Comparison of Pulmonary Function Test Abnormalities between Stone Crushing Dust Exposed and Nonexposed Agricultural Workers

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Abstract

Objectives: The aim of this study is to examine the effects of stone crushing in West Bengal, India, by comparing pulmonary functions of stone crushing workers with those of nonexposed agricultural workers.

Methods: Two hundred seventy two stone crushing workers and 123 nonexposed workers were analyzed in terms of occupational and personal histories, radiological findings, and pulmonary function test (PFT) results including slow vital capacity (SVC), forced vital capacity (FVC) and peak expiratory flow rate (PEFR). Different lung volumes i.e. FEV₁, FEV_{1%} and flow rates i.e. FEF_{200–1200 ml}, FEF_{25–75%} and FEF_{75–85%}, were analyzed with regard to sex, smoking habit, work status, age and work duration.

Results: Contrary to our expectations, the incidences of suspected (2.94%) and definite (1.84%) pneumoconioses were very low and the results of some PFT such as those for FVC and FEV_{1%}, in the exposed group were better than those in the nonexposed group, although a gradual decline the performance in PFT was observed with age and work duration. There was a higher prevalence of restrictive impairment among the exposed group and a higher prevalence of obstructive impairment in the nonexposed group.

Conclusions: Some of the results were unexpected. Possible reasons for these include (i) undetectable concentrations of free silica in the stone dust in the work environment of the exposed workers and (ii) factors, such as climate, in the work environment of the nonexposed agricultural workers that could cause pulmonary impairment. Further protective measures should be undertaken to prevent pulmonary impairment in both groups of workers.

Key words: quarry, crushers, elevators, screens, restrictive impairment, obstructive impairment and combined impairment

Introduction

In rock quarries throughout the world large blocks of stone are blasted apart and then broken down into smaller sizes by stone crushing units according to customers' specifications and requirements. In India, stone crushing units are an unorganized sector of the country's work force employing a small number of workers in each unit.

Stone crushing work is widely carried out in different parts of India, particularly in adjoining hilly regions. In West Bengal,

India, stone crushing units are usually found in the districts bordering the Bihar and Jharkhand. There are fairly large numbers of small units located in different parts of these districts. The workers usually inhale a large amount of dust generated by the crushing units, and this dust contains silicon dioxide or free silica. Free silica is responsible for causing the oldest and most dreaded of occupational diseases, silicosis. There are three types of silicon dioxide quartz i.e., crystalline silica, tridimite and cristobalite. Silica is abundant in nature and composes about 12% of the earth's crust. In this study, the stones crushed in West Bengal had an undetectable range of free silica. Note that the presence of other pollutants, such as those from cigarette or beedi smoking, or environmental pollution outside the work place may also modify the effects of quartz or silica (1). Therefore, it is of important to study the pulmonary function status of these groups of worker, to determine the

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Photograph 1 Stone being pouring into crushing machine by loader and khalasi. (A) Conveyer loader system. (B) A khalasi pouring stones into the mouth of the crushing machine. (C) A chalna worker carrying stones for crushing. (D) Moving chalna. (E) Main crushing unit of stone-crushing machine.

Photograph 2 Collecting, lifting and carrying of stone chips from site of chalna. (A) The loader collects the stone chips coming from the moving chalna. (B) Loader carrying stone chips. (C) Stone dust generated around stone-crushing machine. (D) Moving chalna separates different sizes of stone chip.

magnitude of respiratory problems among stone crushing workers, and to compare their pulmonary function status with that of subjects not exposed to stone dust.

The stone crushing units in West Bengal produce stone chips of different sizes. Large chunks of basalt that are removed by blasting at the quarries are broken into boulders, which are then broken into smaller pieces called “chelli”. Workers break up chelli with the help of heavy hammers called “Churni” of which one side is sharp and the other is blunt. In, Four types of stone chip, i.e., 3/4 inch, 5/8 inch, 1/2 inch and 1/4 inch, are produced from ‘chelli’ by the stone which discard the by-product, stone dust.

The unskilled workers in the crushing units are predominantly tribal women employed on a contract basis. Chelli workers carry chelli and placed it into crushing machines. “Chalna” workers deliver the resulting graded stones either to trucks or separate storage facilities. Chalna workers experience the highest amount of exposure to stone produced from Chalna because the stone crushing units are continuously pouring out crushed and graded stones leading to an extremely dusty environment (Photographs 1 and 2).

