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Evaluation of Occupational Health Hazards Among Industrial Workers in a Irungattukottai Village- A Cross-Sectional Study

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Abstract **Aim:** This study evaluated oral health status, the prevalence of work-related musculoskeletal disorders (WRMSDs), and physical activity readiness among industrial workers in Irungattukottai, Tamil Nadu. The analysis included demographic variables, BMI, and occupational factors. **Methods:** A cross-sectional study was conducted among 122 tyre and steel factory workers employed for at least six months (Sept-Dec 2023). Data collection included a structured questionnaire (demographics, occupational details, PAR-Q, Nordic Musculoskeletal Questionnaire), BMI assessment, and clinical oral examination using WHO protocols. Statistical analyses were performed using SPSS v26, including chi-square tests, one-way ANOVA with post-hoc comparisons, and Kendall's tau-b correlation ($p<0.05$). **Results:** Participants were predominantly male (90.2%), aged 18-30 years (55.7%). DT and DMFT/def scores increased significantly with age ($p<0.001$). BMI was significantly associated with neck discomfort ($p<0.001$). Longer weekly work hours were correlated with upper limb discomfort, while work experience showed negative correlations with neck and lower back pain—likely reflecting a healthy worker effect. No significant correlations were found between work experience and most PAR-Q items. **Conclusion:** The dual burden of oral disease and WRMSDs among industrial workers underscores the need for integrated occupational health programs combining ergonomic interventions, nutrition counselling, and oral health care.

Key Words Occupational Health, Work-Related Musculoskeletal Disorders, Oral Health, Industrial Workers

INTRODUCTION

Occupational health is a vital component of public health focused on preventing and managing diseases, injuries, and other health issues caused by work conditions. It plays a critical role in safeguarding well-being and productivity, especially in low- and middle-income countries where safety standards may be weak or poorly enforced. Rural populations engaged in manual labour, agriculture, and small-scale industries face multiple hazards including chemical exposure, physical strain, poor ergonomics, unsafe work environments, and inadequate awareness of personal protective measures [1]. Irungattukottai, a semi-urban village in Tamil Nadu, has experienced rapid industrial growth, shifting employment from agriculture to tyre, steel, and other manufacturing sectors. While improving economic opportunities, this shift has brought prolonged working hours, repetitive tasks, unsafe machinery, dust, noise, chemical fumes, and weak safety oversight—factors contributing to a substantial, underreported burden of occupational diseases [2,3].

Work-related musculoskeletal disorders (WRMSDs) are among the most common occupational health problems, affecting bones, muscles, joints, ligaments, tendons, nerves, and related systems. They are often caused or worsened by repetitive or forceful tasks, awkward postures, and sustained exertion. Prolonged exposure to such physical demands can result in long-term disability, absenteeism, and reduced quality of life [4,5]. Oral health, another crucial component of overall health, includes the condition of teeth, gums, oral mucosa, and supporting structures, and is increasingly linked to systemic diseases such as cardiovascular disease, diabetes, and respiratory infections [6]. However, it remains neglected in many vulnerable groups, particularly rural industrial workers, due to limited access to care and lack of awareness [7].

In industrial areas like Irungattukottai, long working hours, environmental pollutants, and restricted hygiene facilities can negatively impact oral health. Risk factors such as poor diet, tobacco and betel nut use, and inadequate oral hygiene contribute to conditions including periodontal disease, dental caries, oral mucosal lesions, and even precancerous

changes [8]. Occupational exposures to fine dust, metallic particles, or acidic vapours may lead to dental erosion and gingival inflammation [9], while job stress and fatigue can further reduce self-care. The lack of routine dental check-ups and affordable treatment options accelerates disease progression in these populations [10]. The intersection of occupational hazards and oral health remains underexplored in Indian public health research, making it vital to develop integrated workplace programs incorporating oral health education, preventive services, and timely treatment [11]. This study investigates WRMSDs, oral health status, BMI, and physical activity readiness (PAR-Q) in tyre and steel factory workers, addressing an under-researched intersection of occupational and dental public health.

