Chapter 7

DISCUSSION

7.1 INDUSTRIAL HYGIENE

Ramazzini, “the father of industrial hygiene”, who was the first to advocate the inclusion of patient’s occupation inmedical history and to point out a number of oral symptoms (Schour and Sarnat, 1942) “as injurious effects of occupational hazards also manifest themselves in the teeth, jaw bones, periodontal tissues, tongue, lips and oral mucosa” (Peterson and Henmer, 1988). “Exposure to chemical, physical and biological agents in the work place can result in adverse effects on workers ranging from simple discomfort and irritation to debilitating occupational diseases” (Dagli *et al.,* 2008). “In addition, the health of industrial workers often goes uncared due to their stressful working conditions, busy schedules and poor economic conditions” (Patil *et al.,* 2012).

Rajasthan is the geographically largest state and has the second highest amount of mineral deposits in India. Amid the ancient forts and stunning palaces of Rajasthan is a less alluring sight: hundreds of workers in stone quarries, many dying of silicosis from cutting and polishing the sandstone tiles that adorn gardens and patios here and abroad. Much of the sandstone used in kitchen counter tops and as cobblestones comes from the state's Kota and Bundi districts, where workers toil under extreme conditions, with hardly any protective gear and for very little money. About half the state's 2 million mine workers suffer from silicosis or other respiratory diseases, according to labour rights campaigners. Although there is no comprehensive data, hundreds, possibly thousands, have died of silicosis, an incurable lung disease caused by long-term exposure to silica dust given off in the mining and processing of sandstone and limestone. Rajasthan's human rights commission asked the state government to modernize mining and

conduct regular medical tests to contain the disease. Activists say the state must also do more to ensure there are no child workers, whose vulnerable bodies are even more susceptible to silicosis. India is one of the largest producers of raw stone, accounting for more than a quarter of stones mined worldwide.

About a fifth of India's mine workers are children. Many work for more than 10 hours a day in dangerous and filthy conditions. In the quarry, where chemicals are used to pulverize the earth to reveal the stone, workers often cut and chisel without goggles, masks or other protective gears. The industry's working conditions "fall far short" of national or international standards, and there are "alarming levels" of child labour, according to a 2013 UNICEF report. Child workers make up a fifth of Bundi district's mining workforce of more than 50,000, it said. "The industry has complex social, economic and political challenges due to the multifaceted supply chain and interwoven network of middlemen, which makes it very difficult to trace the exact source of the stones," the UNICEF report said.

Rajasthan is India's largest sandstone-producing state, and the industry is the only source of livelihood for generations of rural workers trapped in poverty and in debt bondage to the 'maliks', or owners of the quarries, many of them illegal. Migrant workers from neighbouring Madhya Pradesh and Bihar and Odisha, are also tricked by agents into coming to the quarries with promises of well-paying jobs. This kind of exploitation is especially common in India's construction sector, particularly in the unregulated areas of brick making and stone quarrying, experts say Aravali, a public-private development agency that surveyed mine workers in the state, found that silicosis is caused by inhaling silica dust for 10 years or longer. Rajasthan is one of the poorest states in the country, with among the lowest literacy rates and a deeply entrenched caste system. Workers in the quarries are mostly from Dalit and other lower-caste and tribal communities. The sandstone industry has come under attack from environmentalists as well, who say the mining and dumping of chemicals have led to significant land degradation, deforestation and contamination of groundwater.

7.2 DEMOGRAPHIC DATA

Totally 980 individuals were examined for the oral health status in the current study. Out of 980 samples 500 individuals were mining employees and the rest 480 individuals belonged to the general population category. The 500 mining employees were again segregated into different groups depending upon the work they undertook in the mining industries. The categories included were Administrative unit (A), Maintenance unit (M), Transportation unit (T), Cutting unit (C), Polishing unit (P). As none of the mining workers belong to feminine gender, the general population was also devoid of the female sample.

7.2.1 Age

Maximum (52.40%) of the mining employees fell in the age group of 25-34 years with the least number found in the age group of 45-54 years. There were around 19.70% of employees were in the age range of 15-24 years indicating the presence of child laborers in the current mining population. Similar to our findings there were around 32.22% of the cement mining workers(Sharma *et al.,* 2014) and 36.6% stone mining workers of Jodhpur city were in the age group of 21-36 years (Solanki *et al.,* 2014). Similar age group i.e from 21- 40 years were seen in maximum number in the battery workers of the Kanpur city (Khurana *et al.,* 2014) and same was true for the metal plant workers of the Brazil (Vianna *et al.,* 2005).In analogues to this finding the, coal mining workers were more prevalent in age group of 50-54 years (39.38%) (Abbas *et al.,* 2016).

7.2.2 Literacy

In the present study it is noted that the maximum number of mining employees i.e. 62.60% were illiterate. Similar high percentage illiteracy was noted in the coal mining workers of Telangana (Abbas *et al.,* 2016). The highest level of education noted was for the high school level with 11.20% in the mining employees. Similar level of literacy was seen in the Brazillian metal plant workers, where 15.5% of the workers had high school level education (Vianna *et al.,* 2005). However in case of general population only 20.63% were illiterate and

rest all were literate with around 15.63% individuals having the degree level education. When compare this data with the other studies we can see that the only 10% of the cement mining workers in Sirohi district of Rajasthan completed their high school level education (Sharma *et al.,* 2014). Contrastingly in the stone mining employees of the Jodhpur city the percentage of illiteracy was only 34.9% which is way too low in comparison to the present study findings (Solanki *et al.,* 2014). Contrastingly, around 67.7% of the sea farer had the secondary level education (Aapaliya *et al.,* 2015).

7.2.3 Socioeconomic status

When the socioeconomic status of the mining employees and the general population was compared, it was seen that most of that the most of mining workers fell under the middle class level and most of the general population feel under the upper lower category. The difference notes between the two groups was statistically significant. Whereas, in between the mining workers most of the transportation, cutting and polishing unit employees belonged to the lower socioeconomic category.

7.3 PERSONAL HABITS

7.3.1 Food Habits

The eating preference of both general and the mining employees remained mixed with 62.29% and 59.80% respectively. However, most of the administrative unit employees (69.77%) were of vegetarian category. There existed significant difference in the food habits of the mining employees.