Background of stone crushing

Stone crushing units are located in open places at the quarry site or near a good road connection for transporting raw materials. During crushing, stone crushing units give off dense clouds of dust that is carried by the wind.

The mostly female chelli workers carry baskets of broken stones on their heads from the stone breaking site to crusher unit and climb a steep rise to reach the stone crushing units. This increases their rate and depth of respiration, causing larger amounts of dust to enter their lungs. A huge amount of dust is generated at the site during working and is expelled stone chips from waste vents. These waste vents are arranged serially and produce thick dust clouds where both male and female workers work (Photograph 2). Note that the populations in the exposed and nonexposed groups in this study are mostly tribal. They are usually from local areas or the surrounding districts. Some workers migrate from nearby places to work. Exposed workers do not work regularly throughout the year. Generally, during the rainy season, they return to their villages and undertake agricultural work such as the cultivation of rice paddies and the rising of other crops. They also leave during the harvesting season. In addition, these work units do not function during the rainy season. During the above-mentioned period, the management cleans and overhauls the stone crushing units.

Materials and Methods

Two hundred seventy-two exposed workers of both sexes (142 males and 130 females) were studied. The nonexposed group was selected from people living more than 20 km away from the study site without any exposure to stone dust and with more or less the same socioeconomic status as that of the exposed groups. These nonexposed subjects, who numbered 123 (74 males and 49 females) were also brought to a study site. Although they were engaged in various jobs, the majority of them were engaged in agricultural work. Others were rickshaw pullers or day laborers who prepared and repair of village roads.

Initially, the stone-crushing units were selected on the basis of a stratified sampling method. Subjects took part in the study voluntarily and were released by their employer from their unit for the evaluation. The scientists visited different study sites, discussed the intention of the study with the subjects, and prepared, tested and validated a standard questionnaire under field conditions prior to undertaking the actual study. Written consent was obtained from each subject before the study, and working and personal histories were taken. The project proposal was approved ethically by an institutional ethical committee according to the rules and regulations of the Indian Council of Medical Research of the Government of India. The exposed and nonexposed subjects usually experience exposure to the sun, rain and other adverse climatic conditions while working.

Standard procedures for clinical examination were performed using a standard protocol. The cross-checking of the observations of medical doctors was performed for one hundred subjects. Chest X-rays (PA) were taken with a 300 mA machine, as per recommendation of the International Labour Organization (ILO), to obtain a clear picture of small fibrotic shadows. As per requirement, 12"×15" and 14"×17" films were used. Three readers evaluated the exposed films separately. The final evaluation was performed taking into consideration the reports of these three readers.

Pulmonary function tests were performed using a Spirovit-sp-10 (Schiller Health Care Pvt, Ltd. Switzerland). The subjects were motivated, had the procedure explained to them and then slow vital capacity (SVC) and forced vital capacity (FVC) were recorded. The peak expiratory flow rate (PEFR) was measured using Wright's Peak flowmeter (Clement and Clarke, UK). The same instrument was used throughout the study. Three successive recordings of SVC, FVC and PEFR were made in a standing posture and the best of the three was used for calculation purposes. The standard spirometric procedure was followed (2, 3). Different flow volumes, i.e., FEV_1 and $FEV_{1\%}$, and flow rates, i.e., $FEF_{200-1200\text{ ml}}$, $FEF_{25-75\%}$ and $FEF_{75-85\%}$, were calculated from the same tracings.

Pulmonary function test results were presented and discussed with regard to age group, the exposure duration and smoking habit. All the lung volumes obtained were expressed with correction for body temperature at the atmospheric pressure of air saturated with water vapor (BTPS). The body height and weight of barefooted subjects were measured on a standard scale. Body surface area was calculated from a standard formula (4). Pulmonary function test results were

calculated from the standard prediction equation of normal Kolkata subjects (5). The criteria followed for the categorization of restrictive impairment severity were based on the differences between the predicted and observed values of SVC and obstructive impairment based on $FEV_{1\%}$ (6). SPSS software was used for statistical analysis.

