Evaluation of spirometric lung function among healthcare professionals working in operating theatres: A comparative cross-sectional study

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Background. Inhalational exposures in the operating theatre, such as waste anaesthetic gases, surgical smoke, airborne particles, microbiological contaminants and cleaning agents, may compromise lung function.
Objectives. To evaluate pulmonary function test (PFT) values of operating theatre staff who work in resource-constrained settings.
Methods. This comparative cross-sectional study included 184 participants (exposed and matched unexposed cohorts). Data were acquired via a structured questionnaire, and the standard procedure was used to calculate each participant's forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), FEV_1/FVC ratio and peak expiratory flow rate (PEFR). Mann-Whitney *U*-tests, Kruskal-Wallis tests, Spearman analysis and multiple linear regression analysis were used to investigate the statistical relationships between variables. A *p*-value <0.05 was considered significant.
Results. The study cohort comprised 38 surgeons, 28 anaesthetists, 14 scrub nurses and 12 assistants, with a median age of 34 years. The median age for the matched unexposed cohort was 33 years. The healthcare staff had significantly lower FEV_1, FVC and PEFR values and FEV_1/FVC ratios ($p<0.05$) than the unexposed cohort. These values decreased significantly as staff experience/exposure time increased ($p=0.001$). Furthermore, the scrub nurses and assistants had significantly lower PFT values than the other healthcare groups ($p=0.001$).
Conclusion. The study showed that PFT values were considerably lower among operating theatre healthcare staff than in a matched unexposed group, with measures decreasing as staff experience/duration of exposure rose.

Keywords. Pulmonary function tests, spirometry, values, occupational lung disease, waste anaesthetic gases.

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Study synopsis
What the study adds. Since occupational lung disease places significant pressure on the healthcare system, this study evaluated the spirometric lung function of healthcare staff who worked in an environment without proper respiratory safeguards.
Implications of the findi gs. The hospital environment may trigger respiratory problems, particularly for healthcare staff who work in operating theatres, restricting their economic productivity. It is therefore vital to establish, execute and maintain high-quality procedures that guarantee workplace health and safety, especially in settings with limited resources.

The frequency of occupational diseases reflects the quality of work conditions and the general healthiness of the workplace environment. Occupational lung diseases can cause significant damage to the lungs, leading to substantial respiratory insufficiency and even mortality.[1,2] Several factors influence the development of occupational lung diseases, such as the chemical nature and physical state of the substance inhaled, the size and concentration of dust particles, the duration of exposure, and individual vulnerability.[3] Although hypersensitivity pneumonitis, occupational asthma and chronic obstructive pulmonary disease are increasingly recognised as occupational lung diseases, historical diseases such as silicosis and coal workers' pneumoconiosis have also been described.[3-5]

Waste management, noise, infection control, radiation safety, general building safety, water quality, heating, ventilation and air conditioning systems, and sewage treatment all have significant effects on complex hospital environments (which include patients, staff, equipment, services and information).[6] Microbiological contamination of hospital units and wards with amoebae cysts and fungal species that can be inhaled increases the risk of patients and healthcare personnel acquiring illnesses, particularly if they are immunocompromised.[7,8] Waste anaesthetic gases, including nitrous oxide and halogenated anaesthetics (such as halothane, enflurane, isoflurane, desflurane, sevoflurane and methoxyflurane), released from or leaked during medical procedures, may endanger individuals who work in high-risk areas such as operating theatres, delivery and labour rooms, recovery rooms, and remote anaesthetic areas such as radiology or post-anaesthesia care units, as well as those who work in dental practices, veterinary clinics and animal research facilities.[9,10] Health concerns caused by exposure to such waste anaesthetic gases include headache, irritability, exhaustion, nausea, drowsiness, difficulties with judgement and co-ordination, liver and kidney diseases, miscarriages, genetic damage and cancer.[11] Additionally, the air in the operating theatre environment may contain airborne particles such as skin cells, dust, lint carried on clothing, or respiratory droplets (mostly produced by the presence of medical staff) that may carry germs that are harmful to both patients and working personnel.[11] Furthermore, surgical smoke, which is defined as a by-product of electrosurgical devices as a result of thermal interactions with soft tissues that disrupt intracellular and extracellular components at 100°C through direct or indirect heat or shock wave exposure, poses a potential danger to respiratory health.[12] Finally, cleaning agents for disinfecting medical equipment (e.g. ortho-phthalaldehyde and enzymatic cleansers) and patient care procedures (e.g. disinfection before operations and of open wounds), and sprays used for fixed-surface cleaning, are substantial occupational risk factors for airway illness among healthcare staff.[13] Similarly, an increased risk of asthma has been documented among healthcare personnel who frequently use cleaning and disinfection agents for their work compared with those who do not.[14] All these health implications are potentially more widespread among personnel in operating theatres and recovery facilities with no or inadequate ventilation or scavenging systems than among those whose workplaces are better equipped.

