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Original Article

Assessment of Respiratory Problems in Workers Associated with Intensive Poultry Facilities in Pakistan

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ABSTRACT

Background: The poultry industry in Pakistan has flourished since the 1960s; however, there are scarce data regarding the impact of occupational exposure on the pulmonary health of farm workers in terms of years working in the industry. The objective of the present study was to assess the effect of poultry environment on the health of occupationally exposed poultry farmers in countries of warm climatic regions, such as Pakistan. This study will also show the effect of exposure to poultry facilities on the health of poultry farmers in the context of low-income countries with a relatively inadequate occupational exposure risk management.
Materials and methods: The lung function capacity of 79 poultry workers was measured using a spirometer. Along with spirometry, a structured questionnaire was also administrated to obtain information about age, height, weight, smokers/nonsmokers, years of working experience, and pulmonary health of farm workers. The workers who were directly involved in the care and handling of birds in these intensive facilities were considered and divided into four groups based on their years of working experience: Group I (3-10 months), Group II (1-5 years), Group III (6-10 years), and Group IV (more than 11 years). The forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and the FEV1/FVC ratio were considered to identify lung function abnormalities. Statistical analysis was carried out using independent sample t test, Chi-square test, Pearson's correlation, and linear regression.
Results: Based on the performed spirometry, 68 (86 %) of workers were found normal and healthy, whereas 11 (14 %) had a mild obstruction. Of the 11 workers with mild obstruction, the highest number with respect to the total was in Group IV (more than 11 years of working experience) followed by Group III and Group II. Most of the workers were found healthy, which seems to be because of the healthy survivor effect. For the independent sample t test, a significant difference was noticed between healthy and nonhealthy farmers, whereas Chi-square test showed a significant association with height, drugs, and working experience. Linear regression that was stratified by respiratory symptoms showed for workers with symptoms, regression models for all spirometric parameters (FVC, FEV1, and FEV1/FVC) have better predictive power or R square value than those of workers without symptoms.
Conclusion: These findings suggest that lung function capacity was directly related to years of working experience. With increasing number of working years, symptoms of various respiratory problems enhanced in the poultry workers. It should be noted that most of the poultry workers were healthy and young, the rationale being that there is a high turnover rate in this profession. The mobility in this job and our finding of 86% of the healthy workers in the present study also proposed healthy worker survivor effect.

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1. Introduction

Poultry farming is flourishing in Pakistan as an industry since the 1960s to meet the protein demands of a growing population. Based on an estimate, the percentage of broiler farms in Punjab, Pakistan is 80 %, whereas, layer and breeder farms are 18 % and 2 %, respectively. Moreover, it is an important source of employment with almost 1.5 million people linked with this sector [1]. Besides fulfilling meat demands, controlled environment poultry facilities are a major source of emissions such as organic and inorganic dust, odorous compounds and greenhouse gases [2–6].The major components of organic dust are bacteria, fungi, spores, pollens, endotoxins, mycotoxins, and various sorts of allergens [7–9]. The sources of these emissions in poultry buildings are animal droppings, feed, litter, dander (bird's skin), and feathers [10,11].

Organic dust from poultry facilities can cause various respiratory problems such as upper respiratory tract irritations, chronic bronchitis, organic dust toxic syndrome, allergic and nonallergic rhinitis, asthma, inflammation, extrinsic alveolitis, and respirational symptoms [7,11–19]. It is reported that occupational respiratory diseases, both chronic and acute, are common in agricultural workers, particularly in pig and poultry farmers [7,12,15,16,20–22]. Health problems particularly of an acute nature develop within a few hours and may last for few days after exposure to these animal confinements [23]. In accordance with a study, occurrence of organic dust toxic syndrome ranges from 10 to 30% in workers, although it depends on the type of animal production units and use of facilities [11]. Moreover, a number of studies reported the prevalence of both respiratory and nonrespiratory symptoms washigher among poultry farmers [8,20,24]. Borlee et al. [25] and Van Dijk et al. [26] described the exacerbation of the respiratory symptoms in patients with chronic obstructive pulmonary disease and patients with asthma living in the vicinity of livestock farms. Various epidemiological studies also showed a high occurrence of respiratory symptoms and antagonistic changes in pulmonary function parameters in poultry workers [20,27–30].

