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Correlation between pulmonary function and health-related quality of life among pressure vessel welders: A cross-sectional study

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Abstract
Background: Welding is associated with occupational exposure to fumes and other workplace hazards that may affect respiratory health. Pulmonary function and health-related quality of life provide complementary information about the health of exposed workers. The present study examined the relationship between peak expiratory flow rate (PEFR) and health-related quality of life measured using the Short Form-36 (SF-36) among pressure vessel welders.
Methods: A cross-sectional study was conducted among 47 male pressure vessel welders using purposive sampling. Participants were aged 25–55 years and had at least one year of continuous occupational exposure to welding fumes. PEFR was measured using a Mini Wright Peak Flow Meter, with three attempts performed and the highest value recorded. Health-related quality of life was assessed using the SF-36. Data were entered into Microsoft Excel and analysed using Jamovi Statistics. Pearson correlation was used after assessment of distributional assumptions.
Results: The mean age of participants was 33.74 ± 5.85 years and the mean working experience was 6.37 ± 2.88 years. The mean PEFR value was 385 ± 78.7 L/min, while the mean SF-36 score was 55.2 ± 10.0. The study analysis reported a positive correlation between PEFR and SF-36 at $p = 0.025$.
Conclusion: In this sample of pressure vessel welders, higher PEFR was associated with higher reported health-related quality of life. The findings support considering both respiratory function and perceived health when assessing occupationally exposed workers. Larger studies using more comprehensive pulmonary function testing and quantitative exposure assessment are needed.

Keywords: Pressure vessel welders, welding fumes, peak expiratory flow rate, PEFR, SF-36, health-related quality of life, occupational health

Introduction

Welding is an important industrial process used to join metals and is widely used in fabrication, repair and maintenance activities, including the manufacture of pressure vessels. Although welding is essential to industrial production, workers may be exposed to fumes, gases, dust and heat generated during the process. Repeated occupational exposure makes welding an important area of occupational health, particularly when exposure continues over several years [1, 2]

Welding fumes are complex mixtures whose composition varies with the welding process, base metal, electrode or filler material and working environment. Repeated inhalation of these fumes may irritate the respiratory tract and may contribute to respiratory symptoms and changes in pulmonary function [1, 2]. Studies among occupational workers have reported respiratory complaints such as cough, phlegm, wheezing and breathlessness, along with impaired pulmonary function. Factors such as longer exposure duration, longer working hours, smoking and inadequate use of personal protective equipment may further influence respiratory health [3].

Pressure vessel welders may experience prolonged exposure because their work involves repeated welding activities in industrial environments where ventilation and fume control are important. They may also work in stooped, squatting or otherwise constrained positions while remaining close to the welding area. These occupational demands may affect not only respiratory health but also physical comfort and day-to-day functioning.

Pulmonary function describes how effectively the respiratory system moves air into and out of the lungs. Peak Expiratory Flow Rate (PEFR) is a simple, non-invasive measure representing the maximum flow achieved during a forceful expiration following full inspiration. It can be measured rapidly using a portable peak flow meter and can be useful for screening and monitoring airway flow.

PEFR is particularly practical in occupational settings because the equipment is portable, relatively inexpensive and easy to use. In the present study, a Mini Wright Peak Flow Meter was used, with three attempts performed and the highest value considered for analysis. Previous work among welders has reported lower PEFR values in exposed workers and has suggested an association between longer occupational exposure and reduced respiratory function [1].

Respiratory health, however, cannot be understood only through physiological measurements. A worker may have measurable changes in pulmonary function while continuing to work and perform daily activities, yet may still experience changes in physical functioning, pain, energy, emotional well-being or social functioning. Health-related

quality of life therefore provides an important complementary perspective.

The Short Form-36 Health Survey (SF-36) is a generic instrument used to assess health-related quality of life. It covers eight domains: physical functioning, role limitations due to physical health, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems and mental health. In occupational populations, the questionnaire can provide information about how health is perceived in everyday life.

Previous occupational studies have reported respiratory impairment among welders and other industrial workers [2,4]. PEFR has also been studied as a simple measure that can reflect changes in pulmonary function when more detailed pulmonary testing is not readily available [5]. Despite this evidence, limited work has specifically examined the relationship between PEFR and health-related quality of life among pressure vessel welders.

Therefore, the present study was undertaken to determine the correlation between pulmonary function and health-related quality of life among pressure vessel welders using PEFR and SF-36. Assessing both measures may provide information about the relationship between a measurable aspect of respiratory function and workers perceived health and well-being.



Fig 1: The image shows demonstration of Peak Expiratory Flow Rate (PEFR) by subject

Materials and Methods

A cross-sectional study was conducted among 47 male pressure vessel welders working in an industrial setting at MIDC, Ambernath, Maharashtra. Purposive sampling was used for participant selection. Male welders aged 25–55 years, with at least one year of continuous occupational exposure to welding fumes, who were actively working in a pressure vessel or similar industrial unit and willing to participate were included in the study after obtaining written informed consent. Participants with a known history of chronic pulmonary diseases such as asthma or chronic obstructive pulmonary disease, smoking exposure of more than 10 pack-years, cardiovascular or neuromuscular conditions affecting respiratory function, or any condition interfering with the assessment were excluded. Ethical approval was obtained from the appropriate ethics committee before commencement of data collection. Participants were informed about the purpose and procedure of the study, and confidentiality was maintained throughout the study.