Pulmonary function tests (PFTs) enable doctors to assess respiratory system function in a variety of clinical settings, including those involving risk factors for pulmonary illness, occupational exposure and pulmonary toxicity.[15] PFTs do not provide a specific diagnosis; to aid in diagnosis, the results should be paired with a pertinent history, findings on physical examination, and laboratory data. PFTs also enable clinicians to define the severity of pulmonary disease, track its progression over time, and evaluate its response to treatment.[16] Readers interested in knowing more about PFT indications, contraindications, precautions and procedures are referred to Stanojevic *et al.*[17] and Ranu *et al.*[18]

Many studies have been undertaken at national and international levels to investigate the effects of various occupational exposures on lung function.[19-21] However, research on the effects of work in the operating theatre setting on respiratory system health is limited. This study therefore aimed to evaluate spirometric measurements of operating theatre staff working in resource-constrained settings.

Methods

Study design, duration and setting

This cross-sectional hospital-based study was carried out from October to December 2022 at Ibn-Sina Teaching Hospital and National Ribat University Hospital in Khartoum, Sudan. Ibn Sina Teaching Hospital is a government tertiary referral hospital with specialist medical and surgical services such as gastroenterology and gastrointestinal haemorrhage centres, urology, otolaryngology, nephrology, and a kidney transplant facility. The hospital has two operating theatre complexes, each with three operating theatres. National Ribat University Hospital is a government hospital that provides medical and surgical care. It has four operating theatre complexes, each with six operating theatres.

Study population and eligibility criteria

The operating theatre personnel studied were surgeons, anaesthetists, scrub nurses and assistants (porters and cleaners). All were Sudanese adults aged ≥18 years who had worked in an operating theatre for ≥3 hours per day, ≥3 days per week, for at least 1 year. Smokers (past or present), pregnant women, individuals on chronic therapy for any disease, those with known cardiopulmonary disease or other chronic diseases (diabetes, hypertension, renal diseases, etc.), and those with any contraindication to lung function tests (e.g. a history of eye, chest or abdominal surgery, haemoptysis, or pneumothorax, emboli or aneurysms; or current respiratory infection) were excluded. Additionally, a comparison group of Sudanese adults matched for age, sex and height comprised postgraduate university students and arts faculty staff who had no prior exposure to respiratory risks.

Survey size determination

The operating theatres at the two hospitals employed ~300 healthcare personnel, of whom about half were excluded because of a history of smoking (n=110), being a new employee (n=31) or having a history of chronic illness (n=11). The remaining 148 healthcare workers were eligible to participate in the study.

Data collection tool and procedure

A structured questionnaire was used to collect sociodemographic, anthropometric and respiratory health data. All the participants underwent a general physical examination. Height (m) and weight (kg) were measured, and the body mass index (BMI) was calculated (weight (kg) divided by height (m^2)). PFTs were done using an electronic digital spirometer (pocket microspirometer D-97204 (VIASYS Healthcare GmbH, Germany)), following a standardised and updated American Thoracic Society/European Respiratory Society (ATS/ERS) recommendation.[17] The study participants were first informed about the principles and processes of the tests. The spirometer was calibrated and tested before the real test, and all the measurements were recorded in the operating theatre during early-morning working hours (08h00 - 10h00). The subjects were told to inhale maximally and rapidly to total lung capacity with a pause of ≤2 seconds and then exhale forcibly into the spirometer mouthpiece with maximal effort until no more air could be exhaled while remaining upright. The forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio and peak expiratory flow rate (PEFR) were measured. Three readings were taken from each individual, with an appropriate rest in between, to confirm the accuracy and reproducibility of the results, and the best of the three readings was chosen. To reduce inter-investigator variability, only one investigator (JBI) did the PFTs. According to the ATS/ERS grading of quality of the PFT session, 140 participants achieved grade A, representing the highest quality (≥3 acceptable manoeuvres with 0.150 L differences between the two highest FVC and FEV_1 values), 30 achieved grade B (2 acceptable manoeuvres with 0.150 L differences between the two highest FVC and FEV_1 values), and 14 achieved grade C (≥2 acceptable manoeuvres with 0.200 L differences between the two highest FVC and FEV_1 values). The PFT data for the exposed participants were compared with those of the matched unexposed cohort on the basis of age, sex and height.

