Assessment of respiratory symptoms and pulmonary functions in rickshaw drivers in Biratnagar, Nepal

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ABSTRACT

Background: Ambient air pollution is a cause of chronic respiratory diseases. Nepal has an increasing burden of respiratory morbidities, and Biratnagar city has a poor air quality index. Rickshaw drivers are exposed to ambient pollutants for long durations. The study aimed to determine the prevalence of respiratory symptoms in rickshaw drivers of Biratnagar and to measure their pulmonary function.

Methods: A cross-sectional study was conducted from January 2022 to January 2023. A structured questionnaire recorded data on socio-demographic variables and respiratory symptoms. Hand-held portable spirometer EasyOne® Air documented lung function parameters. Data was presented as descriptive statistics.

Results: There were 348 rickshaw drivers in Biratnagar enrolled in the study, all were male, with a mean age of 36.13 (±11.07) years and a mean duration of occupation of 5.38 (±3.61) years. Phlegm was present in 102 (29.31%), 78 (22.41%) had cough, 72 (20.69%) noisy breathing, and 54 (15.52%) dyspnea. There were 189 (54.31%) with impaired lung functions. Restrictive impairment was present in 131 (37.64%), mixed disorder in 38 (10.92%), and obstructive impairment in 20 (5.75) drivers. Our descriptive data suggested that rickshaw drivers who had longer duration of occupation had more impairment of pulmonary functions.

Conclusion: Phlegm production, cough, noisy breathing and dyspnea were common respiratory symptoms in rickshaw drivers in Biratnagar. Drivers who had longer duration of occupation demonstrated more pulmonary dysfunction. Rickshaw drivers are at risk for chronic respiratory disease and need proper education on preventive strategies and regular screening for lung function outcomes.

Keywords: Air pollution, lung disease, lung function, respiratory symptoms, rickshaw drivers

INTRODUCTION

Outdoor air pollution causes acute and chronic respiratory diseases, and ambient air pollutants were responsible for 4.2 million premature deaths per year globally in 2019 owing to exposure to fine particulate matter [1]. In Nepal, a leading cause of disability-adjusted life years (DALY) is chronic obstructive pulmonary disease [2]. The concentration of fine particulate matter (PM2.5) in Nepal was 36.43 (31.71 – 42.97) [3], and air quality index (AQI) in Biratnagar from World Air Map (Plume Labs' Application) was 63 (poor) on 3 September 2023, as compared to 20 AQI (fair) in Kathmandu. On average, the air quality index of Biratnagar remained at this level for 80 days a year, with an annual average of 69 [4].

The burden of chronic obstructive pulmonary disease, asthma, and upper airways cough syndrome have increased in Nepal [2], but detailed information on occupation-related causes of respiratory diseases is not known. Moreover, burden of chronic respiratory diseases due to occupation is not known globally [5]. Nepal in 2007 observed 17.1% males and 11.3% females seeking primary health care for respiratory symptoms [6].

A cross-sectional study observed that transport workers developed impaired lung function attributed to road traffic environment. In the study conducted in Kochi, Kerala, it was observed that 19.2% suffered from chronic

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respiratory symptoms [7]. Prolonged duration of exposure to traffic environment showed lower forced expiratory volume in 1 second (FEV1) and forced vital capacity (FVC), probably due to the small airways demonstrating inflammatory response to the pollutants from vehicular traffic [8].

Of the estimated 6000 rickshaw vehicles in Biratnagar, there is no data on respiratory health and lung function outcomes in the drivers, who are presumably on the road for prolonged periods, drive slowly owing to the congested city traffic, and are regularly exposed to ambient air pollutants. The objectives of the study were to determine the prevalence of respiratory symptoms in rickshaw drivers of Biratnagar and to measure pulmonary functions.

