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Research

Prevalence of selected cardiorespiratory symptoms, measurement of PEFR and associated factors among carpenters in selected areas of Colombo district, Sri Lanka

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ABSTRACT

Introduction: Indoor air pollution has become a significant health concern both within households and workplaces. Carpenters face risks from exposure to wood dust, particulate matter, and chemical vapours, which increase their likelihood of developing cardiorespiratory diseases. The objective of this study was to determine the prevalence and associated factors of selected cardiorespiratory symptoms and to measure pulmonary function using peak expiratory flow rate (PEFR) among carpenters in the Moratuwa MOH area.

Methods: A community-based cross-sectional analytical study was carried out in 20 randomly selected Grama Niladhari (GN) divisions of Moratuwa from April 2017 to January 2018. Using multistage sampling, 461 carpenters were selected: 443 participated (response rate 96.1%). Data were collected using a pre-tested interviewer-administered questionnaire, a peak flow meter, a bathroom scale, and a measuring board. Statistical analysis included descriptive measures, chi-square testing, and odds ratios with 95% confidence intervals.

Results: Out of 443 participants, the most prevalent respiratory symptom during the previous month was cough (61.6%, n=273), followed by sneezing/allergic rhinitis (41.5%, n=184). Prevalence of wheezing was 35.4% (n=157). The most prevalent chronic respiratory symptoms were chronic cough (19.9%, n=88) and chronic phlegm, (18.5% n=82). Out of all participants, 25.3% (n=1[12]) complained of central chest pain. In 24.8% (n=110), the chest pain had eased with rest, and 17.6% (n=76) of the people were diagnosed with hypertension. Of all, 86.9% (n=385) had at least one cardiorespiratory symptom. More than half of the carpenters (60.7%) had PEFR <80% of their predicted value. There was a statistically significant association ($p<0.05$) between the presence of at least one cardiorespiratory symptom with age, education level, working duration, awareness and practices to prevent dust exposure and family history of cardiorespiratory diseases.

Conclusions: Carpenters in Moratuwa exhibited a high prevalence of cardiorespiratory illnesses and reduced lung function, likely due to prolonged exposure to dust. Immediate adoption of proper protective measures was strongly advised.

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Introduction

Woodworking remains a longstanding profession with notable health risks from exposure to wood dust and related chemicals. Airborne wood dust is a recognised global occupational hazard, and carpenters are especially vulnerable to long-term respiratory and cardiovascular issues. Evidence shows that exposure to particulate matter (PM) is strongly associated with cardiovascular diseases, including myocardial infarction, arrhythmias, ischemic stroke, vascular dysfunction, hypertension, and atherosclerosis.[1,2,3,4,5]

Numerous epidemiological studies have examined the prevalence of respiratory and cardiovascular symptoms, as well as the changes in pulmonary and lung functions among workers exposed to dust.[6,7,8,9] There is no data on the cardiopulmonary functions of carpenters in Sri Lanka.

Occupational respiratory and cardiovascular conditions remain under-recognised in Sri Lanka despite evidence linking prolonged wood dust exposure to asthma, COPD, and cardiovascular disease.[1,2,3] Moratuwa, a major carpentry hub of Sri Lanka, has many workshops but limited published health data. This study assessed the prevalence of selected cardiorespiratory symptoms, pulmonary function, and occupational risk factors among carpenters in selected areas of the Colombo District, Sri Lanka.

Methods

A community-based, cross-sectional analytical study was conducted from April 2017 to January 2018 in carpentry workshops within a selected area of the Colombo district, Sri Lanka. A multistage sampling method was employed. Initially, 20 out of 38 Grama Niladhari (GN) divisions within the Moratuwa Medical Officer of Health (MOH) area were selected through simple random sampling. Next, carpenters within the selected GN divisions were allocated using probability proportional to size based on Census 2012 data. The total sample of 461 carpenters was proportionally distributed across the selected GN divisions. In each chosen GN division, the carpentry workshop nearest to the GN office was selected as the starting point. Subsequently, every alternate workshop to the right was visited until the required cluster sample was achieved. One eligible carpenter was randomly selected from each workshop. A total of 443 participants took part (response rate 96.1%). Inclusion criteria included male carpenters aged 18 years or older with at least one year of full-time work experience as carpenters. Assistants to carpenters, carpenters engaged solely in wood carving or spray work, and those employed in furniture shops were excluded from the study.