Statistical analysis

The data were analysed with SPSS version 25 (IBM, USA). The distribution of the data was assessed with Kolmogorov-Smirnov and Shapiro-Wilk tests. Continuous variables were reported as medians and ranges, whereas categorical data were presented as frequencies and percentages. When comparing the results between the healthcare workers and the matched unexposed cohort, the Mann-Whitney *U*-test and the Kruskal-Wallis test were employed. Furthermore, correlation (Spearman) analysis and multiple linear regression analysis were used to investigate the relationships between independent factors and PFT results. A p-value <0.05 was considered significant.

Ethical considerations

All procedures involving human participants in this study followed ethical standards established and approved by the research committee of the Faculty of Medicine at The National Ribat University in Khartoum, as well as the 1964 Declaration of Helsinki and subsequent amendments or comparable ethical standards. After a clear and basic description of the research technique and study objectives, each participant provided signed informed consent. The participants were assured that the information obtained would be kept confidential and used only for research purposes.

Results

The study included 184 participants (92 of the eligible 148 healthcare workers, giving a response rate of 62%, and 92 in the matched unexposed cohort). The median age of the healthcare staff was 34 years, with a range of 26 - 74 years, and that of the unexposed group 33 years, with a range of 26 - 74 years. The healthcare workers had a median BMI of 25.7 kg/m² (range 20.1 - 31.6 kg/m²), whereas the unexposed group had a median BMI of 26.8 kg/m² (range 20.34 - 32.2 kg/m²). The healthcare workers comprised 38 surgeons, 28 anaesthetists, 14 scrub nurses and 12 assistants (Table 1). All healthcare staff reported that they could smell anaesthetic gases in the operating theatres. The healthcare workers had significantly lower FEV_1, FVC and PEFR values and FEV_1/FVC ratios than the unexposed group (Table 2).

Assistants and scrub nurses had lower PFT values than the other healthcare categories, and lower values than their matched groups (Table 3). This significant relationship was demonstrated in simple regression analysis (Table 4).

Compared with those of the matched unexposed groups, the PFT values of healthcare workers significantly decreased as their duration of experience/exposure increased (Table 5).

The duration of experience/exposure of healthcare personnel was strongly correlated with and can be a predictor of decreased PFT values (Table 6).

Discussion

Our study assessed spirometry measurements among healthcare personnel working in operating theatres and compared the results with those of a matched unexposed cohort. Spirometry results were significantly lower among healthcare staff than in the matched cohort. Furthermore, values decreased significantly as staff experience/exposure time increased.

Occupational lung illnesses continue to contribute significantly to the respiratory disease burden worldwide, as they can cause respiratory problems and limit economic productivity in young and healthy populations.[22] In Sudan, occupational lung diseases place significant stress on the healthcare system, as many industries, such as lumber, oil, cotton and sugar, have been linked to disturbances in lung function.[19,23]

Our findings demonstrated decreased spirometric values among operating theatre staff. As we practise in a resource-limited setting, potential inhalational exposures such as waste anaesthetic gases, surgical smoke, airborne particles, microbiological contamination and cleaning agents that affect lung function and result in such findings are not unexpected. The waste anaesthetic concentrations of isoflurane and sevoflurane in unscavenged operating theatres have been reported to exceed permissible limits and have been linked to negative health outcomes.[24] Additionally, young doctors exposed to high quantities of waste anaesthetic gases in operating theatres with poor scavenging systems have been found to have genetic and inflammatory problems.[25] Early screening for and diagnosis of occupational lung illness are therefore critical in safeguarding health status and fitness for work of operating theatre personnel.