METHODS

The observational cross-sectional descriptive quantitative workplace-based study was conducted by the Department of Internal Medicine, Birat Medical College Teaching Hospital, Biratnagar, Nepal, from January 2022 to January 2023. The study was reviewed and approved by the Institutional Review Board of Birat Medical College Teaching Hospital (IRC-PA-185/2078-79). Rickshaw drivers aged 14 years and above, working for at least 6 months in Biratnagar metropolitan city of Nepal, and giving informed consent were considered eligible for inclusion in the study. With the prevalence of respiratory symptoms such as breathlessness on exertion in auto rickshaw drivers observed to be 68% [7], a sample size of 335 was calculated by $n=Z^2XpXq/L^2$ ($=1.96^2$ X 0.68 X 0. $32/0.05^2$), with p = prevalence, Z = 1.96 at 95% confidence interval (CI), q =1-p, margin of error 5%. In Biratnagar, the study population size was not verifiable owing to high number of undocumented rickshaw drivers and unregistered rickshaws, and was estimated to be approximately 6000. The study participants were enrolled by convenient sampling till completion of sample size collection. Data was collected at site of workplace of driver during traffic hours.

For the study, lung function outcomes were defined as obstructive impairment, restrictive impairment, and mixed disorder. Obstructive impairment is defined as FEV1/FVC ratio less than the lower limit of normal, with normal or low FEV1 and normal FVC. Restrictive impairment is inferred by FVC less than the lower limit of normal, with normal or high FEV1/FVC ratio, and mixed disorder as FEV1, FVC and FEV1/FVC ratio less than lower limits of normal, depicting both obstructive and restrictive impairments [9]. The lower limit of normal is defined as the lower 5^{th} percentile of the predicted values [10]. Forced expiratory volume in the first second (FEV1) refers to the amount of air exhaled in the first second of a full forced expiration after full inspiration. Forced vital capacity (FVC) refers to maximal amount of air forcefully exhaled after full inspiration [11]. The spirometry used the all-age multi-ethnic Quanjer (Global Lung Function Initiative 2012) reference values [12]. The respiratory symptoms recorded in the study were cough, with or without sputum production, phlegm production, noisy breathing, and dyspnea of any duration.

The modified Medical Research Council (mMRC) scale was used to measure a patient's disability due to breathlessness in daily activities using a self-rated scale of 0 to 4. Score 0 is no breathlessness except on strenuous exercise; score 1 is breathlessness when hurrying on level or walking up slight hill; score 2 is breathlessness that causes the patient to walk slower than people of same age on level, or if patient has to stop to catch breath when walking at own pace on level; score 3 is when patient stops for breath after walking approximately 100 meters or after few minutes on level; and score 4 is the state when patient is too breathless to leave house, or breathless when dressing or undressing [13,14].

A structured questionnaire based on the American Thoracic Society and National Heart & Lung Institute, Division of Lung Disease (ATS-DLD 78-A) was used to record data on socio-demographic data, occupation history, and respiratory symptoms of cough, sputum production, phlegm production, noisy breathing and presence of dyspnea [15]. Presence of co-morbid conditions of emphysema, chronic bronchitis, bronchial asthma, hypertension, heart diseases, and family history of respiratory illnesses were documented. Hand-held portable spirometer EasyOne® Air designed by NDD Medical Technologies was used to document lung function, and it has been observed to yield generally reproducible and valid results [16]. The questionnaire which was answered by the drivers was in Nepali language and was assisted by a trained health personnel who also performed the spirometry test. For the spirometry test, the participant's age, gender, height in Imperial system of measurement, weight in kilograms, and ethnicity were entered in the spirometer device. The EasyOne® Air spirometer corrects the small difference between expiratory air lung temperature and the temperature of air within the flow sensor with a fixed BTPS correction factor of 2%, and that of inspiratory air by BTPS correction factor of approximately 12%. The spirometry test was performed to achieve three acceptable maneuvers, in the seated position to avoid syncopal attacks. Single-use disposable mouthpiece was used to minimize infection risks. After a demonstration of the spirometer test by the trained health personnel, the subject was advised to perform a good start and forceful exhalation, not to cough during the procedure, hold the device properly, without obstruction of the mouthpiece. The spirometer was calibrated at regular intervals. The device recorded values of FVC in liters, FVC% predicted, FEV1 in liters, FEV1% predicted, FEV1/FVC ratio, FEV1/FVC% predicted, FEF 25%-75% predicted, and their respective lower limits of normal. Microsoft Excel 2003 worksheet was used to record data and exported to Statistical Package for Social Science version 11.5 for statistical analyses. Mean, standard deviation, and percentages were used in descriptive statistics, and the data were presented in tabular and graphical representations.