In the food habits, the consumption of the sweet by the mining employees occasionally was noted in greater number than the daily or 2-3 times a week category. The results remained same for the general population also but the percentage was lesser i.e 42.50% and the difference noted between the two groups was statistically significant. Whereas, among the mining workers occasional sweet consumption was most commonly noted in all the groups.

7.3.2 Oral Adverse Habits

Usage of the tobacco products in the present mining employees (79.40%) was high in comparison to the general population (61.67%) and the difference noted was statistically significant. However, the battery mining workers of Kanpur city consumed showed greater prevalence for the consumption of the tobacco products with 85.71% consuming the same (Khurana *et al.*, 2014).Contrastingly, less consumption (58%) of the tobacco products was seen in the Jordanian battery industries workers (Amin *et al.,* 2001), similar trend of lesser percentage of adverse oral habits was seen in the brass mining workers of Moradabad city (Tirth *et al.,* 2013) with 53.8% consumption and the salt workers (49.4%) of the Jaipur city (Sakthi *et al.,* 2011). Such reports of decreased consumption in the foreign countries have been reported by (Knutsson and Nilsson, 1998). It was estimated in 2004 that there will be 930 million of worlds 1.1 billion tobacco users will be from the developing countries. This global shift in tobacco consumption may have around 182 million consumers in India alone (Subramanian *et al.,* 2004). Transportation unit workers consumed more tobacco products then the rest of the employees but the difference noted was statistically insignificant.

Among the tobacco products gutkha was most commonly used by both the mining employees (38.60%) and the general population (22.08%) in the present study group, this was followed by the habit of tobacco leaf consumption in both the groups. Greater consumption of chewable tobacco was reported in the coal mining workers by 84% (Abbas *et al.,* 2016). Bidi consumption was greater in the mining workers (16.00%) than the general population (13.75%). However, the difference noted for the tobacco consumption habit between the two groups is statistically insignificant for the cigarette and bidi but was significant for tobacco leaf, pan and gutkha.

Nevertheless, the difference in the tobacco consumption in between the mining employees showed statistically significant difference with 52.14% of transportation workers consuming gutkha. Tobacco leafs were consumed more by

the maintenance workers (22.22%) but the difference noted for bidi was statistically insignificant.

Alcohol was consumed by 80.80% of the mining workers, which is way higher in comparison to the general population (60.42%). The difference is statistically highly significant. However in the study by Khurana *et al.,* (2014), it is seen that the working population consumed less alcohol then the control group or the general population. In disagreement to this finding less consumption (2.3%) of the Alcohol was reported in the coal mining workers of Telangana (Abbas *et al.,* 2016).

In between the mining workers, alcohol consumption remained greater in transportation unit (89.29%), cutting (81.82%) and polishing (80.80%). Highly significant statistical difference was appreciated for the same.

According to the earlier literature, physically tedious work drives people to consume alcohol and tobacco which further deteriorate their oral health (Sakthi *et al.,* 2011). Kiran Kumar *et al.,* (2011) also found in his study that nicotine dependence is the major diagnosis (27.7%) followed by alcohol abuse (12.3%). Same was true in case of the present study. Another reason which can quoted for the high prevalence of adverse Oral habit practice in these mining workers is the peer influence, as most of the task which they have to perform in the team (Abbas *et al.,* 2016), they might acquire these habits in influence of their peers.

7.3.3 Oral hygiene Habits

When the data pertaining the oral hygiene practice of the current population is analyzed it is seen that the 81 individuals in the mining study population did not brush their teeth at all. Similar poor oral hygiene practice was reported by Amin *et al.,* (2001). In the remaining population it is seen that the maximum of them had a habit of brushing their teeth once daily (100%) i.e 419 members using tooth brush (68.74%) and tooth paste (72.08%). Similar high percentage of brushing once in a day in brass mining workers was reported by Tirth *et al.,* (2013) and Abbas *et al.,* (2001) and the same trend is noticed in the

construction workers (76.9%) of Chennai city (Sakthi *et al.,* 2011).Few of the individuals used their finger to clean their teeth and in the materials few used tooth powder, neem twigs also. High prevalence (43.1%) of use chew sticks for cleaning the teeth was reported in the salt workers of Jaipur city (Sanadhya *et al.,* 2013). Interestingly, in the sea farer community, around 59.2% used sea weed to clean their teeth (Aapaliya *et al.,* 2015), this may be due to the non-availability of the other mechanical aids during the long sea voyages. Other than this it's been proven that the sea weeds are more effective cleansing material then the tooth paste (News, 2012). There was statistically significant difference in the usage of the mechanical aid for cleaning in between the different units of mining employees. Contrastingly, in the earlier reports on the battery mining workers it is seen that 70.2% used toothpowder and finger (Khurana *et al.,* 2014).

The difference in oral hygiene maintenance between the mining workers and the general population was significant for frequency of brushing, mechanical aid used for cleaning and for the material used for the cleaning. In general population three was around 2.2% of individuals who are used to brushing twice.

7.3.4 Usage of Protective Measures

The negligence in protecting themselves was seen the current mining employees as 92.42% of the population did not use in protective measures cover their face and 95.45% of the individuals did not use any ear plugs to cover the ears in noise environment. There existed no significant difference in the usage of the face cloth or the face mask in between the mining employees, however, for the usage of ear plugs there was a statistically significant difference as the maintenance unit (17.78%) staff used the ear plugs in more number than the rest of the staff.

7.4 YEARS OF EXPERIENCE

The years of experience adds to the proportionality of the health damage caused by the work environment. In the present study group most of the employees (40.60%) were having the experience range of 5 to 10 years. Less than

10 years of experience was noted in almost 30% of the population. There existed significant difference in the duration of the employment in between the different mining workers. It is noticed that the individuals who are working in these type industries tend to have experience of greater than 5 years and same was depicted in the earlier studies by Khurana *et al*., (2014).