Compared with other exposed staff, scrub nurses and assistants in the present study had lower PFT values. A study at a Brazilian university hospital that used an infrared gas analyser to detect isoflurane contamination in the operating theatre revealed that the areas of the operating theatre where specific healthcare staff are postioned are critical because the degree of gas accumulation varies, with the majority of accumulation occurring in the breathing corners of anaesthetists and surgeons.[26] Although such an analyser is not available in our country, our study participants indicated that they could smell the escaped anaesthetic gases. However, it is worth mentioning that the odour threshold of a substance is not always indicative of its hazardous potential. Moreover, the low PFT values in our study participants (especially scrub nurses and assistants) may be due to the effects of cleaning agents (such as sodium hypochlorite, ethanol, hydrogen peroxide, chloroxylenol, chlorhexidine gluconate and formaldehyde) used for disinfection and sterilisation in our study setting. Mwanga *et al.*,[13] whose study included both Tanzanian and South African healthcare professionals, reported such effects, finding that cleaning agents for disinfecting medical equipment (such as ortho-phthalaldehyde and enzymatic cleansers), patient care procedures (disinfection before operations and of open wounds), and sprays used for fixed-surface cleaning were potential risk factors for airway illness among participants. Similarly, the relationship between cleaning agents in healthcare settings and the development of occupational asthma is widely recognised.[14] The response to the question 'Does the operating theatre environment pose a potential risk to the spirometric lung function of staff members?' is therefore highly dependent on the individual theatre setting and the roles of the healthcare staff working there. Finally, biological exposures (such as bio-aerosols or airborne particles and dust or surgical smoke, passive tobacco smoke, and vapours) may also be responsible for the low PFT values in the healthcare staff in our study, as they pose a potential risk to the respiratory system, are considered important vehicles of microbiological contamination at workplaces, and are assumed to interact with other occupational agents.[27] They can potentially cause occupational respiratory disorders such as airway inflammation, rhinitis, toxic pneumonitis, hypersensitivity pneumonitis and asthma in exposed workers and are considered job hazards for healthcare providers, especially when combined with other occupational agents.[28] While our study

Table 1. Characteristics of the exposed and unexposed study participants

Variable	Healthcare staff *n*=92), *n* (%)*	Matched unexposed group (*n*=92), *n* (%)*
Age (years), median (range)	34 (26 - 74)	33 (26 - 74)
Sex		
Male	64 (69.6)	60 (65.2)
Female	28 (30.4)	32 (34.8)
BMI (kg/m^2), median (range)	25.7 (20.1 - 31.6)	26.8 (20.3 - 32.2)
Job title		
Surgeon	38 (41.3)	Postgraduate students and arts faculty staff
Anaesthetist	28 (30.4)	
Scrub nurse	14 (15.3)	
Assistant	12 (13.0)	

BMI = body mass index.
*Except where otherwise indicated.

Table 2. Differences in pulmonary function values between the exposed and unexposed study participants

Parameter	Healthcare staff *n*=92), median (range)	Matched unexposed group (*n*=92), median (range)	*p*-value
FEV_1 (L)	2.78 (0.43 - 3.97)	3.14 (2.17 - 3.88)	0.001*
FVC (L)	3.02 (0.52 - 6.18)	3.45 (2.21 - 4.0)	0.001*
FEV_1/FVC (%)	91.91 (50 - 100)	91.01 (76 - 100)	0.012*
PEFR (L/min)	327.5 (115 - 506)	483.5 (137 - 570)	0.001*

FEV1 = forced expiratory volume in 1 second; FVC = forced vital capacity; PEFR = peak expiratory flow rate.
*Significant (*p*<0.05) according to the Mann-Whitney *U*-test.

Table 3. Differences in pulmonary function test values across different healthcare professions and compared with matched unexposed groups

