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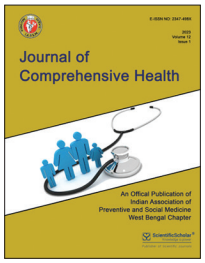

Original Article

Respiratory Abnormalities Among Elderly Women in Urban Slums: A Comprehensive Analysis of Contributing Factors

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ABSTRACT

Background: India experiences a growing aging population and prioritizing the comprehension of respiratory health concerns among the elderly becomes crucial. Those in the elderly demographic residing in urban slums confront notable socioeconomic obstacles and encounter restricted healthcare accessibility, heightening their vulnerability to respiratory illnesses. Therefore, examining respiratory health in this specific urban context provides insights into how living conditions impact the health of vulnerable populations.

Objectives: The present study aims to evaluate the occurrence of respiratory abnormalities among slum-dwelling elderly women and also to determine the concomitant factors responsible for respiratory abnormalities among them.

Material and Methods: The study includes a total of 261 elderly women aged 60 years and above living in slum areas of Kolkata. The standard protocols were followed to collect spirometry and anthropometric data. Descriptive and inferential statistical analyses were performed to satisfy the study objectives.

Results: The majority of the participants show forced vital capacity (FVC) and forced expiratory volume in one second (FEV0.1) below the predicted level, indicating the presence of mild-to-moderate respiratory abnormality. Chronic obstructive respiratory disease (COPD) was observed in 15.2% of elderly women, significantly higher than the national average. The study identified significant correlations between age and respiratory abnormalities. Factors such as overcrowded living conditions, the absence of a separate kitchen, and the use of certain cooking fuels increased the likelihood of COPD. Body fat percentage was found to be inversely related to FVC, $FEV_{0.1}$, and COPD.

Conclusion: The poor living conditions and a few other associated factors are indicative of developing respiratory problems among elderly individuals. As the global population ages, this study contributes valuable insights for public health strategies, emphasizing the need for tailored approaches to address the specific challenges faced by elderly women in urban slums in the megacity of Kolkata.

Keywords: Aging, Spirometry, Obstructive respiratory disease, Urban slum, Kolkata

INTRODUCTION

The rapid aging of the global population stands as a paramount concern in the 21st century, propelled by unprecedented technological and medical advancements coupled with improvements in the standard of living.[1] The proportion of the elderly population of India stood at 8.6% in 2016 and is expected to rise to 15.8% in 2050.[2] This impending expansion of the elderly population is indicative of a parallel rise in average life expectancy, with projections estimating an

increase from 69.3 years in 2016 to 69.8 years for males and 72.3 years for females by 2025.[3] However, this demographic transition is not without its challenges. A substantial portion of the growing elderly population grapples with chronic morbidities, both physical and psychological, leading to a compromised quality of life marked by disabilities. Therefore, increasing interest among the researchers will be needed in this domain to encourage active and healthy aging.

Aging, inherently characterized by degenerative changes in various organ systems, imposes additional challenges on the respiratory system, leading to impaired breathing.[4] Despite the high prevalence of respiratory impairments among the elderly, a concerning number of cases remain undiagnosed and untreated, underscoring the clinical and epidemiological significance of addressing respiratory health issues. Existing studies have reported intricate relationships between lung function traits and demographic, morphological, and other factors such as age, sex, height (HT), weight (WT), and ethnic group.[5,6] Some studies indicate an accelerated decline in lung function after the age of 70.[7] Furthermore, research highlights variations in the decline rates, with slower rates observed among elderly African-American women for measures such as forced vital capacity (FVC) and forced expiratory volume in one second ($FEV_{0.1}$).[8] The association between reduced spirometry levels and various respiratory diseases, including chronic bronchitis, pneumonia, emphysema, asthma, and chronic obstructive respiratory disease (COPD), is well-established in the literature. In addition, poor nutritional status, reduced physical exercise, and the presence of chronic diseases, such as osteoporosis, cardiovascular disease, diabetes, and depression, have been identified as factors increasing mortality chances associated with COPD.[9] An often-overlooked risk factor is the use of domestic wood stoves, as proposed by Hu *et al*. (2010).[10]