7.5 DENTAL DECAY, MISSING AND FILLED TEETH

High caries index is one of commonest oral findings in the mining workers (Peterson and Henmer, 1988; Dagli *et al.,* 2008; Kumar *et al.,* 2008; Petersen and Tanase, 1997; Duraiswamy *et al.,* 2008). The literature shows that the workers working in sweet food industries are more prone to have higher caries index (Anaise *et al.,* 1980; Rekha and Hiremath, 2002). Nevertheless, Massiln *et al,*. (1994) through their study discards the hypothesis that airborne sugar is an occupational dental health hazard and same was supported by the statement that the confectionery industry did not seem to be an exceptionally hazardous environment for dental health in general. Studies do claim that the proper oral hygiene instructions followed by periodic dental evaluation improved the workers oral health condition (Kumar *et al.,* 2008). There are less chances of caries development with high income/high occupational status individuals then with individuals of the low status occupation, thus proving the influence of social inequalities playing the role in the prevalence of caries (Krustrup *et al.,* 2008).

The reports of decrease in the prevalence of dental caries are cited in the literature, but the findings of the present study doesn't support this finding as the more than half of the general population and more than 40% of the mining workers had the decayed tooth. In agreement to this finding a total of 44.4% of the coal mining workers had caries teeth (Abbas *et al.,* 2016). The results were in contradiction to the earlier study done on the stone mining workers in the Jodhpur city, where the prevalence of caries was reported to be 70% (Mandal *et al.,* 2001). Similarly Gambhir *et al.,* (2001) also reported the prevalence of dental caries 71%. Even in the transport workers the prevalence rate of caries was noted to be 64% (Tuominen and Murtomaa, 1996). Increase in the prevalence of dental caries

was also noted in the earlier studies on the different population groups (Bachanek *et al.,* 2001; Tomita *et al.,* 2005; Athanassouli *et al.,* 1990; Bali *et al.,* 2004).

In the present group of population the difference in the prevalence of caries in between the mining workers and the general population was found to be statistically significant. The discrepancy that existed between the mining workers and the general population might be due to the habits of the employees. It is known that the individual who had tobacco chewing habit, had low prevalence of caries and probable reason for the discrepancy noticed in the prevalence of caries can be attributed to this. In the earlier studies on the mining workers it was found that more than 90% of the workers had the habit chewing the tobacco (Mandal *et al.,* 2001). Apart from this the mining workers were exposed to fine particulate matter, which might have caused the attrition of the dentition leading to the formation of secondary dentine which makes the teeth more resistant to caries. The intergroup difference for the caries in the mining workers showed statistically significant difference with the higher prevalence for the employees involved in the transportation group and the least prevalence was seen for the administrative workers. This finding is clear indicator that the literacy plays a major role in prevention of occurrence of caries.

The prevalence of missing teeth was greater in the mining workers than in the general population and the difference was not statistically significant. There existed no significant difference between the different groups of mining workers.

The filled teeth in case of general population (17.71%) was greater than the mining workers (13.80%). The difference noted was statistically significant. Contrastingly, none of the participant had filled teeth in the study of Duraiswamy *et al.,* (2008) on the green marble mining workers and in the study of Abbas *et al.,*(2016) where, out of 356 only 10 of the coal mining workers had the filled teeth.

There existed no significant difference in the presence of filled teeth in between the different groups of the mining workers. Here again the emphasis of literacy and the oral habits is clearer seen. Greater the literacy of the population,

greater is awareness related to oral hygiene practices and the incidences of the dental checkups.

The study though reports the prevalence of decayed, missing and the filled teeth, it didn't explore the co relation between the literacy rates and the oral habits of the population with the incidence of the DMFT prevalence. Thus, the scope to establish the correlation between the literacy rate and the DMFT prevalence still exists.

7.5.1 Age wise distribution of mean number of decayed teeth among the study population

The mean decay was greater in the age group of 35 to 44 years in both the mining employees (3.34±2.12) and the general population (3.56±2.29). But the difference found between the mining employees and the general population and amongst the mining employees was statically insignificant. Mean prevalence of caries experienced was greater in the transportation, cutting and the polishing unit employees. This again emphasizes the lack of oral hygiene in these employees, which may be due to the lack of the education or the oral hygiene negligence.

7.5.2 Dental Caries and Sweet Consumption

The mean decay was higher in the daily sweet consuming group with 6.07±1.66 when compared to occasional sweet consuming group with 1.99±1.24 in general population and 4.49±3.99 and 2.13±0.81 in the daily consuming group and occasional sweet consuming group respectively among mining employees. Higher mean decay can be attributed to the frequency of sweet consumption.

The results were in agreement with the previous study conducted among Lebanese adults that concluded that the poor dietary habits including high consumption of sugar containing products were associated with dental caries (Doughan *et al.,* 2000).

The results were also in agreement with the previous study conducted among Canadian Indian communities that concluded that a correlation might exist

between dietary habits, especially the availability and frequency of consumption of refined carbohydrates and the condition of dental structures (Myers and Lee, 1974).

7.5.3 Dental Caries and Socioeconomic Status

In both mining employees and general population the upper lower class (46.05%, 57.83%), lower class (68.57%, 71.43%) and middle class (26.15%, 56.25%) respectively had higher decay prevalence compared to other higher SES groups. This might be because of the poor oral hygiene habits seen in lower SES groups compared to upper classes.

It is in contrast to a study in Nagpur where higher SES showed higher prevalence of caries due to higher sweet consumption in the higher SES groups (Doifode *et al.*, 2000).

7.6 DENTAL VISITS AMONG STUDY POPULATION

In the present study there was statistically significant difference in dental visits between mining employees (37.20%) and general population (47.50%). Same was true for the Sea farers, only 22.3% of them visited dentist earlier in their entire life as no oral check-up was done except at some port (Aapaliya *et al.*, 2015).In our study among mining workers dental visits among administrative unit (60.47%) and maintenance unit (53.33%) was higher compared to transportation, polishing and cutting unit workers and the difference noted was very highly significant.

Similar results were seen in Danish industrial population where regular dental visits were seen in clerical staff compared to other employees (Petersen and Henmer, 1988).

In our study when the barriers to dental visits were questioned, in case of mining employees, no problem in my teeth remained the most common reason quoted by all the categories of the employees. ‘No dentist nearby’ as reason was

quoted as the second most commonest reason by the administrative and the maintenance staff (25.53% and 28.57% respectively) followed by the reasons such as high cost of treatment' and 'fear'. Whereas, none of the administrative unit had the problem of 'lack of permission' in the mining.

Similar to our study in a study among South Australian employees and among male industrial employees majority perceived that they had no problem in their teeth and hence did not visit a dentist (Srikanth *et al.,* 1983; Ahlberg *et al.,* 1996).