Data were collected using a pre-tested, interviewer-administered questionnaire developed to meet the specific objectives of the study. It was based on "The British Medical Research Council Committee Questionnaire[10]" on respiratory symptoms and cardiovascular health, with modifications and additional items to suit the study design. Socio-demographic and occupational factors, respiratory and cardiovascular symptoms, and use of protective measures were recorded. Height and weight were measured using a standard stadiometer and a calibrated bathroom scale, respectively. Peak expiratory flow rate (PEFR) was measured using a peak flow meter, with participants in the standing position following maximal inspiration and a forceful expiration; the highest of three attempts was recorded. Adequate technique and effort were ensured through prior demonstration and direct supervision by trained data collectors. To maintain quality control, the device was checked regularly for accuracy in accordance with manufacturer recommendations. Measurements were taken during a standardised time period (morning hours) to minimise diurnal variation. The predicted PEFR values were calculated using reference equations derived for Sri Lankan adults based on anthropometric parameters such as age and height.[11]

The questionnaire was pre-tested among carpenters in the Panadura area, which is socio-demographically comparable to the Moratuwa MOH area, and was revised and approved after evaluating clarity, comprehension, and question sequence. Data analysis was carried out using SPSS version 20, with chi-square tests and odds ratios calculated. Ethical approval was granted by the Ethics Review Committee, Faculty of Medicine, University of Colombo. Written informed consent was obtained from all participants after providing an information sheet and explaining the study details, with any questions addressed by the principal investigator prior to data collection.

Among carpenters in the Moratuwa MOH area, the most common acute respiratory symptom was cough (61.6%, $n = 273$), followed by sneezing/allergic rhinitis (41.5%), rhinorrhoea (38.4%), wheezing (35.4%), dyspnoea (17.8%), and throat clearing (2.0%).

Chronic symptoms included chronic cough (19.9%), chronic phlegm (18.5%), and chronic bronchitis (2.5%). Dyspnoea on level-ground exertion was reported by 12.2% (grade 4) and 11.7% (grade 3). Occupational asthma, defined as wheezing or shortness of breath during exposure to wood dust, was observed in 12.6% of participants.

Seventy-six (17.6%) of the participants were diagnosed with hypertension. Around 7.9% ($n = 35$) of carpenters have had angina once in their lifetime, and 3.6% ($n = 16$) have had a previous myocardial infarction.

According to routine clinical practice, if the actual PEFR was greater than 80% of the predicted value, that individual was considered to have normal PEFR, and if the actual PEFR was less than 80%, it was considered abnormal. Out of 443 carpenters, 60.7% ($n = 269$) had PEFR less than 80% of their predicted values. Further, 39.3% ($n = 174$) had normal PEFR values.

Among the study participants, age, education, and certain occupational and behavioural factors were significantly associated with having at least one cardiorespiratory symptom. Participants below 50 years old experienced higher symptom prevalence than those aged 50 and above (56.1% vs 43.9%; OR = 3.34, 95% CI: 1.68–6.64; $p < 0.001$). Symptoms were more common among individuals with education up to grade 11 compared to those with O/L or higher (54.8% vs 45.2%; OR = 6.00, 95% CI: 2.66–13.57; $p < 0.001$) and among those working more than 5 days per week (83.6% vs 16.4%; OR = 5.48, 95% CI: 1.30–23.03; $p < 0.001$). A positive family history of cardiorespiratory disease was associated with increased risk (67.8%; OR = 2.11, 95% CI: 1.21–3.68; $p < 0.05$), while the use of protective measures was associated with a lower prevalence (43.1% vs 56.9%; OR = 0.55, 95% CI: 0.30–0.99).

