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Original Article

Community Medicine Section

Hazards and Health Risks Encountered by Manual Sand Dredgers from Udupi, India: A Cross-sectional Study

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ABSTRACT

Introduction: Globalization and urbanization have resulted in an increased demand on sand dredging. Legal and environmental restrictions on automated dredging have led to a rise in manual technique. The working techniques and environment involved in manual sand dredging may expose the workers to multiple work related disorders.

Aim: To determine the health risks and occupational hazards involved in manual sand dredging.

Materials and Methods: An assessment schedule was developed and content was validated by five experts for the study. A cross-sectional study was then conducted using this assessment schedule. Thirty manual sand dredgers were recruited from three randomly selected docks on Swarna riverbed in Udupi district, Karnataka, India. A detailed work and worksite assessments were conducted using systematic observation and close-ended questions. Work-related health risk evaluation included onsite-evaluation and self-reported health complains.

Results: The prevalence of musculoskeletal pain and discomfort was 93.34% with lower back (70%), shoulder (56.7%) and neck (46.7%) involvements being most common regions. Prevalence of sensory deficits at multiple site and ear pain was 66.6% and 76.6% respectively. All the workers recruited, complained of dermatological and ophthalmic involvements. Also, lack of health and safety measures like personal protective devices and security schemes were identified.

Conclusion: This study shows a high prevalence of multiple work-related disorders and hazards involved in manual sand dredging, a highly demanding job in coastal Karnataka. Lack of health and safety measures were also identified.

Keywords: Mining, Musculoskeletal, Occupation, Prevalence, Unorganized, Workers

INTRODUCTION

An increased demand for urbanization and generous schemes for housing have led to an acceleration of constructions all over India [1,2]. The flourishing of tier 2 cities has clenched India to the third largest construction market worldwide in recent years [3]. This has posed an increased need for sand dredging. But, the prohibition of sand dredging due to environmental disasters has constrained the use of automatized dredging resulting in shortage of sand supply [2,4]. Increased demand but less supply has amplified the problem by making sand a lucrative commodity thereby increasing the market need for manual dredgers [5].

Riverbed sand dredging provides 30%-35% of total sand required for construction [2,5]. Karnataka with its large estuaries and rivers like Cauvery, Nethravati, Swarna, Lakshmanatirtha, Harangi, Hemavathi; is one of the largest sand mining states in India. Moreover, river sand being ideal for construction is in high demand in Southwest coast of India [6-8].

Manual sand dredging involves mining of sand manually from the riverbed and transporting it to the trucks for delivery at construction sites. The job involves workers utilizing country boats and hand tools for rowing, underwater diving, dredging and manual material handling thereby increasing the risk for work-related disorders [9]. The working environment being river water and sand, there might be risk of exposure to hazardous materials [10]. Furthermore, unavailability of Personal Protective Devices (PPD) and social security measures may increase exposure to occupational hazards [11,12]. Thus, an onsite assessment of manual sand dredgers requires multisystem screening for identification of health risks.

A high demand for production, legal constraints on the use of machinery and poor working environment may pose a heightened risk for work related disorders among the manual sand dredgers. Since, it is a cluster industry in this region of Southern Karnataka and has high employee turn-over, it is necessary to identify the inherent risks involved during the task. This study is an attempt to conduct workplace screening programs for detection of health risks and occupational hazards among manual sand dredgers.

MATERIALS AND METHODS

Approval to conduct the cross-sectional study was sought from Institutional Research Committee, SOAHS and ethical clearance was sought from Institutional Ethical Committee, Kasturba Hospital (IEC 616/2015). Permission was taken from dock owners to conduct the study. Written informed consent with thumb impression was obtained from all the participants in the presence of a witness. The data collection was conducted during November 2015 to January 2016.

The study was conducted in two phases. Phase-I was carried out to develop an onsite assessment schedule for the study. Phase-II included recruitment of manual sand dredgers and onsite evaluation.

Phase: I- Development of Health and Occupational Risk Profile (HORP) assessment schedule:

A literature review was undertaken to identify occupational hazards involved in divers, construction workers and manual material handlers [10,13-17]. A pilot study was conducted on 10 individuals involved in manual sand dredging in order to develop a semi-structured assessment schedule. The site for pilot study was conveniently selected from Parampalli region, Karnataka, India. The assessment schedule was compiled and then content validated by five experts. The professionals had expertise in the field of

orthopaedic, neurology, cardiorespiratory and occupational health under physiotherapy discipline.

