Identification of the Cause of Occupational Hazards among Dentists in Chennai Using Regression Analysis

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Abstract: This paper aims in deducing the reasons that causes occupational hazards among dental practitioners. To do so, a survey had been conducted among 394 dentists in Chennai, India based on questionnaire method. By using cluster analysis, the correlation between the factors that cause occupational hazards has been determined. Later the intense level at which these factors are responsible for the occupational hazards of the dentists has been examined using regression analysis. The results of the analysis have been evaluated graphically using main effects plot and residual plots.

Keywords: Occupational hazards, dentists, cluster analysis, regression, main effects plot, residual plots

I. INTRODUCTION

Dental professionals are predisposed to a number of occupational hazards. Occupational hazard can be defined as the risk to the health of a person usually arising out of employment. It can also refer to work, material, substance, process or situation that predisposes or itself causes accidents or disease at work place. The history of occupational hazard awareness can be traced back to the 18th century when BernadinoRamazzini, who is referred to as the 'Father of Occupational Medicine', recognized the role of occupation in the dynamics of health and diseases [1]. Occupational health hazards are not uncommon [2], [3]. Many risks challenge the status of modern dentistry. Studies have shown that dentists report more frequent and worse health problems than other high risk medical professionals [5]. Dental personnel are exposed to various occupational hazards like stress, physical strain, musculoskeletal disorders, legal hazards *etc*. Though dentists face many hazards in their occupation, the common hazards faced by them are physical strain such as musculoskeletal problem, chronic back pain and mental stress.

Estimates suggest that 84% of people may experience low back pain (LBP) at some point in their lifetime [7]. A primary reason individuals seek medical care is for LBP, which can be costly to treat and manage [8]. Risk factors for long-term LBP include age, depression, previous history of back pain, pain distal to the knee, and dissatisfaction with job [9]. Many common treatments for LBP have been found to be ineffective [7], thus, individuals suffering from LBP are turning to some alternative treatment methods, such as yoga [7], [10-14]. Low back pain typically affects individuals between 30 and 50 years of age with the prevalence increasing through adulthood up to 65 years of age [8]. Men and women are affected equally by LBP, and the cause can usually be traced to a work-related disability in adults younger than 45 years [7].

Another important hazard that dentists face in their occupation is mental stress. Stress is the abnormal reaction that the organism displays against threating environmental elements (Luthans, 1994). Stress, which is a general term used for pressure that people are exposed to in life (Jepson and Forrest, 2006) may be defined as the individual harmony effort that the person displays against a stimulant which has excessive psychological and physical pressure on the person. (Griffin, 1990). When a

person feels insufficient in dealing with demands and challenges faced in life, she/he experiences stress [6]. Being harmed by thissitution or taking advantage of it mainly depends on the person because stress may either be a factor threatening the organism physically or psychologically or a power which gives energy in dealing with life (Baltaş, 2002). Sources of stress may be classified as individual, organizational and outside of organization (Gupta, 1981; Kreitner and Kinick, 1992) or it is possible to divide them into two groups as individual and organizational components (Nahavandi and Malekzadeh, 1999; Smith and Milstein, 1984). Organizational stress, which is also called professional stress, is the interaction between working conditions and the working person in environments in which the work demand exceeds the skills of the worker (Ross and Altmaier, 1994).

There is considerable evidence that the stress inherent in health care negatively impacts health care professionals. Stress can lead to increased depression (Tyssen, Vaglum, Gronvold, &Ekeberg, 2001), decreased job satisfaction (Blegen, 1993; Flanagan & Flanagan, 2002), disrupted personal relationships (Gallegos, Bettinardi-Angres, &Talbott, 1990), psychological distress (V. Jain, Lall, McLaughlin, & Johnson, 1996); and even suicide (Richings, Khara, & McDowell, 1986). Stress also may harm professional effectiveness: It decreases attention (Smith, 1990), reduces concentration (Askenasy&Lewin, 1996), impinges on decision-making skills (Klein, 1996; Lehner, Seyed-Solorforough, O'Connor, Sak, & Mullin, 1997), and reduces providers' abilities to establish strong relationships with patients (Pastore, Gambert, Plutchik, &Plutchik, 1995) [6].

Stress also may lead to increased *burnout* (Spickard, Gabbe, & Christensen, 2002), defined as a syndrome of depersonalization, emotional exhaustion, and a sense of low personal accomplishment. A recent study found that burnout was significantly associated with suboptimal self-reported patient care (Shanafelt, Bradley, Wipf, & Back, 2002). Over a decade ago, the field identified these problems and called for change, advocating better care for health professionals (Butterfield, 1988). Despite this call for change, dissatisfaction and distress have continued to increase. For example, a study of U.S. physicians showed a decline in satisfaction with every aspect of their professional life from 1986 to 1997 (Murray et al., 2001). It is clear that health care professionals need support in addressing the numerous stressors inherent in their work.

