiation rates emitted from the used light-curing units are significantly dependent on the daily used number of unit at α=0.01 significance level. Table 2 reveals that exposure times per treatment period consist of four levels: 9.1% of times are 10 seconds, 16.4% of times are 20 seconds, 32.7% of times are 30 seconds and 41.8% of times are 40 seconds. The results explain that there is no relationship between radiation rates and exposure times according to the P-value of chi-square statistic (0.358) which is greater than α=0.05 significance level.

3.1. Multiple Ordinals Logistic Regression Analysis

The multiple ordinal logistic regression model was fitted based on the study data, the evaluation and quality of the model can be checked through several criterion as follows:

3.1.1 Overall Model Test

To test the null hypothesis, which states that there are no significant differences between the model in terms of the constant (intercept only) without the independent variables and the model with the independent variables, the chi-square test of the likelihood ratio function was used. It is clear from Table 3 that the P-value of the test 0.00 which is less than α = 0.01, which means that the null hypothesis is rejected, which confirms the significance of the model in terms of the independent variables at 1% significance level, meaning that all the combined independent variables (age of unit, type of unit, intensity of unit, last maintenance date of unit, daily used times number of unit, and exposure time per treatment period) has a statistically significant effect and contribution to the classification of radiation rate to 0.16, 0.18, 0.20 or 0.22 µSv/h.

Table 3: Test the statistical significance of the model

Model	-2 Log Likelihood	Chi-Square	df	P-value
Intercept Only	127.027			
Final	64.974	62.053	12	0.000**
** : significant at 1%				

One of the assumptions underlying ordinal logistic regression is that the relationship between each pair of outcome groups is the same. This can be checked using the test of parallel lines in which the null hypothesis states that the slope coefficients in the model are the same across the four categories of the radiation rates (0.16, 0.18, 0.20 and 0.22 µSv/h), if the assumption of parallelism is rejected, using multinomial regression should be considered, which estimates separate coefficients for each category.

Table 4: Test of parallel regression assumption

Model	-2 Log Likelihood	Chi-Square	df	P-value
Null Hypothesis	64.974			
General	46.124	18.850	24	0.760$^{n.s}$
n.s : not significant				

The test results shown in Table 4 reveal that all the variables were found insignificant (P-value=0.342). Therefore, there is not enough evidence to reject the null hypothesis for the ordinary regression model.

3.1.2. Coefficient of Determination R2

The results of fitting ordinal logistic model showed that the independent variables included in it interpreted about 73% (using Nagelkerke coefficient) and 68% (using Cox and Snell coefficient) of the changes in the radiation rate, as shown in Table 5; this indicates that there are about 32% or at least 27% of the changes in the radiation rate due to other variables not included in the model.

Table 5: Interpretation of the variables entering the model

Cox and Snell	Nagelkerke
0.676	0.733

3.1.3 Goodness of Fit Test

Other diagnostics that were used to determine goodness of the fit are shown in Table 6. The first row shows the values of Pearson chi-square statistics computed by covariate pattern that measures the deviations between the radiation rates generated by the logistic regression model and the actual radiation rates. The reported P-value 0.831 compared with α value of 0.05 showed that the overall model is fit. Same as deviance chi-square statistic in the second row of the same table. So, the model used in the study very well fits the data of radiation rate and other factors.

Table 6: Goodness of fit test of overall model

	Chi-Square	df	P-value
Pearson	88.302	102	0.831$^{n.s}$
Deviance	53.072	102	1.000$^{n.s}$
n.s : not significant			

3.1.4 Examine the Significance and Effect of each Independent Variable

To test the hypothesis that there is significant effect from the each separately independent variable (age of unit, type of unit, intensity of unit, last maintenance date of unit, daily used times number of unit, and exposure time per treatment period) on the dependent or response variable (radiation rate), the likelihood ratio test that depends on chi-square value was used.

Table 7: Likelihood Ratio Test

	-2 Log Likelihood	Chi-Square	df	P-value
Intercept	23.584	0.000	0	
X_1	28.625	5.041	6	$0.539^{n.s}$
X_2	27.042	3.458	3	$0.326^{n.s}$
X_3	50.243	26.659	6	0.000^{**}
X_4	42.565	18.982	6	0.004^{**}
X_5	45.371	21.787	6	0.001^{**}
X_6	40.622	17.038	9	0.048^{*}
n.s : not significant	*** : significant at 5%**	****: significant at 1%**		

It is clear from Table 7 that the two independent variables (age of unit and type of unit) had no significant effect on the radiation rate according to their P-values that were greater than α=0.05. While there was significant effect from the intensity of unit, last maintenance date of unit and daily used times number of unit on the radiation rate at α=0.01 level of significant according to their P-values that were smaller than α=0.01. Meanwhile the exposure time per treatment period had significant effect on the radiation rate at α=0.05 level of significant according to its P-value that were smaller than α=0.05.