Parameter	Surgeons (*n*=38), median (range)	Anaesthetists (*n*=28), median (range)		Nurses (*n*=14), median (range)	Assistants (*n*=12), median (range)	*p*-value
FEV_1 (L)	3.21 (2.04 - 3.74)	3.05 (2.05 - 3 .97)		2.26 (0.79 - 3.51)	2.22 (0.43 - 2.94)	0.001*
FVC (L)	3.43 (2.32 - 4.02)	3.28 (2.32 - 6.18)		2.6 (0.94 - 3.12)	2.63 (0.52 - 3.84)	0.001*
FEV_1/FVC (%)	93 (68 - 100)	92 (50 - 100)		86 (81 - 93)	84.5 (61 - 100)	0.001*
PEFR (L/min)	410 (163 - 500)	348 (192 - 507)		309 (115 - 360)	277 (153 - 325)	0.001*
	Surgeons (*n*=38), mean (SD)	**Matched group, mean (SD)**	***p*-value**	**Anaesthetists (*n*=28), mean (SD)**	**Matched group, mean (SD)**	***p*-value**
FEV_1 (L)	3.0 (0.51)	3.22 (0.37)	<0.001†	2.94 (0.49)	3.11 (0.32)	<0.001†
FVC (L)	3.26 (0.48)	3.48 (0.44)	<0.001†	3.29 (0.73)	3.37 (0.33)	0.018†
FEV_1/FVC (%)	92.02 (8.48)	91.34 (1.61)	0.559	89.36 (9.83)	91.82 (1.46)	0.388
PEFR (L/min)	388.42 (81.06)	488.87 (55.94)	<0.001†	368 (82.57)	454.89 (64.98)	<0.001†
	Nurses (*n*=14), mean (SD)	**Matched group, mean (SD)**	***p*-value**	**Assistants (*n*=12), mean (SD)**	**Matched group, mean (SD)**	***p*-value**
FEV_1 (L)	2.2 (0.6)	2.53 (0.12)	0.017†	2.03 (0.76)	2.91 (0.51)	0.002†
FVC (L)	2.45 (0.52)	2.84 (0.34)	0.001†	2.46 (0.91)	3.07 (0.44)	0.042†
FEV_1/FVC (%)	89.79 (3.83)	91.43 (3.03)	0.002†	82.52 (10.65)	89.92 (4.75)	0.024†
PEFR (L/min)	277.43 (81.9)	380.14 (57.04)	<0.001†	257.25 (67.02)	372.75 (98.26)	0.004†

FEV_1 = forced expiratory volume in 1 second; FVC = forced vital capacity; PEFR = peak expiratory flow rate; SD = standard deviation.
*Significant (p<0.05) according to the Kruskal-Wallis test.
†Significant (p<0.05) according to the Mann-Whitney *U*-test.

Table 4. Simple regression between pulmonary function test parameters and job title

Parameter	Coefficient	*p*-value	95% CI
FEV_1 (L)	−0.495	<0.001*	−0.247
FVC (L)	−0.445	<0.001*	−0.466 - −0.19
FEV_1/FVC (%)	−0.235	0.024*	−0.037
PEFR (L/min)	−0.441	<0.001*	−35.78

CI = confidence interval; FEV_1 = forced expiratory volume in 1 second; FVC = forced vital capacity; PEFR = peak expiratory flow rate.
*Significant (p<0.05).

settings have explicit theatre and infection control policies and we maintained a low threshold for exclusion criteria, it may not be possible to control for such biological hazards and identify the magnitude of all potential risks.

Although the duration of experience/exposure was a significant predictor of poor PFT results among participants, such exposures cannot be prevented; rather, they should be managed and reduced to the lowest practicable level. Healthcare facilities must establish, implement, monitor, advocate and oversee practices aimed at eliminating hazardous work environments.[29] This is the first study in Sudan to explore how the operating theatre environment affects

Table 5. Effects of duration of experience/exposure on participants' pulmonary function test values