Some literature available in the Indian context regarding respiratory function traits present region and population-specific reference equations to evaluate predictive values of FVC, $FEV_{0.1}$, and $FEV_{0.1}$/FVC.[11,12] In a Dehradun-based study on lung function traits, Saxena and his colleagues suggest that abdominal obesity is an important predictor of lung function.[13] Dhar *et al*. (2017), in their study, show that FVC, forced expiratory volumes ($FEV_{0.05}$, $FEV_{0.1}$, and $FEV_{0.3}$), peak expiratory flow rate, and maximum voluntary ventilation decreased significantly with increasing age in elderly people.[14]

Against the backdrop of these multifaceted considerations, this study endeavors to evaluate the occurrence of respiratory abnormalities among elderly women residing in urban slums. Moreover, the research aims to discern the concomitant factors responsible for respiratory abnormalities in this vulnerable group.

MATERIAL AND METHODS

Study design

The study was part of a larger bio-medical project conducted by the Indian Statistical Institute (ISI) during the year 2016–2019. It is a cross-sectional study. Data have been collected from 20 clusters of slums under Kolkata Municipal Corporation (KMC) Wards (KMC Wards 8 and 15). The study was restricted to Hindu elderly women only to maintain gender and ethnic homogeneity with respect to the variables under study.

The research included women aged 60 years and above residing in the slum areas of Kolkata, West Bengal. A total of 261 elderly women voluntarily participated in the study after giving informed consent on understanding the study objectives. All participants were non-smokers, free from any respiratory infections, and had no recorded history of physical or mental disorders. Due to challenges in recruitment, a purposive sampling method was employed for participant selection. Before the study, formal ethical approval was obtained from the Institutional Review Board of ISI.

Data collection

Data was collected in two parts. Initially, the participants were interviewed through a door-to-door survey. Data on sociodemographic and household characteristics were collected using pre-tested questionnaires. Sociodemographic characteristics included the age of the participants at the time of the interview (which was further categorized under three elderly age brackets: 60–69 years as young old, 70–79 years as old-old, and ≥80 years as oldest-old), marital status, educational status, employment in gainful works, and monthly household expenditure (which were further converted to per-capita expenditure and were categorized following quartile division). Person-per-room (PPR) is the most effective measure of overcrowding in a dwelling unit. It is well documented that overcrowding is a dominant feature of slum areas that may affect the health condition of people adversely. According to the U.S. Department of Housing and Urban Development (2007), a household is considered overcrowded when the value of PPR exceeds 1.5.[15] However, in the present study, we defined overcrowding when the PPR exceeds 2.5 (based on the estimated median value). The type of cooking aids used by the participants and the presence of separate kitchens within the households were also documented.

Further, objective measures were done following the standard protocols. These are as follows:

a. Respiratory/lung function parameters include FVC, $FEV_{0.1}$, and Tiffeneau-Pinelli index (ratio of $FEV_{0.1}$/FVC). FVC is the maximal volume of gas exhaled from

the lung during a forced expiration after full inspiration. $FEV_{0.1}$ is the volume of gas exhaled in the first second of FVC maneuver. The instrument used in this study was a digital battery-operated spirometer (Micro Plus spirometer, Micro Direct Inc., USA). At first, the procedure of the spirometry test was demonstrated to each participant. Then, they were instructed to take a full breath in, close the lips around the mouthpiece, and blow out as hard and fast as possible while remaining in a standing position and nostrils closed. Inspiration should be full and unhurried, and expiration, once begun, should be continued without any pause. Three correct and full attempts were recorded for analysis.