Chronic respiratory symptoms were more common among those with ≥25 years of work. A significant association was observed between working duration and symptoms ($p < 0.05$).

Chronic cough was higher in the ≥25-year group (24.3%, n=65) than in the <25-year group (13.1%, n=23), OR 2.14 (95% CI: 1.3–3.6). Dyspnoea grade 3 was also higher with ≥25 years (14.6%, n=39 vs 7.4%, n=13), OR 2.15 (95% CI: 1.11–4.15). In contrast, dyspnoea grade 4 was more frequent in those with <25 years (16.5%, n=29 vs 9.4%, n=25), OR 0.52 (95% CI: 0.30–0.93).

Carpenters using biomass at home had a higher prevalence of wheezing than non-users (41.4%, n=115 vs 25.5%, n=42; OR 2.06, 95% CI 1.35–3.16).

Home energy source was not significantly associated with cough, sneezing, runny nose, or chest pain. Current or past smoking was not significantly linked to having at least one cardiorespiratory symptom.

Results

Table 1
Prevalence of respiratory and cardiovascular symptoms among carpenters (N=443).

Symptom	Number	%* Confidence Interval (CI)
Acute respiratory symptoms		
• Coughing	273	61.6 (57.1 – 66.2)
• Sneezing/ Allergic rhinitis	184	41.5 (36.9 – 46.1)
• Runny nose	170	38.4 (33.8 – 42.9)
• Wheezing	157	35.4 (31.0 – 39.9)
Chronic Cough	88	19.9 (16.1 – 23.6)
Chronic phlegm	82	18.5 (14.9 – 22.1)
Chronic bronchitis	11	2.5 (1.0 – 3.9)
Dyspnoea grade 3**	52	11.7 (8.7 – 14.7)
Dyspnoea grade 4**	54	12.2 (9.1 – 15.2)
Occupational asthma	56	12.6 (9.5 – 15.7)
Cardiovascular symptoms		
Central chest pain/ Chest tightness	112	25.3 (21.2 – 29.3)
Central chest pain which radiates to the left arm or neck	32	7.2 (4.8 – 9.6)
Central chest pain that is provoked or exaggerated by exertion/ mental strain or cold weather	43	9.7 (6.9 – 12.5)
Central chest pain that gets eased with rest	110	24.8 (20.8 – 28.9)

* Aggregate of percentages is not equal to a hundred due to multiple responses by a single respondent
**Modified Medical Research Council Dyspnea Scale (mMRC scale)

Table 2
Distribution of study participants by the history of cardiovascular diseases.

Disease condition	Number	% *
An injury or operation affecting your chest	10	2.3 (0.9-3.6)
Heart trouble/ Angina	35	7.9 (5.4-10.4)
Myocardial Infarction (heart attack)	16	3.6 (1.9-5.3)
Hypertension	76	17.2 (13.6-20.7)

* Aggregate of percentages is not equal to a hundred due to multiple responses by a single respondent

Table 3
Distribution of the study participants by the prevalence of peak expiratory flow rates (PEFR) (N= 443).

PEFR	Number	Percentage (%)
<80%	269	60.7
≥80%	174	39.3

Table 4
Factors associated with selected cardiorespiratory symptoms.