Results

Three hundred ninety-five people, 272 exposed stone crushing workers and 123 nonexposed agricultural workers were the subjects of this study. Of them, there were 142 exposed males (E-M group), 130 exposed females (E-F group), 74 nonexposed males (NE-M group), and 49 nonexposed females (NE-F group). The smoking habits of the subjects are summarized in Fig. 1. Although 53.8% and 56.8% of the members of the E-M and NE-M groups, respectively, were smokers (SMs), a very small number of females were SMs (8.9% of the E-F group and 4.1% of the NE-F group). Few of the subjects have stopped smoking (7.7, 10.8 and 2.2% in the E-M, NE-M and E-F groups, respectively). Smoking duration ranged from 9.5 ± 9.4 to 13.2 ± 10.7 years. An addiction to chewing raw tobacco (khaini) was found in 89.4, 59.5, 17.8 and 12.2% of the members of the E-M, NE-M, E-F and NE-F groups, respectively. A large number of subjects also consume alcohol. Breathlessness was reported more among the E-M and E-F groups than in the NE-M and NE-F groups.

The physical characteristics and mean pulmonary function test results of the exposed and nonexposed subjects are presented in Table 1. All the parameters of the exposed and nonexposed subjects were compared according to sex. Note that $FEV_{1\%}$ was lowered in the nonexposed subjects in both sexes, although SVC and FVC were higher in females in the nonexposed group. In addition, $FEF_{25-75\%}$ was higher in both sexes among the nonexposed subjects.

All the nonexposed and exposed workers were categorically divided according to age by decade i.e., ≤ 19 , 20–29, 30–39, 40–49, 50–59 and ≥ 60 . As shown in Fig. 2, the pulmonary function test results gradually worsened with age, although the ≥ 60 group included only one E-M subject, four E-F subject, and one NE-M subject.

Fig. 1 Summary of smoking habits of all subjects.

Table 1 Comparison of physical characteristics and pulmonary function test results between exposed and nonexposed subjects by sex

	Male		Female	
	Exposed	Nonexposed	Exposed	Nonexposed
Age (yr)	33.22±11.40	34.47±10.59	34.90±12.40	38.60±11.60
Height (cm)	162.10±7.00	162.80±6.10	149.90±6.10	151.80±8.90
Weight (kg)	46.30±5.90	49.12±6.80	39.90±5.30	39.50±5.40
BSA (m ²)	1.47±0.11	1.50±0.12	1.30±0.10	1.29±0.10
SVC (l)	3.36±0.81	3.36±0.67	2.16±0.51	3.41±0.49
FVC (l)	3.30±0.82	3.28±0.68	2.17±0.53	2.39±0.52
FEV ₁ (l)	2.94±0.82	2.61±0.69	1.92±0.52	1.84±0.46
FEV _{1%}	88±3.2	79±10.8	88±13.0	77±6.8
FEF _{25-75%}	3.79±1.48	3.81±1.45	2.78±0.93	2.91±0.93
PEFR	466±77	465±46	368±65	359±77

BSA: body surface area.

The level of the significance difference was determined by Student t test. *: p<0.01, **: p<0.001.

Fig. 2 Changes in results of three pulmonary function tests, SVC, FEV_{1%} and FEV_{25-75%} according to age divided by decade and comparison of these among E-M, E-F, NE-M and NE-F groups.

The radiological findings of workers in the suspected pneumoconiotic categories (0/1 and 1/0 categories) indicated eight cases (2.94% of 272) among all the exposed subjects. Of those cases, six (4.23% of 142) were males and two (1.53% in 130) were females. Definite pneumoconiosis (1/1 and 2/2) was present in five members of the total exposed population (1.84%). Three (2.11%) were males and two (1.53%) were females.

PFT results in relation to the smoking habit of the above subjects are presented categorically in Fig. 3. Because SMs in the E-F and NE-F groups and ex-smokers in all the groups analysis was performed using the data for male and female NSs and SM males compare the PFT results of the exposed and nonexposed groups. The results indicate that NS NE-F subjects have higher SVC and FVC than NS E-F subjects. In addition, FEV_{1%} is higher in the exposed subjects than in the nonexposed ones in all the groups compared, with higher FEV₁ in NS among E-M subjects than in NS among NE-M subjects.