RESULTS

The study included 348 rickshaw drivers in Biratnagar (219 electric-rickshaw and 129 auto-rickshaw drivers), and all were male. The mean age was 36.13 (±11.07) years.

There were 120 (34.48%) rickshaw drivers belonging to the Janjati ethnic group, 116 (33.33%) to the Madheshi group, 225 (64.55%) had informal education and 196 (56.32%) were smokers . (**Table 1**)

Regarding past medical history, one (0.29%) driver had

Table 1: Sociodemographic characteristics of rickshaw drivers (n=348)

Characteristics		Frequency (%)
Marital Status	Single	66 (18.97)
	Married	282 (81.03)
Ethnicity	Janjati	120 (34.48)
	Madheshi	116 (33.33)
	Muslim	49 (14.08)
	Brahmin	32 (9.20)
	Dalit	31 (8.91)
Education	Informal	225 (64.66)
	Formal	123 (35.34)
Smoking History	Smokers	196 (56.32)
	Nonsmokers	152(43.68)

Table 2: Respiratory symptoms in rickshaw drivers (n=348)

Symptom		N (%)
Cough Duration (years, mean ± SD): 2.04 ± 1.32		78 (22.41)
Phlegm production Duration (years, mean ± SD): 1.89 ± 1.24		102 (29.31)
Noisy Breathing Duration (years, mean ± SD): 1.52 ± 0.91		72 (20.69)
Dyspnea	mMRC 0	29 (53.70)
	mMRC 1	12 (22.22)
	mMRC 2	10 (18.52)
	mMRC 3	3 (5.55)
	mMRC 4	0
	Total	54 (15.52)

mMRC: modified Medical Research Council score

developed pneumonia at the age of 12 years, 7 (2.01%) had been diagnosed with bronchial asthma, of which 5 (1.44%) were diagnosed at the age of 3, 6, 18, 38, and 45 years respectively and 2 (0.57%) at the age of 12 years. The drivers did not have other known history of chronic lung and cardiovascular diseases. There were 4 (1.15%) drivers with their fathers affected by asthma and 3 (0.86%) drivers with their mothers affected by asthma. The father of one driver and the mother of one driver had lung cancer.

The mean duration of occupation was 5.38 years (±3.61), and 82 (23.56%) drivers used facemasks during work.

Phlegm production was present in 102 (29.31%) rickshaw drivers, cough in 78 (22.41%), noisy breathing in 72 (20.69%), and dyspnea in 54 (15.52%). (**Table 2**)

Among 219 electric rickshaw drivers, cough was observed in 54 (24.66%), phlegm production in 65 (29.68%), noisy breathing in 50 (22.83%), and dyspnea in 35 (15.98%). Among 129 auto-rickshaw drivers, cough was present in 20 (15.50%), phlegm production in 34 (26.36%), noisy breathing in 21 (16.28%) and dyspnea in 17 (13.18%).

There were 189 (54.31%) drivers who had abnormal lung function. Restrictive impairment was present in 131 (37.64%) (**Table 3**).

There were 221 (63.51%) drivers working for 5 years or less, 104 (29.89%) working for 6 to 10 years, 16 (4.60%) working for 11 to 15 years, and 7 (2.0%) for more than 15 years. The mean FVC was 3.30 liters (±0.66) in drivers working 5 years or less and 2.66 liters (±0.40) in those working more than 15 years. The mean FEV1 was 2.80 liters (±0.55) in those working 5 years or less and 2.33 liters (±0.45) in those working more than 15 years. (**Table 4**)

DISCUSSION

The study aimed to determine the prevalence of respiratory symptoms and measure pulmonary function in rickshaw drivers in Biratnagar. The drivers were relatively young,

Table 3: Lung function test findings in rickshaw drivers (n=348)