Associated factor	Presence of at least one cardiorespiratory symptom						
	No n = 58		Yes n = 385		Total N = 443		
	No	%	No	%	No	%	
Age (Years)							
< 50 years	47	81.0	216	56.1	263	59.4	χ^2= = 12.98
≥ 50 years	11	19.0	169	43.9	180	40.6	*df* = 1
							p = < 0.001 (0.000)
							OR (95% CI) = 3.34 (1.68 to 6.64)
Marital status							
Single	1	1.7	23	6.0	24	5.4	χ^2= 1.77
Married	57	98.3	362	94.0	419	94.6	*df* = 1
							p = > 0.05 (1.83)
							OR (95% CI) = 0.276 (0.037 to 2.08)
Highest education level							
Up to Grade 11	51	87.9	211	54.8	262	59.1	χ^2= 22.89
Passed O/L or above*	7	12.1	174	45.2	181	40.9	*df* = 1
							p = < 0.001 (0.000)
							OR (95% CI) = 6.00 (2.66 to 13.57)
Working days per week							
> 5 days per week	56	96.6	322	83.6	378	85.3	χ^2= 6.71
≤ 5 days per week	2	3.4	63	16.4	65	14.7	*df* = 1
							p = < 0.05 (0.01)
							OR (95% CI) = 5.48 (1.30 to 23.03)
Family history of at least one Cardiorespiratory disease							
No	29	50.0	124	32.2	153	34.5	χ^2 = 7.06
Positive history	29	50.0	261	67.8	290	65.5	*df* = 1
							p = < 0.05 (0.008)
							OR (95% CI) = 2.11(1.21 to 3.68)
Wearing face mask							
Yes	08	13.8	36	9.4	44	9.9	χ^2= 1.11
No	50	86.2	349	90.6	399	90.1	*df* = 1
							p = > 0.05 (0.30)
							OR (95% CI) = 1.55 (0.68to 3.53)
Washing face							
Yes	7	12.1	87	22.6	94	21.2	χ^2 = 3.34
No	51	87.9	298	77.4	349	78.8	*df* = 1
							p = > 0.05 (0.07)
							OR (95% CI) = 0.47 (0.21 to 1.07)
Covering nose & mouth							
Yes	17	29.3	166	43.1	183	41.3	χ^2= 3.96
No	41	70.7	219	56.9	260	58.7	*df* = 1
							p = < 0.05 (0.047)
							OR (95% CI) = 0.55 (0.30 to 0.99)

$\chi 2$ = Chi square, df = degree of freedom, OR = Odds ratio, 95%CI = 95% confidence interval, *p* = *p* value
*Passed O/L, Studied up to A/L and passed A/L

Table 5
Association of cardiorespiratory symptoms and occupational factors.

Associated factor	Presence of at least one cardiorespiratory symptom						
	Working duration < 25 years n = 176		Working duration ≥ 25 years n = 267		Total N = 443		
	No	%	No	%	No	%	
Coughing							
Yes	84	47.7	189	70.8	273	61.6	χ^2 = 23.85
No	92	52.3	78	29.2	170	38.4	*df* = 1
							p = < 0.001 (0.000)
							OR (95% CI) = 2.65 (1.78 to 3.94)
Sneezing/ Allergic rhinitis							
Yes	90	51.1	94	35.2	184	41.5	χ^2 = 11.08
No	86	48.9	173	64.8	259	58.5	*df* = 1
							p = < 0.001 (0.000)
							OR (95% CI) = 0.52 (0.35 to 0.77)
Runny nose							
Yes	69	39.2	101	37.8	170	38.4	χ^2 = 0.08
No	107	60.8	166	62.2	273	61.6	*df* = 1
							p = > 0.05 (0.77)
							OR (95% CI) = 1.06 (0.71 to 1.56)
Wheezing							
Yes	28	15.9	129	48.3	157	35.4	χ^2 = 48.7
No	148	84.1	138	51.7	286	64.6	*df* = 1
							p = < 0.001 (0.000)
							OR (95% CI) = 4.94 (3.9 to 8.0)
Difficulty in breathing							
Yes	19	10.8	60	22.5	79	17.8	χ^2 = 9.87
No	157	89.2	207	77.5	364	82.2	*df* = 1
							p = < 0.05 (0.002)
							OR (95% CI) = 2.40 (1.4 to 4.2)
Dryness of the throat							
Yes	6	3.4	3	1.1	9	2.0	χ^2 = 2.78
No	170	96.6	264	98.9	434	98.0	*df* = 1
							p = > 0.05 (0.165)
							OR (95% CI) = 1.47 (0.87to 2.48)

$\chi 2$ = Chi square, df = degree of freedom, OR = Odds ratio, 95%CI = 95% confidence interval, p = p value

Table 6
Association of cardiorespiratory symptoms and occupational factors.