The PFT results of the E-M and E-F workers were calculated from to their work duration in the stone crushing

units and are presented in Fig. 4. For the work duration, all the E-M and E-F workers were categorized into duration groups as follows: ≤5 years, 6–10 years, 11–15 years, 16–20 years, 21–25 years and ≥26 years. Pulmonary function values decreased with increasing work duration, although a paradoxical increases were found in the data of a few duration groups in results of some tests such as in the male data for FEF_{25-75%} of the 16–20 years group. In addition, no decrease in FEV₁ % values was observed with work duration.

The spirometric classifications of the pulmonary function impairments of the nonexposed and exposed male and female workers are presented in Fig. 5. Respiratory impairment was categorized as restrictive (RI), obstructive (OI) or combined restrictive and obstructive (CI). Nine (12.2%) of 74 NE-M and 10 (20.4%) of 49 NE-F showed a relatively higher prevalence of OI, whereas 33 (23.2%) of 142 E-M and 20 (15.4%) of 130 E-F had a higher prevalence of RI. The incidence of CI was lower than 3% in all the groups except for the NE-M group, in which it was 8.1%.

The distribution of PFT results for impaired workers

Fig. 3 Comparison of various PFT results according to smoking habit (SM; smoker, NS; non-smoker), sex and status of exposure.

Fig. 4 Changes in various PFT results in exposed subjects according to work duration.

according to age range is presented in Table 2. If pulmonary function impairments among the subjects are divided according to age range, the distribution of workers in each category of workers according to sex is quite scattered. Therefore, the fact that the percentage of impairment in a particular age group is high does not necessarily reflect the actual percentage of the subjects whose PFT performance declines. Thus, no definite trend of reduction in pulmonary function impairment was found

in any particular age groups.

The regression coefficients of SVC, FEV_{1%} and FEF_{25-75%} in the exposed NS and SM workers with regards to sex, age, height and the exposure duration are presented in Table 3. In every case, multistage stepwise analysis was performed to determine regression equation. Age, sex, height, smoking habits and exposure duration were found to be related to SVC, FEV_{1%} and FEF_{25-75%}.

Table 2 Number of subjects classified according to pulmonary function impairment in exposed and nonexposed groups

		Age groups	~19	20–29	30–39	40–49	50–59	≥60	Total
Male	Exposed	Restrictive	3	8	10	7	4	1	33
		Obstructive	0	1	0	1	0	0	2
		Mixed	0	2	0	0	2	0	4
	Nonexposed	Restrictive	2	3	3	1	0	0	9
		Obstructive	0	1	3	4	1	0	9
		Mixed	0	2	0	2	2	0	6
Female	Exposed	Restrictive	2	8	3	4	3	0	20
		Obstructive	0	1	1	3	0	2	7
		Mixed	0	1	0	1	0	0	2
	Nonexposed	Restrictive	0	1	2	1	0	0	4
		Obstructive	1	2	0	3	3	0	10
		Mixed	0	0	0	0	1	0	1

Table 3 Regression coefficients of SVC, FEV_{1%} and FEF_{25–75%} with regard to sex, age, height and exposure duration

Parameter	Category		Regression coefficient (SE of coefficient)			Constant	R2	SE
			Age (Yr)	Height (cm)	Duration of exposure (Yr)			
SVC (l)	SM	M	–0.0156 (0.003)	+0.0241 (0.005)	–0.0193 (0.007)	–0.7571	0.40	0.82
		N-SM	–0.0094 (0.0047)	+0.0540 (0.0108)	–0.0380 (0.0195)	–4.8405	0.36	1.76
		F	–0.0413 (0.007)	+0.0367 (0.010)	+0.0092 (0.0123)	–1.2717	0.47	1.68
FEV _{1%}	SM	M	–0.4165 (0.0872)	–0.2062 (0.1430)	+0.0092 (0.2069)	+129.90	0.16	21.92
		N-SM	–0.0444 (0.1002)	–0.2369 (0.1374)	–0.4553 (0.2485)	+131.35	0.12	22.41
		F	–0.1801 (0.0833)	+0.1139 (0.1160)	–0.2050 (0.1420)	+76.74	0.18	19.49
FEV _{25–75%}	SM	M	–0.0425 (0.0062)	+0.0171 (0.0103)	–0.0180 (0.0149)	+1.79	0.40	1.58
		N-SM	–0.0223 (0.0161)	+0.0242 (0.0221)	–0.0760 (0.0400)	+1.07	0.15	3.61
		F	–0.0669 (0.0158)	+0.0481 (0.0221)	–0.0017 (0.0270)	–1.72	0.33	3.71

SE standard error. SM, Smoker; N-SM, nonsmoker; M, male; F, female.