3.1.5 Estimation of the Model's Parameters

Based on the results of examining the significant effect of the independent variables on the dependent variable, the two variables, age of unit and type of unit, were excluded from the model. Parameters of the ordinal logistic regression model were estimated using the maximum likelihood method, in addition to calculating the standard error and Wald statistic for each estimated parameter.

Table 8: Parameters estimates of ordinal logistic regression model

	Estimates				95% Confidence Interval	
Variables in Model	$(\hat{\beta})$	Std. Error	Wald	P-value	Lower Bound	Upper Bound
X_3: < 300 mw/cm^2	-1.051	1.175	0.800	$0.371^{n.s}$	-3.353	1.252
X_3: 300 – 900 mw/cm^2	4.497	1.267	12.600	0.000^{**}	2.014	6.980
X_3: 900 –1500 mw/cm^2 (Ref)						
X_4: > 24 months	-1.909	0.974	3.841	0.047^{*}	-3.818	0.000
X_4: 0 months	1.755	0.929	3.573	$0.059^{n.s}$	-0.065	3.575
X_4: 12 – 24 months Ref)						
X_5: < 4 times	-4.214	1.214	12.053	0.001^{**}	-6.594	-1.835
X_5: > 8 times	-2.188	0.797	7.530	0.006^{**}	-3.750	-0.625
X_5: 4 – 8 times (Ref)						
X_6: 10 seconds	1.045	1.368	0.584	$0.445^{n.s}$	-1.635	3.726
X_6: 20 seconds	-2.465	1.036	5.663	0.017^{*}	-4.496	-0.435
X_6: 30 seconds	-1.880	0.775	5.888	0.015^{*}	-3.399	-0.362
X_6: 40 seconds (Ref)						
n.s : not significan	*** : significant at 5%** Ref: stands for reference group			****: significant at 1%**		

It is noticed from Table 8 based on the odd ratio values (Odds Ratio=Exp(β̂)) that the unit intensity ranks first in terms of its significance and effect on the radiation rate; the number of daily use of the unit comes in second place, then the exposure time per treatment period comes in the third order, and finally the last maintenance date for the unit.

The unit intensity appears to be the most important indicator of radiation rate risk, the estimated odds ratio (OR = 89.747) indicates that the emitted radiation rate from the used light-curing units is affected by the radiation intensity ranging between 300-900 mw/cm^2 is 89.747 times more than affected by radiation with an intensity ranging from 900-1500 mw/cm^2 keeping all other variables constant, and this number may rise to 1074.918 times and can fall to 7.493 times with 95% confidence. The study revealed that the number of times the unit is used per day is significantly related with the radiation rate, the estimated odds ratio (OR =Exp(4.2140)=67.627) indicates that the emitted radiation rate from the used light-curing units affected by the daily use of units (4-8 times) is 67.627 times more than its effected by daily use of units (< 4 times), and 8.917 times more likely than the daily use of units (> 8 times) keeping all other variables constant. This numbers may rise respectively to 730.698 and 42.521, and can fall respectively to 6.265 times and 1.868 times with 95% confidence. This study also found that the exposure time per treatment period is significantly affect by the radiation rate, the estimated odds ratio (OR =Exp(2.465)=11.763) indicates that the emitted radiation rate from the used light-curing units affected by the exposure time per treatment period is 40 seconds is 11.763 times more likely than the exposure time per treatment period is 20 seconds, and 6.554 times more likely than the exposure time per treatment period is 30 seconds holding all other variables fixed. This numbers may rise respectively to 89.658 times and 29.934 times, and can fall respectively to 1.545 times and 1.436 times with 95% confidence. The results in Table 8 also show that the last maintenance date of unit is a significant predictor of radiation rate, the estimated odds ratio (OR =Exp(1.909)=11.763) implies that the emitted radiation rate from the used light-curing units affected by the last maintenance date of unit between (12-24) months is 11.763 times more than its effect by the last maintenance date of unit (> 24) months keeping all other variables constant, and this number may rise to 45.513 times and can fall to 1 times with 95% confidence.