Symptom	Using Biomass						
	No n = 58		Yes n = 385		Total N = 443		
	No	%	No	%	No	%	
Cough							
Yes	174	62.6	99	60.0	273	61.6	χ^2 = 0.29
No	104	37.4	66	40.0	170	38.4	*df* = 1
							p = > 0.05 (0.59)
							OR (95% CI) = 0.37 (1.12 to 0.75)
Sneezing							
Yes	119	42.8	65	39.4	184	41.5	chi-square = 0.49
No	159	57.2	100	60.6	259	58.5	*df* = 1
							p = > 0.05 (0.481)
							OR (95% CI) = 1.15 (0.78 to 1.70)
Runny nose							
Yes	106	38.1	64	38.8	170	38.4	χ^2 = 0.019
No	172	61.9	101	61.2	273	61.6	*df* = 1
							p = > 0.05 (0.89)
							OR (95% CI) = 0.97 (0.65 to 1.45)

(Continued)

Symptom	Using Biomass						
	No n = 58		Yes n = 385		Total N = 443		
	No	%	No	%	No	%	
Wheezing							
Yes	115	41.4	42	25.5	157	35.4	χ^2 = 11.46
No	163	58.6	123	74.5	286	64.6	*df* = 1
							p = <0.05 (0.001)
							OR (95% CI) = 2.06 (1.35 to 3.16)
Chest pain							
Yes	65	23.4	47	28.5	112	25.3	χ^2 = 1.43
No	213	76.6	118	71.5	331	74.7	*df* = 1
							p = >0.05 (0.23)
							OR (95% CI) = 0.77 (0.50 to 1.19)

Smoking status	At least one cardiorespiratory symptom						
	Not present n = 58		Present n = 385		Total N = 443		
	No	%	No	%	No	%	
Current smoking							
Yes	28	48.3	152	39.5	180	40.6	χ^2 = 1.62
No	30	51.7	233	60.5	263	59.4	*df* = 1
							p = >0.05 (0.204)
							OR (95% CI) = 1.43 (0.82 to 2.49)
Ever smoke							
Yes	33	56.9	207	53.8	240	54.2	χ^2 = 0.20
							df = 1
							p = >0.05 (0.66)
							OR (95% CI) = 1.135 (0.65 to 1.98)

$\chi 2$ = Chi square, Df = degree of freedom, OR = Odds ratio, 95%CI = 95% confidence interval, p = p value

Discussion

Occupational exposure to wood dust and associated chemicals has consistently been linked to impaired pulmonary function and adverse cardiovascular outcomes. The current findings support the growing global evidence that work-related cardiorespiratory diseases are increasing alongside industrial growth, especially in developing regions where occupational safeguards might be insufficient.

A high prevalence of respiratory symptoms was observed among carpenters, similar to findings in other occupational groups exposed to airborne particulates. Tea workers exposed to certain tea dusts had higher rates of chronic respiratory symptoms than controls. Acute work shift-related declines in expiratory flow rates were observed, while FEV_1 changes were minimal.[12] Studies among cement factory workers in Iran reported prevalence rates of cough (60.7%), phlegm (37.5%), and wheezing (41.1%).[13] Similarly, sawmill workers in Nigeria demonstrated substantial prevalence of cough (46.7%) and phlegm (50.2%).[14] These similarities suggest that chronic exposure to wood dust and related particulates contributes significantly to respiratory morbidity.