II. STATISTICAL STUDY

To find out the factors that cause occupational hazards, namely musculoskeletal pain and stress, a statistical study was carried out in the year 2013. The population of the study composed of dentists from various hospitals present at Chennai, India. The study has been carried out by simple questionnaire method in which the following simple questions with options have been asked to the dentists.

[a] What is your age?

1) <30 2) 30 – 40 3) >40

[b] What is your sex?

1) male 2) female

[c] What is your experience?

1) <10 2) 10 – 20 3) >20

[d] How many hours you work per day?

1) <4 hrs 2) >4 hrs

[e] Do you have any systemic disease?

1) diabetes 2) hypertension 3) both 4) none

[f] What occupational hazard you face as a dentist?

1) musculoskeletal pain 2) stress 3) both

[g] How often do you get it?

 1) often – weekly once 2) rare – monthly once 3) never

[h] How do you prevent these?

1) exercise, massage, music, walking 2)yoga 3) none

[i] Do you have any harmful habit (Smoking/Alcohol)?

1) yes 2) no

The collected data has been segregated based on various factors and the inferred details have been tabulated [1]. Based upon the data collected using the above questionnaire method, the factors causing occupational hazards is predicted using regression analysis.

III. REGRESSION ANALYSIS

Linear regression is one of the most common data mining technique for predicting the future value of variable based on the linear relationship it has with other variables [5][6][7][8]. Basically, it assumes there is a straight line that approximates the data set, and bases the forecast on it.

There is only one independent variable and the formula that describes this relationship is the one that defines a straight line: y=a+bx

where, y is the dependent variable

x is the independent one.

a and b are the line's coefficients.

Moreover, the least square method is employed in finding the regression line. The least squares method is expressed as: y=a+bx

where,

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{n\sum xy - \sum x \sum y}{n\sum x^2 - (\sum x)^2}$$

IV. ANALYSIS AND RESULTS

To discover the factors causing musculoskeletal pain and stress among the dental practitioners, regression analysis, a concept of data mining is used. The result of regression analysis predicts the possibility of occupational hazards by analysing the collected data. The analysis is done using MATLAB 7.9.

From the questionnaire it has been inferred that, the questions Q4, Q5, Q7 and Q9 will aid in predicting the occurrence of occupational hazards. Using cluster analysis, the above mentioned questions are clustered based upon various regression parameters and the results are tabulated in Table I.

TABLE I

Results of Cluster Analysis

Steps	No of Clusters	Similarity Level	Distance Level	Clusters Joined	New Clusters	No of observations in new cluster
1	4	28.5526	0.714474	1	4	2
2	3	18.9460	0.810540	2	5	2
3	2	13.5799	0.864201	2	3	3
4	1	13.5799	0.943320	1	2	5

The correlation between the questions taken into account is represented using dendrogram in Fig. 1.
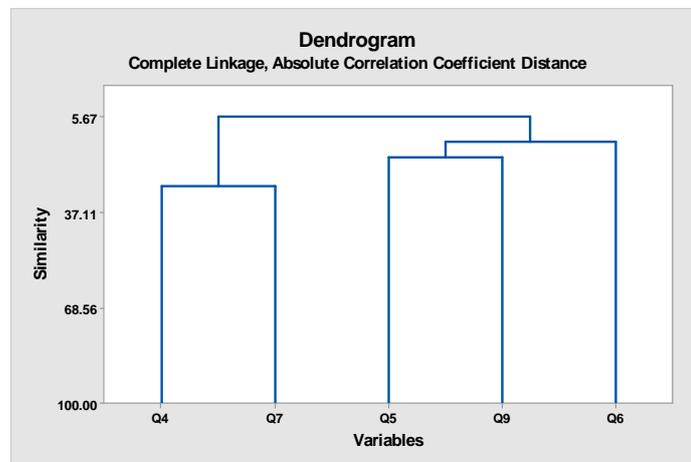

Fig. 1 Dendrogram

The above dendrogram is obtained by considering parameters such as complete linkage, absolute correlation and coefficient distance. From the graph it is inferred that, the questions, how many hours you work? (Q4) and how often do you get it? (Q7) are inter-related and the questions, do you have systematic disease? (Q5) and do you have any harmful habits? (Q9) are inter-related. Further, these questions,lay as a cause for Q6. Q6 is our target question, that is to be predicted, whether a dentist has occupational hazard or not.