Our study correlates with a study conducted among Japanese employees that reported 44% of their study population did not visit the dentist due to lack of time (Kawamura and Iwamoto, 1999). In a study among commuting labourers in Norway working situation, little leisure time, lack of treatment facilities were common reason for reduced dental attendance which is similar to our study (Heloe and Kolberg, 1974).

In our study among general population the underutilization of dental services was mainly due to no problem with the teeth, high cost of treatment and the fear.In India majority of dental services are financed on a fee for service basis and hence the fee barrier could hinder the utilization of dental services among general population also.

In our study the majority of mining employees (64.52%) and general population (57.02%) visited the dentist mainly for extractions. Within mining units visit to dentist for replacement of teeth was higher in administrative unit (19.23%) compared to other units and for extraction of teeth was least (34.6%) compared to other units. The reasons might be due to differences in socio economic status (SES) and literacy levels.

The results of our study were correlating with the previous study conducted on Jordanian adults which stated that people gave dental health a low priority in their lives, especially for the more expensive dental treatment thus

extraction of teeth was the most common treatment modality among poor societies (Hamasha *et al.,* 2000).

In contrast to our study insurance schemes and subsidized rates increased the dental utilization in a study among Danish industrial population (Peterson, 1983). In a previous study among South Australian employees regular dental visits were only by those in higher SES group which is similar to our study (Srikanth *et al.,* 1983).

7.7 ORAL MUCOSAL LESIONS

Prevalence of oral mucosal lesions was mainly related to the occupational stress to which the mining workers will be exposed. Noise, dust or fumes and poor maintenance of equipment added to the predisposing factor; the stress (Dagli *et al.,* 2008). The exposure of the air borne dust particles in the mining or the working atmosphere will lead to the cancerous lesion which can be mortal to the workers. Even the workers who were exposed to acidic fumes were at risk of developing in oral mucosal lesions (Vianna *et al.,* 2005; Vianna *et al.,* 2004) and this was more so with the workers without lip seal (Koskela *et al.,* 1990). However, contrastingly it was reported that occupational acid air fumes didn't increase the occurrence of oral mucosal lesions but they lead to increase in the periodontal pocket depth (Tuominen, 1991). Same was true for the cancer prevalence when the duration is taken into consideration. Longer the exposure more is the chance of cancer occurrence. The granite exposure when pertaining to the general health may be the etiological factor for the initiation and promotion of the malignant neoplasms (Prabhu *et al.,* 2009). The habits like tobacco chewing and pipe smoking apart from mining environment can act as triggering factors in causing the oral mucosal lesions (Browne *et al.,* 1977; Jahanbani, 2003; Prabhu *et al.,* 2009). But there were studies which reported occupation has little effect on the occurrence of oral mucosal lesions (Jahanbani *et al.,* 2009). Vianna *et al.,*(2004) in their study conclude that the evidence of a chronic rather than acute irritative process suggests a possible step on the etiology of oral malignancies, which needs investigation.

In the present study a significant difference was observed in the prevalence of oral mucosal lesions between mining employees (31.6%) and general population (17.08%). Among mining employees 16.60% had leukoplakia, and 5.20% had OSMF, whereas among general population the prevalence was only 7.71% and 3.75% respectively.

A similar result was obtained in a study in Rajasthan among green marble mine labourers where almost 33.3% of workers had leukoplakia which was related to high use of tobacco, stress and malnutrition that was prevalent in the population. It was also postulated in their study that stresses in their work environment drives the workers to use tobacco (Dagli *et al.*, 2008).

The findings of the present study can be attributed to the high prevalence of chewing tobacco habits like tobacco leaf chewing and gutkha chewing (19.7%, 38.60% respectively) among mining employees compared to general population (15.42%, 22.08% respectively), however the difference in consumption of the different tobacco products was statistically insignificant.

In this study regarding the location of the oral mucosal lesions, Buccal mucosa was found as the commonest site affected in both mining employees (67.09%) & general population (56.2%) compared to other sites.

Our results are in agreement with the previous study conducted among Iranian textile mining workers that showed a statistically significant positive correlation between tobacco use and oral pre-cancerous lesion (Jahanbani, 2003).

Similar to our study, previous study reported that in rural inhabitants of Maharashtra state the prevalence of leukoplakic lesions was highest among people with mixed tobacco habits (Deshmukh *et al.*, 1995). It was also found that OSMF was exclusively seen in pan chewers in both mining employees and general population which contains slices of areca nut with slaked lime.

Our present study is also in agreement with a previous study conducted in Xiangatan city, China where the prevalence rate of OSMF was 3.03%, which was due to heavy use of areca nut chewing along with hot pepper among them. Areca

nut chewing has been suggested to be involved in the pathogenesis of this condition (Tang *et al.,* 1997).Within mining units Transportation (20%), cutting (19.29%) and maintenance units (17.78%) had higher prevalence of leukoplakia compared to other units which was statistically significant. This can be due to high tobacco use like gutkha and tobacco chewing among transportation unit (52.14%, 20.00%) compared to other units.

7.8 DENTAL FLUOROSIS

The prevalence of dental fluorosis was higher in mining employees (74.40%) compared to general population (52.08%) which was statistically significant. This might be because of the fact that the most of the examined mining employees and the general population belonged to Rajasthan which is high fluoride belt according to the National fluoride mapping 2002-2003 (Bali *et al.,* 2004).

Even in the salt lake workers of the Jaipur city the dental fluorosis seen was around 59.9% which was high owing to the high fluoride level in the drinking water. High water fluoride level (1.5 ppm) was reported by Sinha (1997) in 19 villages of the Sambhar district, Jaipur.

7.9 PERIODONTAL STATUS OF THE STUDY POPULATION ACCORDING TO CPI SCORES

Overall periodontal status of the industrial or the mining workers remained poor (Peterson and Henmer, 1988; Lie *et al.,* 1988; Panos *et al.,* 1990; Petersen and Tanase, 1997; Amin *et al.,* 2001; Dagli *et al.,* 2008). But the amount of sugar intake and the sweeting agent use along with sugar increased the risk of periodontal diseases (Jahanbani *et al.,* 2009). Age of the worker was directly proportional to the poor periodontal health and the probing depth (Lie *et al.,* 1988; Kumar *et al.,* 2008). Apart from this the habits had their own share of adding the burden to the prevalence of periodontal diseases (Kumar *et al.,* 2008). However, the white collar group or the administration workers had better periodontal health then the mining workers (Lie *et al.,* 1988). But in the survey by pilot *et al*.,(1989)

it was reported that there existed no significant difference in the periodontal status of three group of mining worker; mining equipment mining, a cotton mill and a mining of heavy machinery. There was increase in the periodontal pocket and attachment loss prevalence and it was positively associated with age of the acid mining workers (Tuominen, 1991; Hohlfeld and Bernimoiilin, 1993) than the control group.