Outcome	n (%)	FVC (L) Mean (±SD)	FEV1(L) Mean (±SD)
Normal Airways	159 (45.69)	3.61 (±0.37)	3.11 (±0.33)
Obstructive Impairment	20 (5.75)	4.14 (±0.85)	2.67 (±0.68)
Restrictive Impairment	131 (37.64)	2.87 (±0.37)	2.53 (±0.36)
Mixed Disorder	38 (10.92)	2.42 (±0.62)	1.88 (±0.55)
Total	348 (100%)		

FVC: Forced vital capacity; FEV1: Forced expiratory volume in the first second

Table 4. Lung function parameters of Rickshaw drivers based on duration of occupation (n=348)

Duration of Occupation (years)	N (%)	Parameter (mean ±SD)	
		FVC (L)	FEV1 (L)
≤5	221 (63.51)	3.30 (±0.66)	2.80 (±0.55)
6 – 10	104 (29.89)	3.16(±0.60)	2.65 (±0.54)
11 – 15	16 (4.6)	2.99 (±0.82)	2.51 (±0.73)
>15	7 (2.01)	2.66 (±0.40)	2.33 (±0.45)

FVC: Forced vital capacity; FEV1: Forced expiratory volume in the first second

with a mean age of 36.13 years (±11.07), and 56.32% were cigarette smokers. In comparison, a study of auto-rickshaw drivers in Delhi reported a mean age of 39 years (±10.52) with 35% smokers [17].

In the present study of 348 drivers, phlegm production was observed in 102 (29.31%), chronic cough in 78 (22.41%), noisy breathing in 72 (21.71%), and dyspnea was present in 54 (15.52%) drivers. In a Delhi study, 75 were auto rickshaw drivers and 75 others were cab drivers, and approximately 28% of auto-rickshaw drivers complained of dyspnea, 20% phlegm production, 15% chronic cough and approximately 8% noisy breathing. Of the cab drivers, approximately 20% complained of dyspnea, 10% chronic cough, 5% phlegm production and less than 5% noisy breathing [17]. Similarly, a South Indian study found that 68% of drivers experienced breathlessness on exertion, 22% had phlegm production, and 21% had a cough [18]. In the present study, dyspnea of mMRC grade 0 was present in 29 (53.70%) and mMRC grade 1 in 12 (22.22%) drivers. The presence of dyspnea may be attributed to prolonged exposure to air pollutants and the sedentary nature of the job. Our study demonstrated restrictive impairment in 37.64% of drivers, mixed disorder in 10.92%, and obstructive impairment in 5.75%. This is somewhat consistent with the Delhi study, which found 48% restrictive and 6% obstructive lung functions [17].

Longer occupational duration was associated with decreased FVC, with drivers working more than 15 years showing mean FVC of 2.66 liters (±0.40) and mean FEV1 of 2.33 liters (±0.45). This finding aligns with a study in Puducherry, which observed a decrease in FVC in drivers with prolonged exposure [18]. In contrast, a study of public transport workers in Kathmandu found a mean FVC of 3.71 liters (±0.58) and FEV1 of 2.92 liters (±0.92) for those with over five years of experience [19].

The limitations of this study are that the effects of indoor air pollutants such as biomass fuel, active and passive smoking, and measurements of particulate matter density in ambient air could not be analyzed, which would have provided more information on the causes of the decrease in lung function values. Additionally, the mMRC tool has limitations in distinguishing between actual dyspnea and subjective variations in responses. The study also did not include measures of total lung capacity or DLCO, which could have offered additional information. A case-control study would better analyze the association between the variables.

CONCLUSION

Rickshaw drivers in Biratnagar had developed different respiratory symptoms such as phlegm production, cough, noisy breathing, and dyspnea. There was development of restrictive impairment, obstructive impairment, and mixed disorder in the drivers, with restrictive impairment being the most common lung function outcome. Since the rickshaw drivers are a vulnerable community at risk for developing chronic respiratory diseases, appropriate preventive measures need to be taken.

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Consent: Informed written consent was obtained from all participants prior to data collection.

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Data availability: The data supporting the findings of the research are available from the corresponding author and will be made available upon reasonable request.

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