METHODS

Study Design and Setting

A cross-sectional study was conducted from September to December 2023 in Irungattukottai, Tamil Nadu. Ethical approval was obtained from the Institutional Ethics Committee of Saveetha University, and permissions were granted by factory management. Inclusion criteria: industrial workers aged ≥18 years, employed ≥6 months in tyre/steel factories, consenting to participate. Exclusion: unwilling participants or those with cognitive impairments.

Sample size (n=122) was calculated using an expected WRMSD prevalence of 50%, 95% confidence, and 5% margin of error, with simple random sampling from employee lists. A pilot study (n=15) confirmed questionnaire reliability (κ=0.87).

Data Collection Tools

- Demographic/occupational questionnaire
- Oral examination using WHO DMFT/def and gingival index under natural light
- BMI measurement
- PAR-Q
- Nordic Musculoskeletal Questionnaire [12,13]

The investigators received training in public health dentistry and clinical examination techniques from Saveetha Dental College, Chennai, to ensure standardization of data collection and minimize inter-observer variability.

Statistical Analysis

Chi-square tests, one-way ANOVA with post-hoc tests for DMFT/def, Kendall's tau-b correlation for ordinal associations (SPSS v26, p<0.05).

RESULTS

Age Distribution

We had 55.7% aged 18-30, 36.9% aged 31-50, 7.4% aged 51-65; 90.2% male. Gingivitis was most prevalent in the youngest group (40.98%), followed by 31-50 years (36.89%) (Table 1).

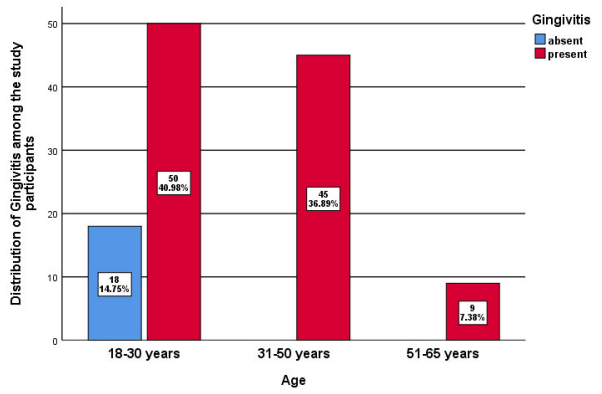

Figure 1: Distribution of Gingivitis Across Age Groups Among Study Participants

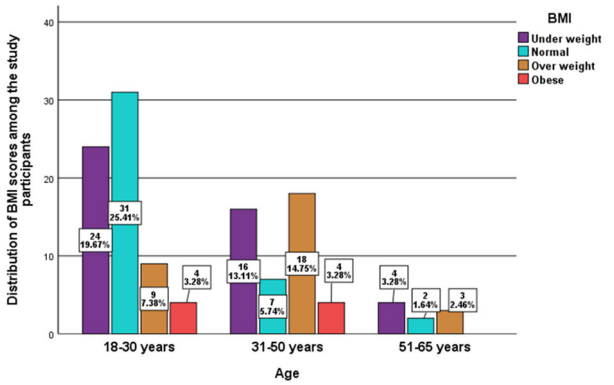

Figure 2: Distribution of BMI Categories Across Different Age Groups

Table 1: Demographic Distribution of Study Participants

Category	Subcategory	Frequency (n)	(%)
Age Group	18–30 years	68	55.7
	31–50 years	45	36.9
	51–65 years	9	7.4
Gender	Male	110	90.2
	Female	12	9.8
Socioeconomic Status	Lower middle	49	40.2
	Upper middle	62	50.8
	Upper	11	9.0

Oral Health

Gingivitis was most common in the 18-30 Age group (40.98%) (Figure 1) DT and DMFT/def scores increased significantly with age (p<0.001); MT increased without significance (p=0.061); FT consistently low (p=0.680) (Table 2).