Periodontal diseases are caused due to multiple factors and one of the most important factors among them is the environment in which the person is living and that constitute the occupational environment as well. The occupations like mining industries are highly strenuous in nature and most of the employees owing to this strain revert to the habits like ghutka chewing, alcohol consumption, bidi and cigarette smoking. These habits are not kind to the oral cavity proper, gingival and periodontal problems ensure with this. The current paper aimed to evaluate the periodontal status of the mining employees of the Udaipur city.

Total of 92.4% population had gingival and the periodontal problems, which is low in comparison to the results obtained for the salt lake workers in Jaipur and the stone mining workers of Jodhpur(Sanadhya *et al.,* 2013; Solanki *et al.,* 2014).However, the results coincided with the National Oral Health Survey and Fluoride Mapping, 2002-03, of India and Rajasthan, the survey conducted by Dagli *et al.,* (2008) on the stone mining workers and the survey conducted by Abbas *et al.,* (2016) on the underground coal mining workers. Similar prevalence as also been noted by the earlier studies in the different industrial workers (Dharmashree *et al.,* 2006; Dini and Guimaraes, 1994; Tirth *et al.,* 2013). It is noted in the earlier studies that an individual if manages to have lip seal during the working hours will tend to have lesser chances of periodontal health risks than in the non-lip sealed individuals (Vianna *et al.,* 2005). In the other study on the Finnish industrial population, 97±58 of mean estimated periodontal treatment need was reported. This is backed by the study on the Chinese mining workers, were the periodontal status was poor and the amount calculus, shallow and the deep pockets noted was very high (Pilot *et al.,* 1989). The trend discussed here

shows that the periodontal health status of the mining or the mining workers is poor in all over the world. Thus, the role of the working or the occupational environment seems to be the major factor which triggers the unhealthy changes related to periodontium. In German mining workers the prevalence of periodontal disease was 100%, which is way higher than the statistics of the present study (Dagli *et al.*, 2008).In comparison to the present study results lesser prevalence of periodontal diseases was noted in sea farers of Gujarat with only 75% of them reporting to be having poor periodontal status (Aapaliya *et al.,* 2015).Still lesser incidence of periodontal disease i.e 40.2% was reported in the migrant mining workers of South Africa (Van Der Merwe and Maat, 2010). This study was done on archeological remnants where periodontitis was assessed based on alveolar resorption of jaw bones, which might be the reason for such lesser periodontal disease observed.

The reports also appreciate the difference in the periodontal health status between the mining workers and the control group and the difference was statistically significant. Even the results of our study show the significant difference between the mining workers and the general population for the periodontal health (Amin *et al.,* 2001). The deep pockets of more than 6mm were found in 6% of the current mining population and similar prevalence rate was noted for the marble stone mining workers of the Jodhpur city (Solanki *et al.*, 2014).Higher prevalence (9.6%) of 6mm pockets were noted in coal mining workers of Telangana (Abbas *et al.*, 2016).

When we considered the different categories of the mining workers, poor periodontal status was noted for the transportation, cleaning and the polishing unit workers. The periodontal health was far better in the administrative group than the other mining workers. The intra group difference noted was statistically significant. Similar reports were published by Lie *et al.,* (1988) where the periodontal health status was evaluated in the aluminum mining workers and there also the administration unit employees had less problematic periodontal health.

Loss of attachment of 4-5 mm was noted in 29.40% of the mining employees and the similar statics were applicable to the general population for the attachment loss of 4-5mm. coinciding reports were published for the Brazilian metal processing plant workers, where the loss attachment 4-5 mm was noted only in 25.3% of the workers (De Almeida *et al.*, 2008). However, a higher percentage (40.7%) of attachment loss had been reported by the Abbas *et al.*, (2016) in the coal mining workers (16%) and in the sea farers (30.9%) by Aapaliya *et al.*,(2015). Contrastingly they reported 7.02% of 6-8mm attachment loss in the coal mining workers (Abbas *et al.*, 2016) and the current mining population it was increased and the percentage noted was 27%. The difference noted between the mining population and the control group was statistically significant. However, the difference existed in between the mining employees was statistically insignificant.

Further, the study carries the scope to establish the correlation between the years of experience of the employees and the oral habits they indulged with the periodontal health status.

In the present study a statistically significant difference was observed in the prevalence of periodontal disease between mining employees (92.4%) and general population (89.58%). This might be due to higher prevalence of tobacco use and poor oral hygiene practices, among mining employees than general population.

Among mining employees highest prevalence of periodontal disease was seen amongst the transportation workers (96.44%) compared to other units. This might be due to higher percentage of tobacco use (85.71%), in particular gutkha chewing (52.14%) and tobacco leaf chewing (20.0%) among transportation workers compared to other units. Concurrently transportation workers had poor oral hygiene habits compared to other units in our study.

The results in present study were in agreement with the study conducted among cement mining workers at Chelm, in Poland where the prevalence of

periodontal disease among workers was 94.43% while in local inhabitants it was 64.94% (Bozyk and Owczarek, 1990).

The finding in our present study was in agreement with the study conducted among industrial workers in Davangere city, Karnataka where periodontal disease prevalence reported among industrial workers was higher compared to general population (Dharmashree *et al.,* 2006).

Our study results was also similar to the study among green marble mine labourers in Rajasthan where prevalence of periodontal disease was about 98.2% with bleeding and calculus as the commonest scores(Dagli *et al.,* 2008).

The findings of our study were analogous with the previous study conducted among industrial employees in rural part of Norway which concluded that periodontal disease was higher among manual workers compared to administrators (Lie *et al.,* 1988).