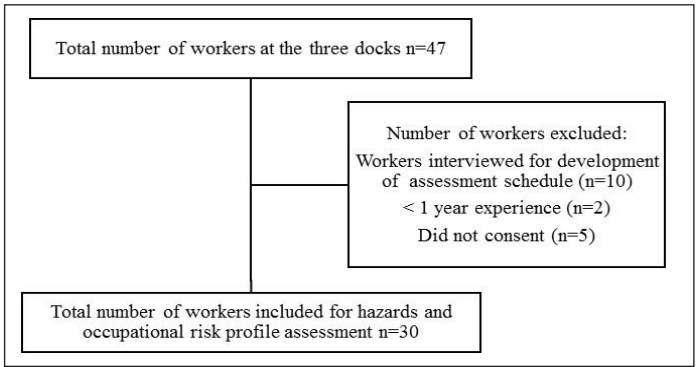
The validated HORP assessment schedule included onsite screening of the work, workplace, the worker and occupational hazards involved in manual sand dredging. It also included availability of occupational health and safety measures and awareness among the workers.

The components of HORP included screening of sensory, dermatological, ophthalmic, respiratory and musculoskeletal system. The schedule included Standardized Nordic Musculoskeletal Questionnaire (SNMQ) [18,19], Rodgers Muscle Fatigue Analysis (RMFA) [20] and Rapid Entire Body Assessment (REBA) [21] for assessing musculoskeletal disorders. To assess on-site ventilator capacity, breathe holding time and peak expiratory flow rate using Wright's peak flow meter were utilized. Protective sensation was evaluated using 10g Semmes Weinstein monofilament. Dermatological and ophthalmic symptoms were observed by investigators. Self-reported symptoms related to ear, bladder and bowel were also recorded [Appendix].

Phase: II- Assessment of occupational hazards and health risks involved in manual sand dredging:

A time bound cross-sectional study was undertaken among manual sand dredgers. Since the river water level rises and temperature decreases during monsoon, sand dredging at Swarna river is undertaken only during pre and post monsoon seasons. Hence, a time bound study was carried out during November 2015 to January 2016, which is the post monsoon period in this region of Karnataka.

The docks owners are usually issued temporary licenses from authorities for sand mining. During the study period, eight docks were functioning near to the study area along the course of Swarna river. Three docks were randomly selected using a lottery method. The selected docks were located at Parampalli, Hoodeh and Thonse along the Swarna riverbed.



[Table/Fig-1]: Flowchart showing the recruitment of participants for the study.

Workers with a minimum of one year experience were selected for the screening. [Table/Fig-1] shows the flow of participants for the study. The duration of administering HORP was 45 to 60 minutes per worker. Workers were not permitted to leave during work hence assessment was conducted during daybreak i.e., prior to the initiation of the work.

STATISTICAL ANALYSIS

The data collected on HORP was analysed using SPSS version15.0 and descriptive statistics was used to summarize the data.

RESULTS

Thirty manual sand dredgers were purposively selected for HORP screening. The results from screening has been summarized under general demographic profile of workers; work and workplace evaluation; worker health profile; and workplace safety and security. The workplace safety and security include reports on occupational hazards and workers' welfare provisions.

Variables	Mean±SD
Age (years)	26.8±5.7
Height (feet)	5.3±0.20
Weight (kg)	56.4±3.7
Body Mass Index (kg/m²)*	22.0±3.3
Work experience (years)	6.06±2.63
Hours of work (per day)	9.0±1.36
Socioeconomic status†	6.96±0.76
Monthly income (INR)	6976.66±465.85

[Table/Fig-2]: Demographic and socioeconomic characteristics of the participants (n=30).
*Belong to underweight category under WHO classification of Body Mass Index [22];
†Belong to upper-lower (IV) socioeconomic class under Kuppuswamy's Socioeconomic Scale [23].

Components	Number of participants (%)
Occupational region	
Parampalli dock	9 (30.0)
Hoodeh dock	7 (23.3)
Thonse dock	14 (46.7)
Tasks involved	
Rowing	30 (100)
Diving	30 (100)
Unloading	30 (100)
Working hours	
8-10 hours	25 (83.3)
10-12 hours	5 (16.7)
Work schedule: Continuous	30 (100)

[Table/Fig-3]: Components of the work and workplace evaluation (n=30).