Fig. 5 Spirometric classifications of the pulmonary function impairment of nonexposed and exposed male and female workers.

Discussion

Silicosis occurs as a result of the inhalation and deposition of crystalline silica particles in the lung parenchyma (7). The most important factor in the silicosis development is the dose of respirable silica contained in dust inhaled and the percentage of respirable silica in the total dust. Other important factors are particle size, the crystalline or non-crystalline nature of the silica, the dust exposure duration, and time period from first exposure to diagnosis (8).

In this study, as there was a very low level of free silica, which was within the non detectable range, the occurrence of silicosis was not noticeable, but changes in PFT results may have been noticed for other reasons. The PFT results of the E-F subjects were found to be significantly lower in most parameters compared with those of the NE-F subjects. In E-M workers, the changes were not as large and did not reach a significant level. However, the lung volumes were higher in

the exposed workers than in the nonexposed subjects. Regarding the possible relation to age, a gradual decrease in the PFT results of the exposed and nonexposed workers of both sexes, except between the ≤ 19 year old and 20–29 year old age groups, was observed. Of these two groups, results the higher age group might have been affected by the small number of subjects. The duration of exposure to the working environment also played its role. The rate of decrease in PFT results was steeper in female subjects than in E-M workers, and in the nonexposed subjects who smoked, the PFT results were higher than in the non-smokers. The reason for this is not clear to us. It might be due to the very small number of subjects in the same category and might also be due to a shorter smoking duration and minimal inhaling while smoking. The usually smoke beedi, which is less harmful than cigarettes. In both male and female workers, the PFT results decreased as work duration increased. Highly exposed workers had lower PFT values than those with minimal exposure. The restrictive types of pulmonary function impairment were found more among the exposed male and female workers, whereas the obstructive and combined types of impairment were found comparatively less in the exposed workers of both sexes. In the nonexposed subjects, obstructive types of impairment were found more in female subjects than in male subjects. The high percentage of the restrictive type of impairment among the exposed workers might be due to the inhalation of dust from the work environment and the subsequent effect on the lung parenchyma. However, the prevalence rate was not significant compared with that of the nonexposed subjects.

A small number of radiographic pneumoconiotic shadows were found in exposed workers. All the workers are more or less exposed to the same dust from the stone crushing activities. They inhale a large amount of dust but the prevalence rate of pneumoconiotic shadows was definitely low in relation to their exposure. Signs of pulmonary tuberculosis diseases present in the chest X-rays of the exposed and nonexposed subjects were found in 44 subjects (16 in the NE-M group (21.6%, $n=74$), 5 in the NE-F group (10.2%, $n=49$), 18 in the E-M group (12.6%, $n=142$) and 15 in the E-F group (11.1%, $n=130$). The thickening of the interlobar tissue was more prevalent among all categories of subjects with a total of 39 cases (11 among NE-M (14.9%), 4 among NE-F (8.2%), 9 among E-M (6.30%) and 15 among E-F (11.1%)). The prevalence rate of pulmonary tuberculosis and thickening of the interlobar tissue was actually greater in the nonexposed population. Among the pneumoconiotic subjects, there were five males with signs of tuberculosis, two with definite tuberculosis (14.3%) and three with suspected tuberculosis (16.7%). There were no cases of pulmonary tuberculosis among pneumoconiotic female subjects. The restrictive type of pulmonary function impairment might be the result of fibrotic lesions of lung fibrosis. Considering the fact that the stone being crushed was basalt with non detectable amounts of free silica contained in it. This could be a possible reason for the low prevalence rate of tuberculosis. An occupationally related annual decline in the degree of ventilatory function has been reported in people with or without silicosis who have worked as gold and other hard rock miners, iron ore miners, and

slate pencil and kaolin workers (9).