BMI

Overweight/obesity more prevalent in 31-50 years. For PAR-Q Item 4, 40.7% of overweight participants answered "Yes," indicating potential limitations to physical activity, with this association nearing statistical significance (χ^2 = 5.361, p = 0.055) (Table 3). Significant association between BMI and neck discomfort (p<0.001) (Figure 2 and Table 4).

Table 2: Age-wise comparison of dental caries experience among study participants

Variable	Age Group	Mean Std	One-way Anova	p value
DT	18–30 years	1.10 ± 1.70	10.258	0.000
	31–50 years	1.09 ± 1.69		
	51–65 years	3.89 ± 2.667		
MT	18–30 years	0.04 ± 0.20	2.860	0.061
	31–50 years	0.22 ± 0.90		
	51–65 years	0.67 ± 2.00		
FT	18–30 years	0.07 ± 0.49	0.386	0.680
	31–50 years	0.16 ± 0.767		
DMFT/def	18–30 years	1.22 ± 1.907	8.779	0.000
	31–50 years	1.47 ± 2.242		
	51–65 years	4.56 ± 4.157		

Table 3: Association Between BMI Categories and Physical Activity Readiness (PAR-Q Items 4 & 5)

PAR-Q Item	BMI Category	No	Yes	χ^2 Value	p-value
PAR-Q 4	Under weight	35(36.8%)	9(33.3%)	5.361	0.055
	Normal	34(35.8%)	6(22.2%)		
	Over weight	19(20%)	11(40.7%)		
	Obese	7(7.4%)	1(3.7%)		
PAR-Q 5	Under weight	37(35.6%)	7(38.9%)	1.454	0.105
	Normal	36(34.6%)	4(22.2%)		
	Over weight	24(23.1%)	6(33%)		
	Obese	7(6.7%)	1(5.6%)		

Table 4: Association Between BMI and Reported Discomfort in Various Body Regions

Body Region	BMI Category	Yes	No	χ^2 Value	p-value
Neck	Underweight	0 (0.0%)	44 (62.0%)	80.621	0.000
	Normal	14 (27.5%)	26 (36.6%)		
	Overweight	29 (56.9%)	1 (1.4%)		
	Obese	8 (15.7%)	0 (0.0%)		
Shoulders	Underweight	23 (32.4%)	21 (41.2%)	3.506	0.320
	Normal	23 (32.4%)	17 (33.3%)		
	Overweight	18 (25.4%)	12 (23.5%)		
	Obese	7 (9.9%)	1 (2.0%)		
Upper back	Underweight	22 (32.8%)	22 (40.0%)	0.760	0.859
	Normal	23 (34.3%)	17 (30.9%)		
	Overweight	17 (25.4%)	13 (23.6%)		
	Obese	5 (7.5%)	3 (5.5%)		
Hip	Underweight	24 (33.3%)	20 (40.0%)	2.167	0.539
	Normal	22 (30.6%)	18 (36.0%)		
	Overweight	21 (29.2%)	9 (18.0%)		
	Obese	5 (6.9%)	3 (6.0%)		
Knees	Underweight	10 (27.0%)	34 (40.0%)	2.728	0.435
	Normal	12 (32.4%)	28 (32.9%)		
	Overweight	12 (32.4%)	18 (21.2%)		
	Obese	3 (8.1%)	5 (5.9%)		

Table 5: Correlation of Work Experience, Weekly Hours, and Musculoskeletal Symptoms

Correlations			Experience	Hours of work/week	Neck	Shoulders	Elbows	Wrist	Upper back	Lower back	Hip	Knees	Ankles
Kendall's tau_b	Experience	Correlation Coefficient	1.000	-0.528**	0.025	-0.239**	.	.	-0.155*	.	-0.019	-0.075	.
		Sig. (2-tailed)	-	0.000	0.745	0.002	.	.	0.046	.	0.808	0.331	.
	Hours of work/week	Correlation Coefficient	-0.528**	1.000	0.080	0.482**	.	.	0.262**	.	0.163	0.182*	.
		Sig. (2-tailed)	0.000	.	0.372	0.000	.	.	0.003	.	0.069	0.042	.