Variables	Numbers (%)
Co-morbidities	
• Hypertension	2 (6.6)
• Diabetes	0
• Others*	8 (26.7)
Substance abuse	
• Tobacco chewing/ Smoking	10 (33.3)
• Alcohol	20 (66.7)
• Multiple substance abuse	03 (10.0)
Sensory symptoms	
• Self-reported sensory problems	30 (100)
• Hands	
Unilateral presentation	03 (10.0)
Bilateral presentation	22 (73.4)
• Feet	
Unilateral presentation	0
Bilateral presentation	21 (70.0)
• Multiple (more than two sites involved/ both hands and feet were involved)	20 (66.7)
Trench foot (Bilateral)	20 (66.7)
Dermatological symptoms	
• Callosities	20 (66.7)
• Dermatitis/ Itching	30 (100)
Ophthalmic symptoms	
• Redness	30 (100)
• Itching	4 (13.4)
Others	
History of bowel and bladder discomfort	0
Ear pain/ discharge	23 (76.7)
Variable	**Mean ± SD**
Respiratory system	
• Breath holding time (sec)	61.26±7.43
• Peak expiratory flow rate (L/min)	470.16±55.65

[Table/Fig-4]: General health profile of the participants (n=30).
*Responses included asthma, arthritis, and back pain

Demographics of the workers: It was observed that only male workers are involved in sand dredging. The workers were seasonal migrants from Northern states of India. All the participants were right hand dominant. [Table/Fig-2] shows the demographics and socioeconomic characteristics of participants [22,23].

Work and workplace evaluation: The work was carried out by the participants only during post-monsoon season. Tasks involved in manual sand dredging include two phases. The first phase of collecting and loading the sand includes, rowing the boat to the middle of the river, diving, dredging and loading the boat with sand. The second phase includes rowing the boat to the shore and unloading the sand from the boat to the trucks. All the components of both phases of work profile was combined and categorized to rowing, diving and unloading for data analysis and presentation. Rowing included maneuvering the boat to the sand bar and back to shore. Diving included diving to river bottom, dredging the sand and loading it on to the boat. Final task was unloading, that included shifting the sand from boat to truck. All the workers were involved in continuous worker with only one macro-break provided. [Table/Fig-3] shows components of job profile for manual sand dredging.

Due to high demand, limited time period and no work segregation, the participants have a continuous work schedule. Each participant had to complete all the tasks including rowing, diving and unloading. Hence, they had limited rest periods which merely included brief stops. The extraction of sand varied every day with an average of 15 to 20 trucks with approximately 10-15 tons per day. The amount was reported by the dock owners and participants.

Region	Prevalence of pain and discomfort (%) using SNMQ	
	12-months prevalence	7-days prevalence
Neck	19 (63.3)	14 (46.7)
Shoulder	15 (50.0)	17 (56.7)
Elbow	03 (10.0)	10 (33.3)
Wrist/ Hand	07 (23.3)	12 (40.0)
Upper back	18 (60.0)	16 (53.3)
Lower back	22 (73.3)	21 (70.0)
Hips/ Thighs	11 (36.7)	11 (36.7)
Knees	02 (6.7)	06 (20.0)
Ankle/ Feet	03 (10.0)	05 (16.7)

[Table/Fig-5]: Prevalence of musculoskeletal pain and discomfort using SNMQ (n=30).

Tasks involved*	Fatigue risk using RMFA		REBA scores	
	Prevalence (%)	Priority for change	Mean±SD	Corrective measure
Rowing	19 (63.3)	Very High	11.93±1.74	Very high risk, implement change
Diving	07 (23.3)	-	-	-
Unloading sand	22 (73.3)	Very High	13.83±0.74	Very high risk, implement change

[Table/Fig-6]: Prevalence of fatigue and postural risks (n=30).
*Tasks performed for more than 10% of shift duration

Variables	Number (%)
Mechanical	
• Slips/ Trips	10 (33.4)
• Fall	04 (13.3)
Physical/ Thermal	
• Cold water exposure	26 (86.7)
• Weather related- heat exposure	25 (83.4)
Chemical/ Biological	
• Direct contact with salty water	28 (93.3)
• Accidental water ingestion	12 (40.0)
Workers' Welfare provisions*	
• Social security schemes	15 (50.0)
• Employment security schemes	0
• Health insurances schemes	18 (60.0)
• Availability of Personal Protective Devices	06 (20.0)

[Table/Fig-7]: Self-reported exposure to occupational hazards (n=30).
*Awareness about safety and security at workplace

Equipment utilized for all tasks were customized stool, customized bucket, shovel and oars. Metal stools of 330-350 cm height were used as ladders. The stool was the equipment used for diving. It was entrenched on the riverbed and the workers climbed down the stool and dug sand, using the bucket. Bucket has a metal handle and perforated bottom to help in digging and separating the sand from water. Shovels used had either wooden or metal handle and were used to transfer sand from boat to trucks.