Our findings were in agreement with the previous study conducted among Japanese mining workers which states that poor lifestyles were related to high prevalence of periodontal pocketing and gingival symptoms in these population (Shizukuishi and Hayashi, 1998).

A previous study conducted among citizens of Oulu in Finland was in agreement with the present study which concluded that periodontal disease increase with poor standard of oral hygiene and unhealthy lifestyle practices (Sakki *et al.,* 1995).

Calculus is the commonest score in our study in both mining employees (41.9%) and general population (38.0%) compared to other scores.

Similar results were found among industrial workers of Davangere where 98.7% prevalence of periodontal disease was reported with calculus being the commonest score (61%) (Dharmashree *et al.,* 2006).

The results in our present study are analogous with the studies done on mining workers in Shangai, China with only 1.75% having healthy periodontium with calculus score as commonest (Pilot *et al.,* 1989).

A study on worker population Araraquara, in Brazil also reported that calculus was the most frequently observed periodontal condition(Dini and Guimaraes, 1994).Similar results were also seen in a study among green marble mine labourers in India (Dagli *et al.,* 2008).

In our study bleeding score was seen in 7.60% and 4-5 mm pocket was seen in 29.20% of mining employees. A study among mining workers of Romania was similar to ours where 21.49% had bleeding score and 32.7% showed shallow pockets (Roman and Pop, 1998).

In a study from Danish granite industries bleeding score was the commonest score among the study population that was contrasting our study results which is evident from the higher prevalence of twice brushing habit among the workers in their study (70%) (Peterson and Henmer, 1988).

7.9.1 CPI Scores and Tobacco Use

A statistically significant difference was observed in the present study in the prevalence of periodontal disease between tobacco users and non-users in both mining employees and general population.

In both groups prevalence of healthy periodontium was more among non-smokers compared to smokers.

Overall, the prevalence of healthy periodontium was higher among mining employees (29.13%) compared general population to (23.91%), this contrast may be due to the unequal sample size of the study population.

Transportation unit and cutting units had higher prevalence of increasing CPI scores of 4-5mm and 6mm or more deep pockets.

This can be due to high tobacco use like gutkha and tobacco chewing among these units compared to other units.

In a study from Nagpur, generally lower SES, high tobacco use and increasing age were considered as risk factors for periodontal diseases which*h is similar to our study (Doifode *et al.,* 2000).

Our study findings were also in accordance with the previous study conducted among Northern Jordanian adults that suggested a positive correlation between smoking and periodontal disease which might be due to greater presence of plaque and calculus deposits in smokers but there was no significant difference between smokers and non-smokers in regard to bleeding and probing depths this might be because of the other influencing factors like oral hygiene habits and age (Taani, 1997).

Similar results were also seen in a study among Japanese mining workers which showed significant association of poor periodontal health among tobacco users (Imaki *et al.,* 1997).

Negative life style practices were associated with poor periodontal health in a study conducted in Oulu, Finland (Sakki *et al.*, 1995).

A recent study in 2008 by Palmar *et al.,* (2008) concluded that the occurrence of periodontal pockets was more among tobacco quid chewers which is similar to our study.

A recent study in 2009 indicated in all age groups there was a significant difference in periodontal health between smokers and non-smokers where calculus was observed more among smokers than non-smokers (Pucau *et al.*, 2009).

7.9.2 CPI Scores and Oral Hygiene Habits

Oral hygiene habits were better in general population than mining employees where twice brushing was about 2.27% among general population whereas, only 0.0% among mining employees. Brush and paste was used by 85.68% and 75.0% respectively by general population whereas only 68.74% and 72.0% were using brush and paste among mining employees which could have led to poor periodontal status in this group.

These findings were in conformity with a previous study conducted among Japanese mining workers in Osaka that concluded that in a group with a poor state

of oral hygiene, the negative effects of smoking were evident faster resulting in unhealthy periodontal tissues (Shizukuishi and Hayashi, 1998).

Our findings were also in conformity with the earlier study done on citizens of Oulu in Finland which concluded that periodontal pocketing increased with diminishing tooth brushing frequency and an unhealthier life style (Sakki *et al.*, 1995).

Among Danish Granite industrial workers there was 70% prevalence of twice a day brushing habit and hence revealed better periodontal health which was contrasting our study (Sakki *et al.*, 1995).

7.9.3 Prevalence of Loss of Attachment among the Study Population

In the present study there was less prevalence of loss of attachment among the general population compared to mining employees and the difference was statistically significant. This might be because of high prevalence of tobacco habits and poor oral hygiene habits among mining employees as compared to general population.

A study conducted among randomized sample of Swedish population stated that tobacco habits were a significant risk factor for probing attachment loss (Axelsson *et al.*, 1998).

7.10 PROSTHETIC STATUS

Total of 34% of mining employees and 29.58% of general population needed the prosthetic replacement. However, the difference noted between the two groups was statistically insignificant. Similar need of the prosthetic rehabilitation (37%) was noticed in the brass industry workers of Moradabad city (Tirth *et al.*, 2013). Within the mining employees the prosthetic need was more in cutting unit employees and in transportation unit employee's highest number of prosthesis were found.

Among the general population 7.29% had prosthesis in comparison to 6.20% of the mining employees. Higher prosthetic rehabilitation was reported for

the brass industry workers with 37.2% of them having the prosthesis (Tirth *et al.*, 2013).

This difference among the two groups could be attributed to the low literacy levels, socio economic status and lack of permission in the mining among the transportation, cutting and polishing unit workers.