Owing to continuously increasing demand for meat from a growing population and the advancements in the poultry industry, interest in joining this sector is increasing in Pakistan. In view of the importance of the health and safety of poultry workers, there is a need to assess the effect of poultry environment on the health of workers. The objective of the present study was to evaluate the prevalence of respiratory problems among Pakistani poultry workers, determining the extent to which occupational exposure in a poultry facility will impact the respiratory health of workers. This study is also first of its kind from a warm climatic region such as Pakistan that will show the effect of exposure to poultry facilities on the health of poultry farmers in the context of low-income countries with a relatively inadequate occupational exposure risk management.

2. Materials and methods

Eighteen controlled environment broiler houses located on Raiwind and Kasur Road near Lahore, Pakistan were visited. The spirometry of 79 poultry workers was performed from Dec 2016 to July 2017. A detailed questionnaire was also designed to obtain general information about the worker's health, medical history, working conditions as shown in Table 9. Parameters of the questionnaire also included use of drugs and smokers/nonsmokers.

After filling questionnaires, the workers taken through a detailed demonstration about the use of a spirometer (MDX Instruments, USA) in accordance with the methods of the American College of Occupational and Environmental Medicine described by Townsend et al. [31] and (ATS/ERS 2005 guidelines) used by Viegas et al. [23]. A MDX USA spirometer model SP 10 Spirotron was used during the study. It was a light weight and portable equipment and has a maximum volume of 10L, flow range of 16L/s, volume accuracy of ±3% or 50ml, flow accuracy of ±5% or 200ml/s, built in lithium battery (DC 3.7V), and dimensions of 97mm (L) × 89 mm (W) × 36 mm (H) with 150g net weight. The workers were instructed on the performance of spirometry and a digital spirometer of model SP10 was used with disposable mouthpieces. Before test performance, the information of gender, age, weight (body mass in kg was collected with already calibrated Wahoo balance smart phone scale 7/10) and height (measured in foot at standing position and converted in cm) was entered for each worker, and the use of spirometer was demonstrated by one of the worker for their ease of understanding. The following parameters were obtained from recorded data: forced vital capacity (FVC), forced expiratory volume in one second (FEV1), peak expiratory flow and FEV1/FVC ratio, force expiratory flow 25 (FEF), force expiratory flow 75 (FEF) and force expiratory flow 25-75; (FEF) however, only FVC, FEV1 and FEV1/FVC was considered for the interpretation of results. The spirometry test was revised twice or thrice with any workers that was not using spirometer in the appropriate way.

Poultry workers were categorized into four groups based on working experience: Group I (3-10 months), Group II (1-5 years), Group III (6-10 years), Group IV (more than 11-years) experience.

2.1. Statistical analysis

Data was statistically analyzed by descriptive statistics, independent samples t test, Chi-square test and by fitting linear regression using SPSS (version 25) [32]. The independent t test was used to test significant differences between two unrelated groups (healthy and nonhealthy farmers), Chi-square test was used to find association of lung function parameters with different variables. Moreover, linear regression was applied to predict different lung functions parameters of poultry workers in Pakistan.

3. Results

Of the total 79 poultry workers, 10 % were smoker, whereas 90 % were nonsmokers and only 3 % of smokers were also taking chewing tobacco products. It was noticed that 86 % of workers were normal and healthy, whereas 14 % had mild obstruction and respiratory problem such as chest tightness, eye and nose irritation, cough, sore throat, dyspnea, wheezing, and phlegm problems that particularly enhanced in winter (Table 1). The workers were divided into four groups as per their years of working experience and the ratio between total number of workers and workers with respiratory symptoms were higher in Group IV (more than 11 Years) as compared with all other groups (Table 2). In all determined parameters only FVC, FEV1 and FEV1/FVC ratio or FEV1% also called Tiffeneau–Pinelli index, was focused and used for diagnosis

Table 1
Frequency of recorded parameters of poultry farm workers and values in parenthesis showing %

Recorded parameters	Frequency (%)
Total	79 (100)
Smoker	8 (10)
Nonsmoker	71 (90)
Drug + Smokers	2 (3)
Obstructive issues	11 (14)
Healthy farmers	68 (86)