The number of boats available at each riverbed varied. The boats owned by dock owners were 4, 8 and 5 at Parampalli, Hoodeh and Thonse respectively. However, all the boats were not used for dredging due to lack of workers. Each boat had at least three crew members for completion of first two tasks of a cycle. But as the boat reached shore for unloading, more number of workers would get involved to shift sand from boat to truck.

Worker profile: [Table/Fig-4] shows the self-reported and onsite evaluated general health profile. Respiratory and sensory systems were evaluated onsite using Mini Wright's Peak Flow Meter and 10 g Semmes Weinstein monofilament respectively. A 3-point sensory evaluation was carried out at palmar and dorsal aspects of hands; and the sole of feet. Among all the system evaluations, sensory, dermatological and ophthalmic symptoms were most prevalent.

Musculoskeletal evaluation included pain and discomfort [Table/Fig-5], fatigue and posture evaluations [Table/Fig-6]. Prevalence of acute and chronic pain and discomfort was reported according to body segment. About 93.34% of participants complained of pain and discomfort at any of the body segments in the past 12 months. Fatigue and posture evaluation was conducted using photography and videography for tasks consuming more than 10% of daily shift. Moore JS and Garg A, had proposed an evaluation method to assess work-related strain [24]. The method used included 10% of the work cycle as the least duration for exertion. Hence, 10% was set as criteria for the study so as to include most of the tasks performed during a work cycle. The photography and videos were used afterwards to document each task, perform a direct observation and score REBA for identification of risk for musculoskeletal disorders. The three tasks identified were rowing, diving and unloading. Self-reported fatigue was only assessed for diving because videography could not be carried out.

Workplace safety and security: Mechanical, physical/thermal and chemical/biological hazards were reported by participants which have been enumerated in [Table/Fig-7]. Safety from occupational hazards through personal protective devices and availability of security schemes were also identified.

DISCUSSION

This study is a preliminary research on work-related disorders among manual sand dredgers. Manual sand dredging is an economic non-market activity with no fixed workplace and temporary employment [25]. The exclusive hiring of male workers was due to the tasks requiring rigorous manual material handling. The participants were seasonal migrant young adults who migrate to Karnataka when cultivation is poor in their states [26]. The participants belonged to upper-lower (IV) socioeconomic class which has been reported previously for other jobs under unorganized sectors [27,28].

Most of the workers were unaware regarding any health problems like hypertension, diabetes mellitus or any form of medication and health checkups. Co-morbidities like hypertension and lower back pain have been proved to cause work loss due to avoidance of risk exposures at work like lifting loads [29]. Workplace substance abuse among workers hamper productivity, work efficiency, general health and most importantly can cause accidents [25, 30-32]. Kumar YS et al., had conducted a study in the same geographical location on industrial workers showing 23.1% of workers involved in abusive habits with majority indulging in multiple substances [28].

Majority of the participants (73.34%) showed bilateral sensory deficit of hands however, all the workers (100%) reported of some sensory problem. Bilateral presentation of sensations symptoms of hands (73.4%) and feet (70.0%) was more than unilateral presentations. Symmetrical sensory changes in hands were probably because of bimanual repeated use of hand tools leading callosities in the hands [33]. Prolonged exposure to non-freezing cold water would have led to diminished sensation and trench feet [10]. This type of exposure causes Huntington's response characterized by epidermal vasoconstriction but with continued long duration exposure leads to cold induced vasodilation [34].

Callosities occur as a protective response to repetitive contact stress and friction [35]. Low friction and cylindrical grip on shovel handles might have led to callosities [33]. A study on Swarna river water samples has reported increased levels of chloride reaching two times higher than permissible limits [36]. Higher chloride content may be a factor causing symptoms of dermatitis. Moreover, prolonged immersion of feet in water can alter the skin layers and sweat pattern thereby making them prone to bacterial and fungal infections [10,37,38]. These factors could have caused itching and symptoms of dermatitis [10,37-39].