7.11 Tooth Surface Loss

Dental erosion has been defined as a progressive irreversible loss of dental hard tissue by a chemical process, usually by acids other than those produced by plaque bacteria (Meurman and Ten Cate, 1996). The erosion of teeth was most commonly seen in the individuals who worked in acid factories (Gamble *et al.*, 1984; Tuominen, 1991; Erik and Charlotte, 1991; Tuominen *et al.*, 1991; Fukayo *et al.*, 1999; Amin *et al.*, 2001; Vianna and Santana, 2001; Kim *et al.*, 2003; Kim and Douglass, 2003; Ann-Katrin *et al.*, 2005; Suyama *et al.*, 2010).It is a common oral finding in professional wine tasters. There existed significant difference for the erosion between the wine tasters and the non-wine tasters (Mulic *et al.*, 2011). Nevertheless, in a review article by Wiegand and Attin, (2007) claim that the literature evidence show that the occupational dental erosion is limited to the battery and galvanizing workers. They also claim that the data available for the other occupations needs to be confirmed by further studies(Wiegand and Attin, 2007).The fumes produced in the industries like phosphate, battery (sulfuric acid, lead acid), silicone sealers (acetic acid release), copper smelters (sulfuric acid), zinc extraction by electrolytic methods, war industry are deleterious to oral hard and soft tissues (Gamble *et al.*, 1984; Tuominen, 1991; Erik and Charlotte, 1991; Tuominen *et al.*, 1991; Fukayo *et al.*, 1999; Amin *et al.*, 2001; Vianna and Santana, 2001; Kim *et al.*, 2003; Kim and Douglass, 2003; Ann-Katrin *et al.*, 2005; Wiegand and Attin, 2007; Suyama *et al.*, 2010; Mulic *et al.*, 2011). There existed a highly significant difference for the prevalence of dental erosion between the control group and the acid mining workers (Gamble *et al.*, 1984; Tuominen *et al.*, 1991; Fukayo *et al.*, 1999; Amin *et al.*, 2001; Ann-Katrin *et al.*, 2005). The medical problems like upper respiratory tract symptoms persisted

commonly in these workers (Ann-Katrin *et al.,* 2005). In battery workers the incidence of erosion was more common in the anterior region (Erik and Charlotte, 1991; Goto *et al.,* 1996) and the posterior region showed incidence of attrition (Ann-Katrin *et al.,* 2005).However, in another study in organic and inorganic acid factories, showed the prevalence of erosion to be more in maxillary teeth (Tuominen *et al.,* 1991; Goto *et al.,* 1996). Contrasting results were reported in the recent study where the erosion was seen in the mandibular anterior teeth (Wiegand and Attin, 2007). But, Mullic *et al.,* (2011) noted that the erosion was most commonly seen on the occlusal surface of the mandibular molar toothin the wine tasters.

By wearing the protective respiratory mask one can reduce the overall occupational dental erosion (Kim *et al.,* 2003; Kim and Douglass, 2003). Dental erosion was noticed even in the female food industry workers, owing to the inhalation of the dust containing Tartaric acid, sucrose, magnesium sulphate and sodium bicarbonate. It also noted that the Longer the duration of exposure more the chances of dental erosion (Goto *et al.,* 1996; Suyama *et al.,* 2010). In the recent study on dental erosion they have measured the density of acid in the working environment and have found out a significant relationship between the density of the acid and erosion rate (Suyama *et al.,* 2010).

It is one of the common dental problems noticed in the miners (Enbom *et al.,* 1986). The duration of the working has definite influence on the enamel wear, longer the person has worked in the mining field greater are the chances of the enamel wear. Same has been proved in earliest study to the latest study on the dental wear and the working environment (Enbom *et al.,* 1986; Peterson and Henmer, 1988; Jokstad *et al.,* 2005). Few studies took control group-the non-miners for comparing the extent of wear between the two groups, they found that white collar workers or the non-miners showed less prevalent dental wear. (Peterson and Henmer, 1988; Tuominen and Tuominen, 1991; Jokstad *et al.,* 2005).This observation can be attributed to the mining environment, especially the abrasive component of the air which they breathed. 100% abrasion was observed

by Peterson and Henmer (1988) in the granite mining workers and was particularly severe in the anterior teeth. So, far the occupational related abrasion studies were conducted on cement mining workers, granite mining workers, olivine mining workers. Even the noise pollution in the industrial set up has bearing on the dental abrasion rate and same was proven in the study by Kovacevic and Belojevic (2006), they found female workers exposed to noise showed more prevalent abrasion.

In the present study the presence of tooth surface loss of the anteriors was recorded and its severity was graded according to Eccles and Jenkins criteria (Eccles and Jenkins, 1974). Statistically significant difference was observed in the prevalence of tooth surface loss in the anterior teeth between mining employees (33.8%) and general population (11.46%).This might be due to continuous exposure to airborne stone dust particles in the employees working environment that might cause friction and result in tooth surface loss (Tuominen and Tuominen, 1991).

The prevalence of anterior tooth surface loss was higher among polishing unit (47.72%) and cutting unit (39.28%) compared to administrative staff, maintenance staff and the difference was found to be statistically significant. This might be due to heavy and continuous dust exposure and less use of personal protective measures (PPM) among polishing unit (7.58%) and cutting unit (6.43%) workers.

The results of our present study is in agreement with the previous study conducted at Tanza cement company Tanzania, that also found higher prevalence of tooth surface loss among workers (72.2%) compared to staff employees (48.4%). This very high prevalence of tooth surface loss compared to our study might be due to inclusion of both anterior and posterior tooth surface loss in their study (Tuominen and Tuominen, 1991).

Similarly, among Danish Granite industrial workers, 100% abrasion was found in the oral cavity in particular in the front teeth (Peterson and Henmer, 1988).

The results of the current study reveal that the severity and prevalence of tooth surface loss increased with the duration of employment in the mining employees. Similar finding was reported in a previous study conducted at Tanza cement company Tanzania and in Danish Granite industries in which there was an increased severity of tooth surface loss with length of service of the workers in the mining (Peterson and Henmer, 1988; Tuominen and Tuominen, 1991).

Our study results are also similar to a study among workers exposed to olivine dust in Norway (Jokstad *et al.*, 2005).

A longitudinal study design is needed to observe the association between tooth surface loss and dust exposure in these factories because tooth surface loss can be attributable to other causes also.

7.11.1 Noise and Teeth Grinding Habits

Interestingly it seen that teeth grinding habit during work time had direct relationship with the noise produced during the working. This probably is the reason why the tooth loss was most prevalent in polishing and cutting unit employees.

Similar results were seen in other studies, which hypothesized that there was an increased masticatory muscle reflex and eventual tooth grinding habit in workers exposed to high decibel of noise in the work environment which was seen in our study also(Kovacevic, 2006; Kovacevic and Belojevic, 2006).

Moreover the workers using earplugs as a personal protective measure were also very scarce with only about 5.71% and 4.55% of cutting and polishing unit respectively who are exposed to continuous noise in the work environment in the present study.