Pulmonary function was assessed using a Mini Wright Peak Flow Meter. The Mini Wright Peak Flow Meter has demonstrated good reliability for measurement of peak expiratory flow, including reliable performance after prolonged use [6] Participants were seated upright with relaxed shoulders and instructed to take a deep breath, seal their lips around the mouthpiece and exhale as forcefully and rapidly as possible as shown in the figure 1. The tongue was kept away from the mouthpiece to avoid obstruction, and a disposable mouthpiece was used for each participant. Three PEFR attempts were performed and the highest reading was recorded as the final PEFR value. Health-related quality of life was assessed using the Short Form-36 Health Survey (SF-36), The SF-36 has demonstrated good internal consistency, with cronbach's alpha values of >0.80 across its eight domains,supporting its reliability for assessing health –related quality of life.Its validity has also been established through item level ,scale-level and known group validity assesments.[5] The SF-36 evaluates eight domains including physical functioning, role limitations due to physical health, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems and mental health. The SF-36 total score was used in the present study to represent health-related quality of life.

Statistical Analysis

The data were entered into Microsoft Excel and analysed using Jamovi Statistics. Descriptive statistics were used to summarise the study variables, and normality was assessed before selecting the correlation test. As the variables were considered normally distributed, Pearson's correlation was applied to assess the relationship between PEFR and SF-36 score.

Results.

Table 1: Descriptive statistics of study variables.

Variable	Mean ± SD
Age (years)	33.74 ± 5.85
Working experience (years)	6.37 ± 2.88
PEFR (L/min)	385 ± 78.7
SF-36 score	55.2 ± 10.0

A total of 47 pressure vessel welders were included in the final analysis. The mean age of participants was 33.74 ± 5.85 years, and the mean working experience was 6.37 ± 2.88 years. The mean value of PEFR was 385 ± 78.7 L/min and the mean SF-36 score was 55.2 ± 10.0.

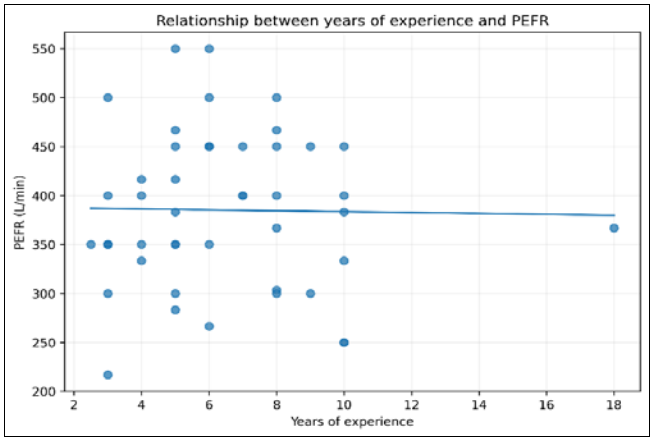


Fig 2: illustrates the scatter plot distribution of PEFR values across years of occupational experience showed considerable individual variation, with no clear linear pattern.

Table 2: Pearson Correlation Analysis Between Peak Expiratory Flow Rate (PEFR) and Quality of Life (SF-36 Score)

Correlation Matrix			
		PEFR	**SF 36**
PEFR	Pearson's r	—	
	df	—	
	p-value	—	
	95% CI Upper	—	
	95% CI Lower	—	
SF 36	Pearson's r	0.327	—
	df	45	—
	p-value	.025	—
	95% CI Upper	0.561	—
	95% CI Lower	0.044	—

Pearson's correlation analysis was used to assess the relationship between PEFR and SF-36 score. The study analysis reported a positive correlation at p = 0.025

Discussion

The present study examined the relationship between pulmonary function and health-related quality of life among pressure vessel welders. 47 male pressure vessel welders were assessed using PEFR and

SF-36. The use of both measures allowed the study to consider a physiological measure of expiratory flow alongside participants' perceived health and daily well-being.

The mean age of participants was 33.74 ± 5.85 years and the mean working experience was 6.37 ± 2.88 years. The participants therefore represented relatively young working adults with several years of occupational exposure. Occupational exposure duration is relevant in welding populations because respiratory effects may develop gradually and may not always be recognised at an early stage. Previous occupational studies have reported respiratory morbidity and impaired lung function among workers exposed to welding fumes and other industrial dust [1,4].

The mean value of PEFR in the present study was 385 ± 78.7 L/min, with variation across participants. Differences in age, duration of exposure, working conditions, smoking history, use of protective equipment and individual respiratory health may contribute to variation in PEFR. Gupta *et al*. reported reduced PEFR among welders and observed greater reduction among workers with longer exposure and among smokers [1]. Siregar and Ferawati also reported impaired lung function among welders and highlighted occupational factors such as duration of work and PPE use [3].