A high prevalence of redness, itching of eyes and ear pain might be probably due to diving and exposures to chemicals dissolved in water [40-42]. The workers complained of increased lacrimation, itching, gravel like sensation and redness which disappeared within few hours. There was no change in visual acuity which was suggestive of mild conjunctival irritation [40]. Though the workers had no complains of bladder and bowel problems, 50 to 60 ml accidental ingestion of water was reported which may cause bowel irritations [42].

On-site respiratory evaluation on breath holding time and peak expiratory flow rate showed values within normal ranges. However, the participants involved in manual sand dredging may be at risk of diving response. Diving response occurs due to breath holding along with exposure of face to cold water. This response comprises of reduction in heart rate, peripheral vasoconstriction and an increase in sympathetic activity [43]. Consequently a detailed evaluation of the respiratory system of the participants is recommended.

Manual sand dredging involves heavy physical work, awkward postures, forceful movements, continuous work hours and substantial work demands which are established risk factors for musculoskeletal fatigue, pain and discomfort [14,44-46]. These risk factors cause micro-trauma thus resulting in pain and inflammation [20,47,48]. Low back, neck and shoulder were the most prevalent sites of musculoskeletal pain and discomfort. Postural risk analysis using REBA showed rowing and unloading as very high risk tasks requiring static muscle activity, repetitive movement and awkward posture. Static loading and repetitive activity cause lactic acid accumulation leading to micro-trauma and inflammation [49,50]. These tasks require immediate implementation of an ergonomic measure. Similar findings regarding factors influencing musculoskeletal have been reported on workers involved in manual material handling [11,13,14].

Hazards at workplace influence the efficiency and health of workers [49]. Exposures to high chloride content water and early morning drop in water temperatures were substantially reported hazards. Day time heat exposure while unloading task can cause discomfort and heat strokes [11,15]. Accidents reported were slips or trips occurring frequently while getting in or out of the boat. These slips or trips sometimes led to fall. There were no provisions for PPD during manual sand dredging at any of the docks. Lack of awareness regarding health risks and use of PPD can extensively increase the chances of occupational diseases [50,51].

None of the workers were insured nor aware regarding social security schemes. Meager health, employment and social security available to these workers expose them to immense occupational and health risks [11,12,50]. Although the dock owners have an association, the workers had no associations to represent their rights.

Subsequent to the completion of the study, workers from the three docks and the owners were given informal group education on good practices, need for health check-ups and measures for improving safety and security at work.

LIMITATION

The limitations of the study are a detailed system evaluation like the range of motion and all parameters of ventilation could not be included due to time and space constrains. The self-reported health problems by the participants also require medical examination for confirming any diagnosis.

CONCLUSION

Workplace exposure to hazards and resultant injuries have a complex multifaceted relation. This study shows a high prevalence of multiple work-related disorders and hazards involved in manual sand dredging, a highly demanding job in coastal Karnataka. Lack of health and safety measures were also identified.

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APPENDIX: HEALTH AND OCCUPATIONAL RISK PROFILE (HORP)

This is an assessor-administered assessment schedule. The assessor must interview, observer and evaluate to generate the responses for each item.

I. GENERAL DEMOGRAPHICS:

1) Age:
2) Gender:
3) Place of residence:
4) Hand dominance:
5) Height:
6) Weight:
7) BMI:
8) Work experience:
9) Education status:
10) Monthly income:
11) Working hours:

II. WORK AND WORK PLACE EVALUATION:

12) Which occupational region does the worker belong?: (Parampalli/Hoodeh/Thonse)

13) Type of recruitment of the worker: Seasonal/ throughout the year
14) Tasks performed per work cycle by the worker: (rowing/diving/unloading/all the above/others)
15) Number of working hours per day:_____
16) Do the workers have a working shift? Yes/no
17) Is their work continuous or intermittent per work cycle?_____
18) If continuous whether do they take micro/macro breaks:_____
19) Equipment used to perform the tasks: (bucket/spatula/none/others/all of above)
20) Mode of diving: (customised stool/rope/none/others)
21) Which season do you perform the activity: (pre monsoon/monsoon/post monsoon)
22) Number of boats on the river bed:_____
23) Number of crew per boat:_____

III. WORKER EVALUATION:

24) Has the worker been diagnosed with any prior disease: Diabetes/ hypertension/ asthma/ Please specify if any other conditions:_____
25) Do you have any habit of alcohol consumption/smoking/tobacco chewing/ multiple
26) Please specify if any other:_____
27) Respiratory system evaluation:

i. Do you have any respiratory problems: shortness of breath/ cough/ no complains
ii. Please specify if any other:_____
iii. Breath hold time (in secs):_____
iv. Peak expiratory flow rate (in L/min):