7.12 TREATMENT NEEDS

7.12.1 Prosthetic rehabilitation Needs

There was a difference between mining employees and general population in terms of prosthetic need but the difference was statistically non-significant. The

difference may be due to the higher prevalence of dental visit among general population for prosthetic rehabilitation (7.29%) than mining employees (6.20%) which could be due to poor access to the dentist and lack of permission in the mining to visit dentist in the working hours.

In the present study a non-significant difference was found within the mining units though there was a higher prosthetic need among the transportation unit, polishing and cutting unit which might be because of lack of permission in the mining, lower socio economic conditions and lower literacy levels of these workers as seen in our study.

An earlier study conducted among Lebanese adults was in agreement with the present study that concluded low SES subjects were in greater need of dentures (Doughan *et al.*, 2000).

7.12.2 Restoration, extraction and pulp care need

A statistically significant difference was observed between mining employees (29.20%) and general population (43.75%) in the need for restoration of teeth.

There was no statistically significant difference between mining employees and general population in extraction needs. Nevertheless, there was statistically significant difference for the pulp care treatment between the mining employees and the general population with general population showing more need of pulp care.

In the present study within the mining employees the transportation unit (15.71%, 17.86%) followed by polishing unit (10.71%, 12.86%) were more in need of extraction and pulp care compared to other units. This difference might be due to more extensive lesions, which are not suitable for restorations, less dental visits and lower socio-economic status among these units. There was no statistically significant difference for the mean restoration, extraction and pulp care therapy between general population and the mining population.

The results in our present study were in conformity with the study conducted among Danish industrial population that concluded that dental extraction was the most frequent treatment need among manual workers (Peterson and Henmer, 1988).

7.13 TMJ DISORDERS

Temporomandibular Disorders are again multifactorial in origin and not one factor can be attributed to its presence. Nevertheless, the psychosomatic disorders are considered as the major etiological factors. In the mining employees the day to day strenuous work and the stress involved due to this can be the major players in the causation of this disorder and to prove this the prevalence of TMJ disorder was greater in the mining employees in the current study.

Temporomandibular Disorders were more in the mining employees then the control group by 6.0%. Reports of the current study show the prevalence of 16.40% of Temporomandibular disorders in the mining employee group and in the control group the prevalence was 10.42%. The difference noted between the two groups was statistically significant. In the previous studies on the prevalence of the TMJ disorder in the general population it is seen that almost 40 to 60 % of the subjects suffer from one or the other signs and symptoms of the TMJ (Nassif and Hilsen, 1992; Chuang, 2002). These findings are contrasting to our results as the TMJ disorders were seen in only 10.42% of the general population. Similar low prevalence of TMJ disorders were reported by Johansson *et al.,* (2000) on the Swedish population and by Pow *et al.,* (2002) on the adult Chinese population.

In between the mining employees, greater prevalence of TMJ Disorders were noted in the maintenance group (22.22%) and it was least prevalent in transportation unit employees. However the difference noted was not statistically significant.

The literature pertaining to the prevalence of the occupational related TMJ disorder is scanty to nil, so the scope to discuss and compare our results with the other occupational groups was not possible. However, the increased prevalence of TMJ disorder in mining employees may be due to the development of the

parafunctional habits like grinding of the teeth and clenching of the teeth during the strenuous physical labor. Pertaining to this, in the Nigerian population who suffered from TMJ disorders, it was found that maximum number (89.7%) of them had one or the other parafunctional habit which triggered the signs and symptoms of TMJ disorder (Saheeb, 2005). Same may be applicable to present mining employees.

7.14 DENTAL AESTHETIC INDEX SCORE

Maximum number of the mining workers and the control group population judged their dentition as satisfactory. Twenty four percent of the mining workers judged their dentition in grade 1 category, however, 26.67% of the general population judged their dentition to be belonging to the grade 1 category. In rest of the grading also the similar higher prevalence of judgment was seen in the general population. However, the difference noted was statistically insignificant.

This difference in judgement might be due to the increase in the awareness in the general population regarding their esthetic need of their dentition than the mining workers. Again the increase in awareness can be attributed to the increased literacy level of the general population then the mining employees.

7.15 SYSTEMIC DISEASES

Respiratory disease were the most common finding in the mining employees (23.3%), which is followed diabetes (21.0%) and the eye problem (16.9%). This high prevalence for the respiratory disease could be attributable to the working conditions and the higher prevalence of the smoking habit. In the control group the main prevalent systemic problem was related to eyes (27.7%). This was followed by the diabetes (22.22%) and respiratory diseases (15.74%). However, the difference found between the mining workers and the general population. It is cited that the Lung function impairment was relatively higher in miners than in controls in the previous study on the Gypsum mining workers (Nandi *et al.,* 2009). It is noted that diabetes was seen in 8% of the miners in the same study, which way lower (21%) than the findings of our study (Nandi *et al.*,

2009).Similarly, in health survey study of the lime stone workers 15% of impairment in the pulmonary function was noted and in agreement to this two more reports were also cited(Chatterjee *et al.,* 2008; Dhatrak *et al.,* 2014; Oliveira *et al.,* 2014).

Hypertension was seen in 9.9% of the mining workers and in 8.33% of the control group. This increase in the percentage of hypertensive individuals in mining group again reflects their unhealthy work environment, including the adverse habit which they indulged themselves in. in accordance to this finding few studies previously on different occupational groups have reported in an increased hypertension prevalence by 5.92%, 8.3% and 22.6% in lime stone workers, iron ore workers and gypsum mining workers respectively (Nandi *et al.,* 2009; Dhatrak *et al.,* 2014; Oliveira *et al.,* 2014).

In between the mining workers respiratory diseases were most common in the polishing workers (32.79%), eye problems were most common in maintenance unit (37.50%) and diabetes was the most common problem in administration unit workers (38.46%). Hearing problem was once again more prevalent in polishing unit (13.11%). However, the difference noted was statistically not significant.

7.16 COMPARISON OF PM VALUES IN DIFFERENT AREAS OF UDAIPUR CITY

The particulate matter level seen in the Udaipur Ambamata (119.00) and Udaipur Town hall region (134.00) were low in comparison to the Udaipur industrial area (212.00) and the mining area (254.00). The difference found between the different regions was statistically significant with the P=0.000. This increase in the PM level might be the reason for the tooth loss seen in the mining employees. However, when we talk about the air quality, in all the regions the air quality was critical.