Using cluster analysis the factors that play a major role in causing occupational hazard has been determined. Now, as a next step, the level at which these factors cause occupational hazard has to be observed. To do so, the variance of these factors are determined using the Analysis of Variance (ANOVA) table and the results are tabulated in Table II.

TABLE III

Analysis of Variance

Source	DF	Adjacent SS	Adjacent MS	F-Value	P-Value
Q1	2	10.234	5.1169	10.25	0.000
Q2	1	4.855	4.8546	9.73	0.002
Q3	2	2.495	1.2474	2.50	0.084
Q4	1	6.716	6.7164	13.46	0.000
Q5	3	10.177	3.3924	6.80	0.000
Q7	2	0.786	0.3929	0.79	0.456
Q8	2	26.534	13.2669	26.58	0.000
Q9	1	0.000	0.0001	0.000	0.990

where, DF = Degree of Freedom

SS = Sum of Squares

MS = Mean Square

F-Value = Fisher Value

P-Value = Probability Value

The formula of ANOVA table is given in Fig. 2.

Source	Bracket Term	SS	df	MS	f	p-value
Between Groups (A)	$[A] = \dfrac{\Sigma A_j^2}{n}$	$[A] - [T]$	$a - 1$	$\dfrac{SS_A}{df_A}$	$\dfrac{MS_A}{MS_{S/A}}$	Look it up in the f table!
Within Groups (S/A)	$[Y] = \Sigma Y_{i,j}^2$	$[Y] - [A]$	$a(n - 1)$	$\dfrac{SS_{S/A}}{df_{S/A}}$		
Total	$[T] = \dfrac{T^2}{an}$	$[Y] - [T]$	$an - 1$			

Fig. 2 ANOVA Table

Table II shows that P>0.05 for Q3 and Q7, so it is inferred that the experience and smoking/drinking habits do not contribute much to the occupational hazards. Whereas, the other factors Q1, Q2, Q4, Q5 and Q8 plays a role in causing occupational hazards.

By analysing the variance, the level at which each factor, inferred from the questionnaire, causes occupational hazards has been evaluated and the results are represented using Main Effects Plot as shown in Fig. 3.
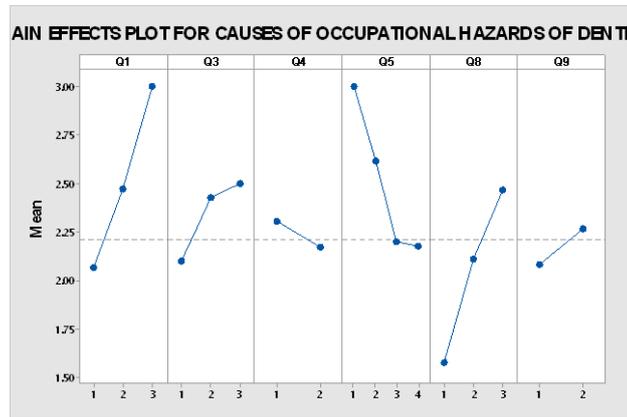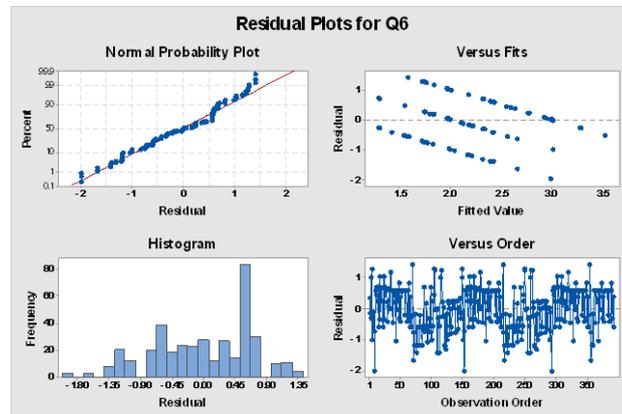

Fig. 3 Main Effects Plot Analysis

Finally, to evaluate the perfectness of the prediction, residual plots of Q6 has been shown in Fig. 4.

In Fig. 4 the versus order graph shows that the maximum difference between the predicted and original value is ±2. This shows the accuracy in prediction.

V. CONCLUSION

The study has concluded that the major factors causing musculoskeletal pain and stress among the dental practitioners and their contribution levels (obtained using main effects plot) such as age > 40, experience > 20years, having systemic disease,

particularly diabetes and lack of any kind of exercise has got a high impact on the cause of occupational hazards for dentists. This has also been confirmed through analysis of variance test.

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