Table 2
Healthy and obstructive poultry farm workers with different working experience and values in parenthesis showing their %

Different age groups	Total workers	Healthy poultry farm workers frequency (%)	Obstructive poultry farm workers frequency (%)
3-10 Months	5	5 (100)	0 (0)
1-5 Years	48	44 (91.7)	4 (8.3)
6-10 Years	16	12 (75)	4 (25)
More than 11 Years	10	7 (70)	3 (30)

Table 5
Association of health conditions with different variables

Variables	Chi-square test (p-value)
Working experience	33.180 (0.032)
Age	24.135 (0.568)
Weight	30.409 (0.496)
Smoker/nonsmoker	0.067 (0.796)
Height	29.054 (0.034)
Drug	4.575 (0.032)

of obstructive and restrictive lung diseases. The FVC and FEV1% value greater than 80 is considered normal (healthy) and values were not analyzed for FVC/FEV1 ratio. However FVC greater than 80% but FEV1 less than 80 % and FVC/FEV1 ratio less than 70 % considered obstructive (nonhealthy). In this study, 86 % were found healthy and 14 % workers had shown lower FEV1 % and FVC/FEV1 ratio and considered as case of mild obstruction (Table 3).

Spirometry results were statistically analyzed for independent sample t test and absolute values provided in liters were compared between healthy and nonhealthy farmers for different lung function parameters (Table 4). The results of independent sample t test showed different parameters such as FEV1, FEV1 % predicted, peak expiratory flow and FEV1/FVC ratio have statistically significant difference at a 0.05 significance level; however, FVC and FVC % predicted have no significant difference at the 0.05 significance level (Table 4).

During performance of spirometry, the age, weight, height, drug taking, smoking and nonsmoking habits, working experience, and health history was recorded. A Chi-square test was carried out to see association between different variables of healthy and nonhealthy farmers. In accordance with the Chi-square findings, p-value greater than >0.05 showed no association (Table 5). It was observed age, weight, smoker and nonsmoker were not significantly related to health conditions. However, significant association was found for height, drugs, and working experience at the (0.05) significance level.

Table 3
Normal and obstructive values of FVC and FEV1 of poultry farm workers

Parameters	Normal Mean ± SD	Obstructive Mean ± SD
FVC (L)	4.0 ± 0.035	3.82 ± 0.26
FVC % Predicted	89.3 ± 1.44	86.5 ± 5.73
FEV1 (L)	3.46 ± 0.036	2.58 ± 0.17
FEV1 % Predicted	89.7 ± 0.11	74.1 ± 4.25
FEV1/FVC %	-	67.4 ± 0.016

FVC, forced vital capacity; FEV1, forced expiratory volume in one second.

Table 4
Independent sample T test (p-value) against different lung function parameters

Parameters	Independent sample T test (p-value)	95% confidence interval of the difference	
		Lower	Upper
FVC (L)	-1.379 (0.195)	-0.28222	0.00073
FEV1 (L)	3.121 (0.011)	0.272074	0.510707
FVC % predicted	-0.051 (0.961)	-6.383690	6.004011
FEV1 % predicted	2.821 (0.014)	2.170892	14.601835
PEF (L/s)	-4.076 (0.001)	-1.308673	-0.343840
FEV1/FVC ratio	5.565 (0.000)	0.100631	0.147749

FVC, forced vital capacity; FEV1, forced expiratory volume in one second; PEF, peak expiratory flow.

The correlation of lung function parameters with different measured variables such as age, weight, height, experience, smoker/nonsmoker, and respiratory symptoms were determined. It was noticed that significant positive correlation was present between FVC and height. Furthermore, a significantly negative correlation was present with symptoms. However FEV1 was significant but negatively correlated with height, experience, and symptoms (Table 6).

A linear regression analysis was carried out and two sets of regression equations were obtained for all lung function parameters (FVC, FEV1, and FEV1/FVC) with predictor variables of age, weight, height, experience, smoker and nonsmokers, and respiratory symptoms. The estimated regression models for all spirometric parameters were stratified by respiratory symptoms. Prediction power of models was analyzed by R square value. It was noticed that in the first set of regression model to predict FVC was found significant (Table 7). It was seen the regression was significant in all lung function parameters, whereas symptoms were included in the model and has more predictive power than without symptoms (Table 8).