To determine the reason for the etiology of low prevalence rates of pneumoconiosis, we collected settled dust from a few stone crushing units to measure the free silica content in the dust. The estimation of the free silica contains in the samples was carried out at the National Institute of Occupational Health, Ahmedabad, by the Fourier Transform Infrared (FTIR) Spectrophotometric method. In this study, other minerals present in the dust were not taken into consideration or estimated because the objective of the study is to determine the occurrence rate of silicosis in these groups of workers. Only free silica was estimated to determine what effect the dust has on the onset of silicosis. The results of the dust analysis showed free silica concentrations to be undetectable. Earlier, a study carried out by the National Institute of Small Mines (Regional Centre, Kokata) revealed that there is only a remote chance of acquiring silicosis among laborers working in a dusty atmosphere of black stone dust (basalt stone) because the dust not contain any free silica. The results of this study correlate strongly with their observation.

The main comparisons of pulmonary function test (PFT) parameters were affected by the confounding factors of age, height and smoking habits. Individual PFT results differ from each other with respect to these factors. Therefore, carrying out a comparison with respect to a single factor and neglecting the others is not appropriate. In this context, analysis of variance was used to eliminate the effects of variations in age, height and smoking habits mathematically. Regarding the variation in exposure duration among the exposed groups, no effects (SVC, FVC, FEV₁, FEV_{1%}, FEF_{25–75%} and PEF_R) were found. Regression equations were drawn with the above factors, namely sex, age, height and exposure duration taken into consideration. The relationship of age with SVC, FEV_{1%} and FEF_{25–75%} were negatively linear in all cases. Those of height were positively linear except for with the FEV_{1%} of females and nonsmoker males. Similarly, the exposure duration was negatively linear with the above-mentioned pulmonary function test parameters. The coefficient of determination (R^2) gives the percentage dependence of variables. Therefore, the values of R^2 were presented in terms of percentage, with the total variance of one variable being associated with the variance of the others. The findings of this study supported the postulate that functional impairments of the lungs are not fully dependent on the exposure duration.

The nonexposed subjects were also exposed to different work environments depending on their occupations in the course of earning their livelihood. Most of the nonexposed subjects, both males and females, were engaged in agricultural work and were exposed to extreme weather during the seasons without sufficient protective measures. As a result, many suffered from colds and coughing. Some of the workers complained of respiratory problems during the conduct of questionnaire survey. Addictions to alcohol, and smoking and the chewing of raw tobacco and irregularities in food habits can lead to poor health. These nonexposed subjects live in a single room, share it with domestic animals and cook their food inside it. Different types of biomass fuel were used in cooking, polluted their poorly ventilated rooms. These all might be

probable reasons for their obstructive type of respiratory impairment.

Recommendation

Because the dust generated during the different operations of stone crushing becomes airborne and spreads to the surrounding areas, not only the exposed workers but also people living in the surrounding community are affected. Therefore, it is essential to improve working conditions to reduce and minimize human suffering. Effective engineering and dust control measures need to be instituted to make the working zones safe and more suitable for workers. Because of poor roads at quarry sites, settled dust becomes airborne as a result of passing cars, buses, and trucks. Road conditions need to be improved and arrangements need to be made so that the settled dust does not become airborne. The suppression of airborne dust by spraying water on it is a widely accepted method of dust control. It is easy and cost effective. However, because water is scarce at crushing sites, rainwater needs to be collected for this purpose. Another method of reducing the concentration of dust is suctioning the dust at its source. This suctioned dust needs to be passed through water. The dust will then settle and the water can be recycled. Alternatively, an electrostatic precipitator could be used, but it is too costly, it is not recommended.

For personal protection, proper masks should be worn and they need to be cleaned or the filter should be changed as and when required. To prevent accidents during stone crushing, the proper use of removable fencing with wire nets (foldable with joints) is desirable. A supply of shoes and clothes for this work is also essential. One basic requirement should be the performance of a detailed environmental assessment of total and respirable dust. A chemical analysis of the dust especially for silica should be performed and noise level measurements should be made. Because female workers from the adjacent area stay at the stone crushing unit sites with their children, some

hostel type of accommodation and a crèche for their children (to avoid exposing of the children to dust should be provided to). Efforts need to be made to extend medical benefits to these workers and providing Employees State Insurance (ESI) coverage should be considered. For the nonexposed subjects, a health awareness programme is required to raise their health awareness. The ill effects of different addictions, the proper utilization of their earnings and the need to reside in a pollution-free house must be explained to them for the improvement of their health status. Because the main basic need is to maintain good health, health education, a continued awareness programme, pre placement, and periodic medical examinations and recording findings are necessary.

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