1st trial	2nd trial	3rd trial	Average value

28) Evaluation of peripheral sensation:

i. Do you have problems in sensation like touch or temperature? Yes/ No
ii. If yes, does it vary with the temperature of water? (cold/warm)

Table on 3-point sensory evaluation			
	Right	Left	Total
Hands: Ulnar nerve distribution			
Median nerve distribution			
Feet: Posterior-tibial nerve distribution			

29) Musculoskeletal system evaluation:

i. Do you have any history of musculoskeletal discomfort in the past 12 months? Yes/ No
ii. Evaluation of musculoskeletal pain and discomfort:

The assessor must use the Standardized Nordic Musculoskeletal Questionnaire (Kuorinka I. et al., 1987 and Dickinson CE et al., 1992) and ensure that all the participants answer the items, even though there are no complains of pain or discomfort.

iii. Task related muscle fatigue evaluation: The assessor must score the muscle fatigue using Rodgers Muscle Fatigue Analysis (Rodgers SH., 1992)
iv. Postural analysis for musculoskeletal disorder:

The assessor must observe the workers during work cycles. Videography and photography of each worker while performing a task must be carried out. The assessor will use the video and photography to score risk for work related musculoskeletal disorders using REBA (Hignett S and McAtamney L, 2000)

30) Dermatological system evaluation:

i. Are you having any skin problems: Yes/No
ii. If yes, the assessor must observe the type of skin problem:

(callosities/ dermatitis/itching/open wounds/bruises/trench feet)

iii. What is the site of skin problem: (hand/foot/forearm/leg/multiple sites?)

31) Other systems evaluation:

While being involved in manual sand dredging:

i. Have you had any history of bowel and bladder discomfort /indigestion? Yes/ No
ii. Have you had any history of eye irritation? Yes/ No
iii. If yes, did you have excessive watery/redness/itching/other _____problems in your eyes?
iv. Have you had any history of ear problems? Yes/ No

v. If yes, did you have pain/discharge/others_____in your ears?

IV. OCCUPATION RELATED HAZARDS:

32) Are you aware about any risks involved in sand dredging? Yes/ no

33) If yes, please name them_____

34) Mechanical hazards:

While being involved in manual sand dredging:

i. Have you had any slips and trips on boat? Yes/ No

ii. Have any of the slips/ trips resulted in fall? Yes/ No

iii. Have you been struck by any object while diving (like propeller/ ladder)? Yes/ No

iv. Have you had any open wounds like cuts or scratches while working? Yes/ No

v. Others if any, specify_____

35) Physical hazards:

While being involved in manual sand dredging:

i. Have you had any trouble tolerating the weather conditions? Yes/ No

ii. How would you describe the weather condition? Hot/ Cold

iii. Have you had a previous history of heat stroke: Yes/No

iv. How would you describe the river water condition? Hot/ Cold

v. Have you had cold feet: Yes/No

36) Chemical and Biological hazards:

While being involved in manual sand dredging:

i. Have you been bitten or stung by any marine creature? Yes/ No

ii. How would you describe the water content of the river and its effect on your skin? (normal/ irritant)

iii. If the participant answers irritant, mention what would be the reason for being irritant: (salty water/ chemicals/ others)_____

iv. Have you accidently swallowed the river water while diving? : Yes/ No

V. WORKERS' WELFARE PROVISIONS:

37) Are you aware regarding insurance and need for insurances? Yes/ No

38) If yes, please specify: medical/ social/ employment: _____

39) Are you aware regarding any provisions for Personal Protective Devices (PPDs): Yes/No

40) Please specify the PPDs available at worksite:_____

REFERENCES

[1] Bhagat RB. Emerging pattern of urbanisation in India. Econ Polit Wkly. 2011;46(34):10–12.

[2] Rege A. Not biting the dust : using a tripartite model of organized crime to examine India's sand mafia. Int J Comp Appl Crim Justice. 2016;40(2):101–21.

[3] Sen S. India to be world's 3rd largest construction mkt by 2025 - The Economic Times. 2013 Jul 1 [accessed 4 Jan 2016]; Available from: http://economictimes.indiatimes.com/india-to-be-worlds-3rd-largest-construction-mkt-by-2025/articleshow/20856489.cms.