Mostly workers complained for cough, cough with expectoration (sputum), sore throat, dyspnea, phlegm, wheezing, nose watering, eye irritation, and skin allergies that exacerbate in winter however, no history of hemoptysis and any systemic complaints such as fever, headache, and myalgia (muscle pain) on exposure to these controlled environment broiler facilities was noticed (Table 9). It was noticed most of the poultry workers were young in these facilities, which might be due to high turnover rate. The data was organized age wise and frequency along with percentage was determined (Table 10). It was also noticed that there was no training or use of masks and any other personal protective equipment (PPE) in the sheds for the workers.

4. Discussion

The study aimed to evaluate the respiratory symptoms and lung function parameters among workers in broiler facilities. The seventy-nine workers were divided into four groups based on their job experience, and it was seen almost 86 % workers were with good health and 14 % showed mild obstruction, and the study was in agreement with De Alencar et al. [33] where, 72.98 % occupationally exposed broiler house workers were found normal and healthy; however, 24.32 % had light restriction and 2.70 % had severe obstruction. However, Taluja et al. [24] reported the prevalence of respiratory symptoms in poultry farm workers were 43.93 % which was higher than the present study. The study is also in line with various other studies that suggest a direct relation exist for reduction of pulmonary functions and number of working years [13,23]. The respiratory problems in poultry workers are associated with occupational exposure to hazards such as organic dust, and certain allergic factors enhanced the percentage of mild obstruction in intensive agriculture farm workers and chiefly responsible for

Table 6
Correlation coefficient between lung parameters and various factors

Lung parameter	Age (year)	Weight (Kg)	Height (cm)	Experience (year)	Smoker/nonsmoker	Symptoms
FVC	.009	.021	.402*	-.003	.135	.173
FEV1	-.05	.026	.173	-.136	.127	-.291*
FEV1/FVC	-.048	-.036	-.297*	-.226*	.016	-.495*

†Correlation is significant at the 0.05 level (2-tailed).
FVC, forced vital capacity; FEV1, forced expiratory volume in one second.
* Correlation is significant at the 0.01 level (2-tailed).

Table 7
Predicted equations for lung function parameters of poultry farm workers without symptoms

Model	Un-standardized coefficients		Standardized coefficients			Model summary		SE	ANOVA*	
	B	Std. Error	Beta	T	Sig	R	R square		F	Sig.
FVC										
(Constant)	1.862	.543		3.428	.001	.438*	.192	.21	3.474	.007†
Age	.001	.004	.053	.335	.738					
Weight	-.002	.002	-.113	-.926	.357					
Height	.013	.003	.451	3.904	.000					
Experience	-.006	.006	-.152	-.976	.332					
Smoker/nonsmoker	.065	.076	.094	.860	.393					
FEV1										
(Constant)	2.544	.598		4.253	.000	.262*	.069	.23	1.075	.381†
Age	.002	.004	.066	.393	.695					
Weight	-6.96	.002	-.004	-.028	.977					
Height	.004	.004	.146	1.174	.244					
Experience	-.010	.006	-.259	-1.55	.127					
Smoker/nonsmoker	.082	.083	.114	.978	.331					
FEV1/FVC										
(Constant)	1.060	.148		7.144	.000	.245*	.060	.056	.929	.468†
Age	.000	.001	.037	.216	.830					
Weight	.000	.001	.080	.606	.546					
Height	-.002	.001	-.208	-1.67	.100					
Experience	-.001	.002	-.153	-.905	.368					
Smoker/nonsmoker	.009	.021	.052	.446	.657					

FVC, forced vital capacity; FEV1, forced expiratory volume in one second; ANOVA, analysis of variance.
* Dependent Variable: FVC; FEV1; FEV1/FVC.
† Predictors: (Constant), smoker/nonsmoker, experience, height, weight, age.