3.1.6 Model Classification Efficiency Test

The results of the model classification efficiency test, which is considered one of the methods of checking the goodness of fit of the model's fit to the data, are shown in Table 9.

Table 9: Model classification efficiency test

Observed	Predicted				% Correct
	0.16	0.18	0.20	0.22	
0.16	6	3	0	0	66.6%
0.18	2	21	2	0	84.0%
0.20	0	4	4	4	33.0%
0.22	0	3	0	6	66.7%
Overall %	14.5%	54.5%	12.7%	18.2%	67.3%

It is evident from the table that the model achieved a correct overall classification rate, which is the number of correct predictions out of the total number of the sample, 67.3%, which is an acceptable ratio.

3.1.7. ROC Analysis

Receiver Operating Characteristic (ROC) analysis is a useful way to assess the accuracy of model predictions by plotting sensitivity versus (1-specificity) of a classification test. [15] The null hypothesis states that the area under the ROC curve resulting from modelling the dependent variable to the ordinal logistic model does not differ from the chance by 50%. A good model has a value above 0.5, while a value less than 0.5 indicates the model is no better than random prediction. The ROC curve was obtained by representing the different cut points against the specificity and sensitivity as in Figure 1.

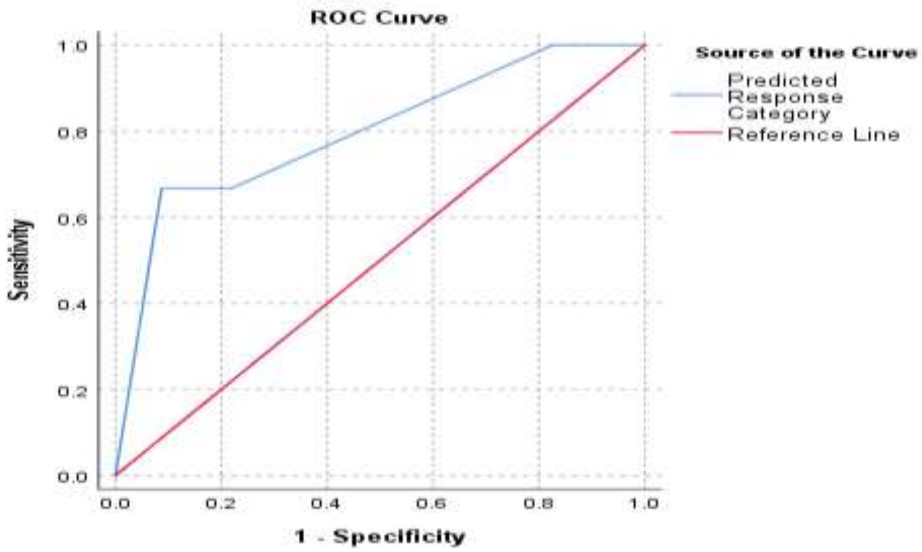

Figure 1: ROC curve for modeling radiation rate by ordinal logistic regression model

It is evident from Figure 1 that the model classifies the observed data of radiation rates better than the chance factor, as it appears that the ORC curve moves away from the diameter of the chance (50% for both specificity and sensitivity) to give more space than the chance gives. Hosmer-Lemeshow considered that the lower limit for the consideration of the discriminatory power is acceptable for the model if the area under the ROC curve is between 0.7 and 0.8 [16, 17]. Table 10 shows the area under the ROC curve for ordinal logistic regression. Overall model quality is 0.62 which is > 0.5 indicating that the model predictions are better than random predictions.

Table 10: Area under ROC curve for ordinal logistic regression model

Test Result Variable	Area	Std. Error	P-value	95% Confidence Interval	
				Lower Bound	Upper Bound
Predicted Response Category	0.797	0.088	0.001**	0.624	0.970
** : significant at 1%					

4. Conclusion

This study revealed the influence of radiation from devices during light processing, the influence of some characteristics related and an understanding of the technical knowledge of these devices. According to the survey data collected, a regular layer of restoration will receive light doses ranging from the lowest to the most applicable dosages for appropriate treatment. Typical treatment times with radiant light, along with a typical number of daily restorations, may exceed the risk limits for blue light reflected on the eyes. This is worrisome, given that the dentists did not protect their eyes with enough blue light. Today's reliance on dentistry requires the operator to have knowledge of basic technical specifications and the safe use of devices and tools routinely used in dental treatment.

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