[4] Sreebha S, Padmalal D. Environmental impact assessment of sand mining from the small catchment rivers in the southwestern coast of India: A case study. Environ Manage. 2011;47(1):130–40.

[5] Padmalal D, Maya AK, Sreebha AS, Sreeja AR. Environmental effects of river sand mining: a case from the river catchments of Vembanad lake, Southwest coast of India. Environ Geol. 2008;54:879–89.

[6] Padmalal D, Maya K. Sand mining environmental impacts and selected case studies. London: Springer; 2014. pp. 68-75.

[7] Kumar A, Jayappa KS. Long and short-term shoreline changes along Mangalore Coast, India. Int J Environ Res. 2009;3(2):177–88.

[8] Jayappa KS, Vijaya Kumar GT, Subrahmanya KR. Influence of coastal structures on the beaches of southern Karnataka, India. J Coast Res. 2003;19(2):389–408.

[9] Padmalal D, Maya K. Sand mining environmental impacts and selected case studies. London: Springer; 2014. pp. 27-29.

[10] Park K. Park's textbook of preventive and social medicine. 23rd ed. Jabalpur: Bhanot; 2015. pp. 803-814.

[11] Tiwary G, Gangopadhyay PK. A review on the occupational health and social security of unorganized workers in the construction industry. Indian J Occup Environ Med. 2011;15(1):18–24.

[12] Mahmood SA. Social security schemes for the unorganized sector in India: a critical analysis. Manag Labour Stud. 2010;35(1):117–28.

[13] Neupane S, Leino-Arjas P, Nygård C-H, Oakman J, Virtanen P. Developmental pathways of multisite musculoskeletal pain: what is the influence of physical and psychosocial working conditions? Occup Environ Med. 2016;oemed-2016-103892.

[14] Mayer J, Kraus T, Ochsmann E. Longitudinal evidence for the association between work-related physical exposures and neck and/or shoulder complaints: a systematic review. Int Arch Occup Environ Health. 2012;85(6):587–603.

[15] Adsul BB, Laad PS, Howal PV, Chaturvedi RM. Health problems among migrant construction workers: A unique public-private partnership project. Indian J Occup Environ Med. 2011;15(1):29–32.

[16] Nichols AW. Medical care of the aquatics athlete. Curr Sports Med Rep. 2015;14(5):389-96.

[17] Rodriguez JO, Lavina AM, Agarwal A. Prevention and treatment of common eye injuries in sports. Am Fam Physician. 2003;67(7):1481-88.

[18] Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233–37.

[19] Dickinson CE, Campion K, Foster AF, Newman SJ, O'Rourke AM, Thomas PG. Questionnaire development: an examination of the Nordic Musculoskeletal questionnaire. Appl Ergon. 1992;23(3):197-201.

[20] Rodgers SH. A functional job analysis technique. Occup Med. 1992;7(4):679–711.

[21] Hignett S, McAtamney L. Rapid entire body assessment (REBA). Appl Ergon. 2000;31(2):201–05.

[22] WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004;363(9403):157–63.

[23] Oberoi SS. Updating income ranges for Kuppuswamy's socio-economic status scale for the year 2014. Indian J Public Health. 2015;59(2):156–57.

[24] Moore JS, Garg A. The strain index: a proposed method to analyse jobs for risk of distal upper extremity disorders. Am Ind Hyg Assoc J. 1995;56(5):443-58.

[25] Ministry of Statistics & Programme Implementation. Informal Sector and Conditions of Employment in India. [Internet]. Kolkata; 2014. [accessed 27 Jan 2016]; Available from: http://www.indiaenvironmentportal.org.in/files/file/Informal sector and conditions of Employment in India, NSS 68th Round.pdf.

[26] Subramanian M, Hegde M. Migrant workers in Udupi Taluk. Econ Polit Wkly. 2015;32(31):7–8.

[27] Tiwary G, Gangopadhyay PK, Biswas S, Nayak K, Chatterjee MK, Chakraborty D, et al. Socio-economic status of workers of building construction industry. Indian J Occup Environ Med. 2012;16(2):66–71.

[28] Kumar YS, Acharya S, Pentapati KC. Prevalence of oral potentially malignant disorders in workers of Udupi taluk. South Asian J Cancer. 2015;4(3):130–33.

[29] Buist-Bouwman MA, Graaf R, Vollebergh WAM, Ormel J. Comorbidity of physical and mental disorders and the effect on work-loss days. Acta Psychiatr Scand. 2005;111(6):436–43.