Cardiovascular morbidity was also significant in the current study, with notable proportions reporting hypertension, angina, and previous myocardial infarction. Similar findings from Kaduna State, Nigeria, showed elevated systolic and diastolic blood pressure among carpenters,[5] suggesting that occupational exposure may impact not only respiratory health but also cardiovascular risk.

Impaired pulmonary function was demonstrated by reduced PEFR values in many participants, aligning with previous evidence indicating significant airflow limitation among carpenters.[5] Educational status was linked to respiratory symptoms, supporting findings from Nigeria, where lower educational levels were associated with higher symptom prevalence.[14] This may reflect differences in occupational awareness and protective practices.

Duration of exposure showed a statistically significant association with chronic respiratory symptoms, consistent with findings from Bengal, where prolonged wood dust exposure was linked to asthma and respiratory morbidity.[15] These findings highlight the cumulative effect of prolonged occupational exposure.

Although the use of personal protective equipment (PPE) was reported, the prevalence of symptoms remained high. Similar findings were observed in Tanzania, where workers using PPE still reported higher rates of symptoms, possibly due to inconsistent use, poor adherence, or substandard protective devices.[16,17] Reverse causation – where symptomatic workers start using PPE after developing symptoms – may also explain this result.

Smoking is a recognised independent risk factor for respiratory disease. A study from Bengal reported significantly higher respiratory symptoms among smokers.[15] However, statistical significance between smoking and cardiorespiratory symptoms could not be demonstrated in the present study, possibly due to sample distribution or confounding effects.

Environmental exposures outside the workplace may further increase risk. Indoor particulate matter smaller than 10 microns (PM10) has been shown to negatively affect respiratory health.[18] In the current study, biomass fuel use at home was significantly associated with wheezing ($p < 0.05$), supporting the additive impact of domestic air pollution on occupational exposure.

Overall, the findings highlight the significant burden of cardiorespiratory morbidity among carpenters and emphasise the need for improved occupational health policies, regular screening, engineering controls, and effective respiratory protection strategies to minimise the long-term disease burden.

Limitations

This cross-sectional study provides only a snapshot and cannot establish causality or temporal relationships. Findings were based on self-reported symptoms recalled over the previous month, which may lead to recall bias and misclassification, especially in the absence of an occupational disease surveillance system. The absence of an unexposed comparison group, potential confounding factors, survival bias, and lack of objective diagnostic confirmation further limit interpretation. Since the study was conducted in selected GN divisions within a single MOH area, its generalisability is limited. Additionally, potential confounding factors may have influenced the observed associations.

Conclusion

Carpenters in the Moratuwa MOH division experience a high occurrence of cardiorespiratory symptoms and reduced pulmonary function. Occupational health measures such as dust control methods, provision and enforcement of personal protective equipment, and targeted health education are urgently needed to lessen disease burden and enhance quality of life among carpenters.

Recommendations

Future research should examine carpenters across various regions of Sri Lanka, particularly in key woodworking centres such as Moratuwa, to identify differences in exposure and disease patterns. Including comprehensive spirometry (FVC, FEV_1, FEV_1/FVC) alongside PEFR would enhance the detection of respiratory impairment. Implementing regular occupational health screening within the primary healthcare system and establishing a national surveillance system for informal-sector workers would help reduce cardiorespiratory morbidity among carpenters in Sri Lanka.

Author Declaration

Conflict of Interest

The authors declare that they have no known competing interests.

Ethics declaration

Ethical approval for this study was granted by the Ethics Review Committee of the Faculty of Medicine, University of Colombo, prior to the start of the study. Written informed consent was obtained from all participants before data collection.

Criteria for authorship

All authors have made substantial contributions to the study and meet the criteria for authorship. Conception, study design, data collection, and manuscript drafting: KDBRI Jayaweera; conception, manuscript correction, and overall supervision: I Suraweera.

Data availability

The data supporting the findings of this study are available from the corresponding author on reasonable request.

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