Table 6: Correlation of Work Experience, Weekly Hours, and PAR-Q Responses

Correlations			Experience	Hours of work/week	PAR-Q 1	PAR-Q 2	PAR-Q 3	PAR-Q 4	PAR-Q 5	PAR-Q 6	PAR-Q 7
Kendall's tau_b	Experience	Correlation Coefficient	1.000	-0.528**	.	.	.	-0.060	-0.047	.	.
		Sig. (2-tailed)	.	0.000	.	.	.	0.438	0.547	.	.
	Hours of work/week	Correlation Coefficient	-0.528**	1.000	.	.	.	0.011	-0.048	.	.
		Sig. (2-tailed)	0.000	.	.	.	.	0.898	0.595	.	.

Musculoskeletal

Work experience negatively correlated with neck (τ=-0.528, $p<0.001$) and lower back pain (τ = -0.155, p = 0.046) - consistent with healthy worker effect. Weekly work hours positively correlated with shoulder, elbow, and wrist pain (Table 5). PAR-Q: No significant correlations between work experience and most items; only Item 1 showed a weak negative correlation (Table 6).

DISCUSSION

This study demonstrates a high prevalence of oral disease and WRMSDs in industrial workers. The negative correlation between work experience and certain pain sites may reflect the healthy worker effect, where less fit individuals leave the workforce earlier. Longer working hours were associated with upper limb pain, aligning with evidence from repetitive-task industries.

The strong BMI-neck pain association is consistent with prior research linking excess weight to increased cervical spine loading. Oral health disparities reflect cumulative effects of limited access to dental care, poor hygiene practices, and occupational exposures. The findings provide a comprehensive insight into the health risks associated with occupational exposure in a rural industrial setting, shedding light on the critical factors

that contribute to the deterioration of health in these workers [14-18]. A study by Moreira-Silva et al. [19] found that overweight and obese workers reported higher pain intensity in the shoulders and wrist/hand regions compared to their lean counterparts. Research by Sethi et al. [20] demonstrated a significant association ($p<0.001$) between high BMI and increased scores of musculoskeletal discomfort and occupational stress among computer workers in Bangalore, India.

Moreover, oral health problems, such as gingivitis and caries, can be aggravated by factors such as dietary habits, which may be influenced by socioeconomic status and access to healthcare [21]. The study also highlighted the impact of socioeconomic status on occupational health outcomes. Socioeconomic disparities play a significant role in determining the overall health of workers, as individuals from lower socioeconomic backgrounds often have limited access to healthcare, nutrition, and preventive measures [22]. Our study findings on the impact of socioeconomic status (SES) on oral health outcomes are echoed in a systematic review and meta-analysis by Knorst et al. [23], which concluded that individuals of lower SES had poorer oral health-related quality of life, regardless of the country's economic classification, SES indicator, or age group.

This calls for a multi-dimensional approach that includes not only workplace health interventions but also broader social determinants of health interventions, such as improving healthcare access and addressing the underlying socioeconomic disparities.

CONCLUSIONS

The co-occurrence of WRMSDs and oral diseases in this workforce calls for integrated workplace interventions, including ergonomic redesign, physical activity promotion, nutrition education, and on-site dental screening.

Limitations

Limitations include cross-sectional design, male-dominated sample, and reliance on self-report for musculoskeletal symptoms. Recommendations include Implement workplace ergonomics and rest-break schedules. Provide regular dental check-ups at factory clinics. Offer weight management and physical fitness programs. Conduct longitudinal studies to assess intervention effectiveness.

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