[30] Bush DM, Autry JH. Substance abuse in the workplace: epidemiology, effects, and industry response. Occup Med. 2002;17(1):13–25, iii.
[31] Pidd K, Berry JG, Harrison JE, Roche AM, Driscoll TR, Newson RS. Alcohol and Work Patterns of use, workplace culture and safety [Internet]. Canberra; 2006 [accessed 27 Nov 2016]. Available from: http://nceta.flinders.edu.au/files/1612/5548/2196/EN152.pdf.
[32] Frone MR. Handbook of Occupational Health Psychology. 2nd ed. Quick JC, Tetrick LE, editors. Washington, D.C: American Psychological Association; 2014. pp. 280-286.
[33] Bhattacharya A, McGlothlin JD, editors. Occupational Ergonomics: Theory and Applications. New York: Marcel Dekker, Inc.; 1996. pp. 311-317.
[34] Imray CHE, Richards P, Greeves J, Castellani JW. Nonfreezing cold-induced injuries. J R Army Med Corps. 2011;157(1):79–84.
[35] Singh D, Bentley G, Trevino SG. Callosities, corns, and calluses. BMJ. 1996;312(7043):1403–06.
[36] Das S, Chadaga M. Temporal variation of surface and groundwater quality in Manipal region – a case study. Int J Innov Res Sci Eng Technol. 2007;3297(6):4939-43.
[37] Tsai TF, Maibach HI. How irritant is water? An overview. Contact Dermatitis. 1999;41(6):311-14.
[38] Basler RS, Basler GC, Palmer AH, Garcia MA. Special skin symptoms seen in swimmers. J Am Acad Dermatol. 2000;43(2 Pt 1):299-305.
[39] Fernández-Luna Á, Burillo P, Felipe JL, del Corral J, García-Unanue J, Gallardo L. Perceived health problems in swimmers according to the chemical treatment of water in swimming pools. Eur J Sport Sci. 2016;16(2):256–65.
[40] Friedlaender MH. A review of the causes and treatment of bacterial and allergic conjunctivitis. [Discussion 779]. Clin Ther. 1995;17(5):800–10.
[41] Klingmann C, Praetorius M, Baumann I, Plinkert PK. Otorhinolaryngologic disorders and diving accidents: an analysis of 306 divers. Eur Arch Oto-Rhino-Laryngology. 2007;264(10):1243–51.
[42] Schijven J, de Roda Husman AM. A survey of diving behaviour and accidental water ingestion among Dutch occupational and sport divers to assess the risk of infection with waterborne pathogenic microorganisms. Environ Health Perspect. 2006;114(5):712–17.
[43] Foster GE, Sheel AW. The human diving response, its function, and its control. Scand J Med Sci Sport. 2005;15(1):3–12.
[44] Fredriksson K, Alfredsson L, Thorbjörnsson CB, Punnett L, Toomingas A, Torgén M, et al. Risk factors for neck and shoulder disorders: a nested case-control study covering a 24-year period. Am J Ind Med. 2000;38(5):516–28.
[45] Miranda H, Punnett L, Viikari-Juntura E, Heliovaara M, Knekt P. Physical work and chronic shoulder disorder. Results of a prospective population-based study. Ann Rheum Dis. 2008;67(2):218–23.
[46] Nahit ES, Macfarlane GJ, Pritchard CM, Cherry NM, Silman AJ. Short term influence of mechanical factors on regional musculoskeletal pain: a study of new workers from 12 occupational groups. Occup Environ Med. 2001;58(6):374–81.
[47] Barbe MF, Barr AE. Inflammation and the pathophysiology of work-related musculoskeletal disorders. Brain Behav Immun. 2006;20(5):423–29.
[48] Rafie F, Zamani Jam A, Shahravan A, Raoof M, Eskandarizadeh A. Prevalence of upper extremity musculoskeletal disorders in dentists: symptoms and risk factors. J Environ Public Health. 2015;2015:517346.
[49] CDC – Impact of Climate on Workers – NIOSH Workplace Safety & Health Topics [Internet]. 2016 [accessed 21 Dec 2016]. Available from: https://www.cdc.gov/niosh/topics/climate/how.html.
[50] Pingle S. Occupational safety and health in India: now and the future. Ind Health. 2012;50(3):167–71.
[51] Occupational Safety and Health Administration (OSHA). Personal Protective Equipment [Internet]. 2004 [accessed 25 Nov 2016]. Available from: https://www.osha.gov/Publications/osha3151.pdf.

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