Exposure duration (years) (participants, *n*)	FEV1 (L), median (range)	FVC (L), median (range)	FEV1/FVC (%), median (range)	PEFR (L/min), median (range)
1 - 5 (50)	3.2 (2.05 - 3.97)	3.43 (2.32 - 6.18)	93 (50 - 100)	379 (192 - 506)
6 - 10 (10)	3.06 (2.32 - 3.59)	3.35 (2.6 - 3.96)	91.5 (76 - 93)	337.5 (163 - 500)
11 - 15 (7)	2.36 (2.12 - 2.86)	2.61 (2.41 - 3.12)	90 (80 - 82)	285 (170 - 310)
>15 (25)	2.19 (0.43 - 3.3)	2.6 (0.52 - 3.58)	84 (61 - 100)	310 (115 - 410)
p-value	0.001*	0.001*	0.001*	0.001*
Exposure duration (years) (participants, *n*)†	**Parameter**	**Exposed (*n*=92), mean (SD)**	**Matched group (*n*=92), mean (SD)**	***p*-value**
1 - 5 (50)	FEV_1 (L)	3.04 (0.49)	3.19 (0.33)	<0.001‡
	FVC (L)	3.32 (0.65)	3.47 (0.38)	<0.001‡
	FEV_1/FVC (%)	91.56 (7.9)	91.93 (0.15)	0.574
	PEFR (L/min)	384.18 (74.66)	477.2 (57.47)	<0.001‡
6 - 10 (10)	FEV_1 (L)	3.0 (0.46)	3.18 (0.41)	0.36
	FVC (L)	3.29 (0.47)	3.47 (0.44)	0.005‡
	FEV_1/FVC (%)	91.18 (5.28)	91.64 (1.94)	0.311
	PEFR (L/min)	371.9 (109.77)	462.4 (78.51)	0.007‡
11 - 15 (7)	FEV_1 (L)	2.38 (0.24)	2.63 (0.37)	0.075
	FVC (L)	2.69 (0.24)	2.87 (3.8)	0.063
	FEV1/FVC (%)	88.4 (4.1)	91.63 (2.08)	0.072
	PEFR (L/min)	269.29 (49.15)	358.23 (48.11)	0.018‡
>15 (25)	FEV_1 (L)	2.12 (0.69)	2.8 (0.41)	<0.001‡
	FVC (L)	2.56 (0.76)	3.09 (0.41)	0.002‡
	FEV_1/FVC (%)	82.81 (10.47)	90.61 (3.78)	<0.001‡
	PEFR (L/min)	289.04 (93.17)	404.96 (90.74)	<0.001‡

FEV1 = forced expiratory volume in 1 second; FVC = forced vital capacity; PEFR = peak expiratory flow rate; SD = standard deviation.
*Significant (p<0.05) according to the Kruskal-Wallis test.
†Years of education and employment in the matched unexposed group were adjusted to match the years of experience/exposure in the exposed group.
‡Significant (p<0.05) according to the Mann-Whitney *U*-test.

Table 6. Correlations and regressions between duration of experience/exposure and pulmonary function test results

	Correlation		Regression			
Parameter	ρ coefficient	*p*-value	Coefficient	*p*-value	95% CI	Adjusted R2
FEV_1 (L)	−0.560	<0.001*	−0.248	<0.000†	−0.355 - −140	0.371
FVC (L)	−0.437	<0.001*	−0.235	0.001†	−0.027 - 0.005	0.211
FEV_1/FVC (%)	−0.498	<0.001*	−0.001	0.160	−0.027 - 0.005	0.226
PEFR (L/min)	−0.438	<0.001*	−29.768	0.001†	−46.685 - −12.851	0.204

CI = confidence interval; FEV_1 = forced expiratory volume in 1 second; FVC = forced vital capacity; PEFR = peak expiratory flow rate.
*Significant (p<0.05) according to Spearman's correlation.
†Significant (p<0.05). The regression models were also adjusted for age and body mass index; however, duration of experience/exposure was the only significant variable.

the PFT values of healthcare workers. Furthermore, the inclusion of a matched unexposed group helped to control for confounding factors and improved the conclusions reached through this study design. However, our study has several limitations. First, we did not measure anaesthetic gas concentrations. Second, because the study was conducted at only two hospitals, a larger study is needed. Third, the recall and response biases inherent in such surveys restrict causal inferences. Fourth, we followed restricted exclusion criteria, which could result in selection bias. Fifth, owing to the cross-sectional design, participants were not followed up. Sixth, while we made every effort to ensure good consistency across the exposed and matched cohorts, full control for ethnicity may not have been be feasible. Seventh, PFT manoeuvres for 44 participants were acceptable at grading levels B and C, but their results were useful based on the clinical judgement of the primary data collector, who had an overarching goal to achieve the maximum possible testing quality for all study participants.

Conclusion

Compared with the matched unexposed group, healthcare workers had significantly poorer FEV_1, FVC and PEFR values and FEV_1/FVC ratios. Quality practices to maintain workplace safety in operating theatres must be developed, implemented and sustained.

Data availability. The datasets generated and analysed during the present study are available from the corresponding author (MAM) on reasonable request. Any restrictions or additional information regarding data access can be discussed with the corresponding author.

Declaration. The research for this study was done in partial fulfilment of the requirements for JBI's MSc degree at The National Ribat University.

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