Table 8
Predicted equations for lung function parameters of poultry farm workers with symptoms

Model	Un-standardized coefficients		Standardized coefficients			Model summary		SE	ANOVA*	
	B	Std. error	Beta	T	Sig	R	R square		F	Sig.
FVC										
(Constant)	1.867	.535		3.489	.001	.476*	.227	.20	3.518	.004†
Age	.001	.004	.066	.426	.671					
Weight	-.002	.002	-.111	-.923	.359					
Height	.012	.003	.422	3.674	.000					
Experience	-.008	.006	-.216	-1.365	.177					
Smoker/nonsmoker	.063	.075	.090	.838	.405					
Symptoms	.126	.070	.197	1.792	.077					
FEV1										
(Constant)	2.527	.472		5.354	.000	.654*	.428	.18	8.978	.000†
Age	.001	.003	.023	.173	.863					
Weight	.000	.002	-.010	-.099	.921					
Height	.007	.003	.238	2.411	.018					
Experience	-.002	.005	-.056	-.409	.684					
Smoker/nonsmoker	.090	.066	.126	1.371	.175					
Symptoms	-.417	.062	-.637	-6.726	.000					
FEV1/FVC										
(Constant)	1.055	.097		10.930	.000	.780*	.608	.037	18.585	.000†
Age	-9.66	.001	-.017	-.152	.879					
Weight	.000	.000	.071	.837	.405					
Height	-.001	.001	-.093	-1.141	.257					
Experience	.001	.001	.099	.879	.382					
Smoker/nonsmoker	.012	.013	.067	.882	.381					
Symptoms	-.127	.013	-.786	-10.027	.000					

FVC, forced vital capacity; FEV1, forced expiratory volume in one second; ANOVA, analysis of variance.
* Dependent Variable: FVC; FEV1; FEV1/FVC.
† Predictors: (Constant), symptoms, smoker/nonsmoker, experience, height, weight, age.

Table 9
History of recorded symptoms and percentage of their occurrence

Symptoms	Frequency (%)
Cough with expectoration (sputum)	4 (5.1)
Cough without any expectoration (sputum)	18 (22.8)
Nose watering	35 (44.30)
Eye irritation	12 (15.2)
Phlegm (mucous secretions)	4 (5.1)
Sore throat	30 (38)
Skin allergies enhanced in winter	24 (30.4)
History of dyspnea on exertion (difficulty in breathing)	4 (5.1)
Wheezing	3 (3.80)
History of chest tightness	3 (3.80)
History of hemoptysis and amount	NA (0)
History of any post nasal drip	4 (5.1)
Any exacerbation on exposure to poultry sheds	39 (49.4)
Any systemic complaints such as fever, headache and myalgia (muscle pain)	NA (0)
Use of any personal protective equipment such as face mask	NA
Medical history of workers	NA
Job turnover rate	High

Table 10
Frequency of age of workers in years and values in parenthesis showed their %

Age in years	Frequency of poultry workers (%)
15-25 years	48 (61 %)
26-35 years	18 (23 %)
36-45 years	10 (13 %)
46-55 years	1 (1 %)
56-65 years	2 (3 %)

exacerbating respiratory symptoms with the passage of time [13,27,34,36,36,37].

De-Alencar et al. [33] findings of a weak association present between lung function capacity and respiratory symptoms is in agreement with the present study as spirometry results were found normal for most workers; however, they were experiencing various respiratory symptoms on exposure to these facilities. It was also noticed that most of the workers reported the appearance of certain specific symptoms on exposure to these facilities such as cough, eye watering, nose irritation, and sore throat as mentioned in (Table 9), and this is in agreement with Kearney et al. [38] who reported the percentage of eye irritation (55 %), nose irritation (50 %), and dry cough problems (50 %) in workers. De-Alencar et al. [33] also reported nasal, eye, and throat complaints were found common in poultry workers. Moreover, Kirkhorn et al. [39] reported the presence of mucous membrane irritation and Rylander and Carvalheiro [28], reported various other respiratory problems such as chronic bronchitis, airways inflammation, chest infections, and toxic pneumonitis prevailed in poultry workers on exposure to organic dust as compared with a control group. However, Kirychuk et al. [37] reported a higher percentage of chronic phlegm in floor houses compared with caged house workers owing to a higher level of dust in floor house. De-Alencar et al. [33] also found asthma-like and mucous membrane syndrome. Rees et al. [40] reported work-related cough and wheezing problems 32 % and 23 %, respectively along with asthma, chest, eye, nose, skin, and throat irritations.