The findings are also consistent with broader occupational literature Manivannan and Ayyappan reported respiratory morbidity among workers in dusty occupations.while Garg *et al*. reported reduced pulmonary function and respiratory symptoms among metal industrial workers, [2,4]. These studies support the importance of respiratory health monitoring in occupationally exposed workers.

The mean SF-36 score in the present study was 55.2 ± 10.0. Health-related quality of life is broader than pulmonary function because it reflects perceived physical functioning, usual roles, pain, energy, social interaction and emotional well-being. A worker may continue working despite respiratory impairment, while still experiencing changes in comfort, physical capacity or general well-being. For this reason, assessing quality of life together with a physiological measure may provide additional information about the functional impact of occupational health problems.

The main finding reported in the study analysis was a positive correlation between PEFR and SF-36 score at p = 0.025. The positive direction indicates that participants with higher PEFR tended to report higher SF-36 scores. Similar relationships between respiratory function and perceived health have been described in other occupational populations. Purani and Shah reported a relationship between respiratory symptoms and pulmonary function among construction workers, while Chittaluru *et al*. reported reduced pulmonary function together with poorer respiratory morbidity-related quality of life among construction workers [7,8]. The populations and outcome measures differed from the present study, so these findings should be considered supportive rather than directly equivalent.

The present study also reported that 21.27% of participants had low PEFR along with higher occupational exposure duration. This may indicate an association between longer occupational exposure and pulmonary function in the study population. Gupta *et al*. reported greater reduction in PEFR among welders with longer exposure, and Siregar and Ferawati identified occupational exposure and workplace factors as considerations in impaired lung function [1,3]. However, the cross-sectional design does not establish causality.

Other factors, including smoking history, respiratory protection, ventilation, type of welding process, working hours and individual susceptibility, may influence pulmonary function. These factors were not quantitatively controlled in the present analysis. PEFR was practical for this occupational setting, although it does not provide the complete information obtained from spirometry. Appannavar *et al*. reported a significant relationship between PEFR and spirometric measures such as FEV1 and FVC, supporting the usefulness of PEFR as a screening measure [9].

From an occupational physiotherapy perspective, regular respiratory screening may help identify workers who require further evaluation. Education regarding appropriate PPE use, workplace ventilation and reduction of unnecessary fume exposure may also support respiratory health. Assessing health-related quality of life alongside respiratory function can help identify whether physiological changes are accompanied by perceived limitations in everyday life.

Overall, the findings reported in the present study suggest an association between pulmonary function and health-related quality of life among the pressure vessel welders studied. Because the sample was relatively small and the study was cross-sectional, the findings should be interpreted cautiously and further evaluated in larger, longitudinal studies.

Conclusion

The present study examined the correlation between pulmonary function and health-related quality of life among 47 male pressure vessel welders using PEFR and SF-36. The mean PEFR was 385 ± 78.7 L/min and the mean SF-36 score was 55.2 ± 10.0. The study analysis reported a positive correlation between PEFR and SF-36 at p = 0.025. The findings suggest that participants with higher

pulmonary function tended to report better health-related quality of life. The study highlights the value of considering both respiratory function and perceived health when assessing occupationally exposed workers.

Limitations

- Only male pressure vessel welders were included, so the findings may not be generalisable to female welders.
- The sample size was limited to 47 participants and was obtained using purposive sampling, which may limit generalisability.
- The study was conducted in a specific occupational setting, so the findings may not represent all pressure vessel welders or other welding workers.
- Pulmonary function was assessed using PEFR only; comprehensive spirometric parameters such as FEV1, FVC and FEV1/FVC were not included.
- The cross-sectional design allows identification of association but does not establish a causal relationship between pulmonary function and quality of life.
- Individual exposure to welding fumes, ventilation conditions, specific welding processes and exact exposure dose were not quantitatively measured.

Clinical / Occupational Relevance

- PEFR can be used as a quick and practical screening measure for respiratory impairment among pressure vessel welders.
- Regular monitoring of pulmonary function may help identify workers who require further respiratory evaluation.
- Assessment of health-related quality of life can provide information about the functional and perceived impact of respiratory problems.
- Combining respiratory screening with occupational health education may support early prevention and management of work-related respiratory problems.
- Appropriate use of personal protective equipment and attention to workplace ventilation are important components of respiratory health protection.

Future Scope

- Future studies can include a larger sample and participants from multiple industrial settings to improve generalisability.
- Female welders can be included to provide a broader understanding of occupational respiratory health.
- Longitudinal studies can examine changes in pulmonary function and quality of life over time.
- Future research can include spirometry along with PEFR to provide a more comprehensive assessment of pulmonary function.
- Further studies can examine years of occupational exposure, daily working hours, type of welding, PPE use, smoking history and workplace ventilation.
- Future research can compare welders with non-exposed control groups to better understand the occupational contribution to changes in pulmonary function and quality of life.

Ethics Approval and Consent

The study was approved by the Institutional Ethics committee Written informed consent was obtained from all participants before data collection, as stated in the study procedure.

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Conflict of Interest

There are no conflicts of interest

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