The study was also analogous to different work-related problems such as asthma, nose, eye watering, skin allergies, and an insignificant decrease in lung function capacity which was high in poultry workers compared with control according to Rimac et al. [22]. Wheezing problems, a trait that partially leads to occupational asthma in response to exposure to contaminated to poultry farms, was found almost in one-third of poultry workers according to Borghetti et al. [41]. A number of literature studies support that harmful pollutant in the surrounding environment affects the health of people generally and lungs particularly [29,35,42–48].

In the context of the present study, the FVC/FEV1 ratio was found <70 % with lower FEV1 and normal FVC, which suggests mild obstruction in poultry workers and similarly a significantly lower values of FVC/FEV1 with obstruction and restrictions was reported in workers of other animal caring units i.e., (swine and broiler houses) [33,37].

The present study also informed that age, exposure time, and smoking had no effect on FVC, FEV1 and FVC/FEV1, and similar confirmation was given by Stoleski et al. [49]. However, a study by Abdullah and Hashim [50], reported that smoking significantly enhanced the frequency of symptoms and impaired lung functions.

Linear regression model was used to predict FVC, FEV1, and FEV1/FVC using predictors (age, height, weight, experience, smoker/nonsmoker, and symptoms). It was noticed R^2 values were improved with the addition of symptoms as compared with values without symptoms (Tables 7 and 8). The derivation of prediction equation was found in literature for different population groups; however, it was noticed that the use of derived equation for one population might be inappropriate for other population even after applying correction factors [51]. Various other studies also informed that applying different equations on the same population results in conflict in the diagnosis [52,53]. The predictive equations also showed great variations owing to considered parameters such as height, age, weight, smoking status, and symptoms, which were used to predict an equation by Nku et al. [54] and socioeconomic status was also considered for the prediction of the equation along age, height, weight, and smoking by Rabbani and Nafees [55].

In the present study, it was observed by the Chi-square test that different variables such as working experience, height, and drugs were associated with health conditions, but no association was found with age, weight, smoker, and nonsmoker with their health conditions. However, a study conducted with poultry workers for prevalence of tuberculosis and avian influenza using a Chi-square test showed a significant association between occupational health problems and marital status, educational level, and employment status [34].

Most of the workers in the present study were young, and Ajetomobi et al. [56] also mentioned in his study that most of the poultry workers were young. The rationales behind young workers are high turnover rate in this profession. The causes for higher turnover rate were discussed with supervisors and explanation were similar in all controlled environment broiler facilities as low income, more working hours, and some of them when they felt any sort of health irritation they discontinued the job. This mobility in the job and our finding of 86 % of the workers in the present study as healthy may suggest healthy worker survivor effect [57]. There was no availability of preliminary medical data regarding health issues of workers and employees who had left. The use of PPE was not found in poultry workers even though they complained about high levels of dust and irritation on exposure and findings were in agreement with de-Alencar et al. [33] and Viegas et al. [23]. However, the use of PPE was recommended owing to high dust exposure to poultry farmers by Rousset et al. [46]. A study by Kearney et al. [38] regarding PPE showed 76 % workers reported that the use of PPE is important and only 48 % workers reported no or rare use of PPE while working in dusty environment.

5. Conclusion

It was seen that respiratory health issues were found in poultry farm workers; however, most of the workers in this study were healthy (86 %) and only 14% showed mild obstruction. The obstructive problems increased with the number of working years. Furthermore, respiratory problems such as chest infection, cough, sore throat, skin allergies, chest tightness, phlegm, eye and nose irritation were reported that exacerbate in winter season. However, the job turnover rate was high owing to low income, long working hours, and health issues. It was observed that those people who felt health issues from their work left the job. Most of the persons related to this occupation were found to be young, and the use of PPE was not in practice. There is a need to not only enforce existing occupational health and safety laws by the country Labour Department but also for the provision of information and training to both owners and workers on the potential risks of exposure to organic dust and appropriate administrative, environmental, as well as PPE to reduce the risk of exposure to workers in these facilities. Further studies with larger sample size of poultry workers and control group are needed to improve certainty in degree and frequency of exposure and resultant health consequences.

Conflict of interest

All authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2019.12.011.

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