Further, predicted values were estimated using eastern Indian population-specific reference equations.[11]

The reference equations are as follows:

Predicted FVC = 0.0972+ (–0.0186* age) + (0.0216* HT)

Predicted $FEV_{0.1}$ = 0.0381+ (–0.0197* age) + (0.0196* HT)

Predicted $FEV_{0.1}$/FVC = 0.9205 + (–0.00214* age) + (0.00001* HT)

The lung function parameters and their respective categories were classified as,

Parameters	Categories
FVC (lit.), $FEV_{0.1}$ (lit.)	≥80% of predicted=Normal 70–79% of predicted=Mild 60–69% of predicted=Moderate <60% of predicted=Severe
Tiffeneau-Pinelli index ($FEV_{0.1}$/FVC)	≥70% of predicted=Normal 60–69% of predicted=Mild 50–59% of predicted=Moderate
COPD (GOLD criteria, 2020)[16]	$FEV_{0.1}$/FVC <0.70 and $FEV_{0.1}$ ≥80% of predicted=Mild 50% ≤$FEV_{0.1}$ <80% of predicted=Moderate 30% ≤$FEV_{0.1}$ <50% of predicted=Severe $FEV_{0.1}$ <30% of predicted=Very severe

COPD: Chronic obstructive respiratory disease, FVC: Forced vital capacity, FEV: Forced expiratory volume, $FEV_{0.1}$: Forced expiratory volume in 1 second

b. Anthropometric measures such as standing HT, WT, waist circumference (WC), and hip circumference (HC) were taken from each participant following standard protocol.[17] Height (to the nearest of 0.1 cm) was measured using a portable GPM anthropometer for each participant standing without shoes on a horizontal surface with the body stretched upward to the fullest extension and the head in the Frankfurt plane. WC and HC were measured to the nearest 0.1 cm with a non-stretchable fiberglass insertion tape. WC was measured at the minimum circumference of the torso between the iliac crest and the rib cage. HC was measured horizontally at the level of maximum extension of the buttocks over tight clothing. Waist-hip ratio (WHR) was calculated using the standard formula:
WHR = WC (cm)/HC (cm).

Another body composition measure – percent body fat (PBF) was measured using bioelectrical impedance (Omron Body Composition Monitor, HBF-362). The participants were on light apparel and without shoes at the time of taking all these measurements.

c. The hemoglobin level was assessed by pricking the tip of the fourth digit on the left hand, using a HemoCue (Hb 301) device.

Statistical analysis

Descriptive statistical analysis (such as frequency and percentage) was performed to find out the distribution of sociodemographic and household characteristics of the study participants. One-way analysis of variance (ANOVA) has been performed, following the test of normality, to find out the differences between and among age groups in terms of all lung function traits. The significant results of ANOVA were further analyzed with Scheffe's test (post -hoc test) to find out the exact significant differences between age groups. Age-specific prevalence rates of all lung function abnormalities were exhibited through a line graph. Logistic regression analysis was performed to find out the relationship between lung function parameters and its concomitant factors. A probability value of 0.05 or less was considered significant. Data analysis was performed on a Statistical Package Predictive Analytics Software version 18.0.[18]

RESULTS

Sociodemographic and household characteristics are described in Table 1. It was found that the majority of the study participants (60.2%) were aged 60-–69 years, and the frequency declined with increasing the age brackets. Among the total population studied, only 22.6% were living in wedlock, while 73.9% were either widows, divorced, or separated. Educational attainment of the group shows that 54.4% of the participants did not have any formal education; 15.0% and 30.7% have obtained education up to primary and secondary level, respectively. Most of the participants (72.4%) were unemployed, and only 27.6% had gainful employment. Per-capita monthly household expenditure of this group ranged between INR 1,251–1,666.66 among 26.1% of the participants. About 50.6% of the study participants were reported to have a person-per-room (PPR) ratio of 2.5 and below, whereas 49.4% of the participants did have a person-per-room (PPR) ratio of more than 2.5. The majority

Table 1: Sociodemographic and household characteristics of the study participants.

Sociodemographic profile (*n*=261)	***n* (%)**
Age groups	
Young old (60–69 years)	157 (60.2)
Old-old (70–79 years)	73 (28.0)
Oldest-old (≥80 years)	31 (11.9)
Marital status	
Married	59 (22.6)
Unmarried	9 (3.4)
W/D/S	193 (73.9)
Educational attainment	
Non-literate	142 (54.4)
Primary	39 (15.0)
Secondary	80 (30.7)
Working status	
Working (gainfully employed)	72 (27.6)
Non-working	189 (72.4)
Monthly per-capita household expenditure (in INR)	
≤1,250	67 (25.7)
1,251–1,666	68 (26.1)
1,667–2,366	61 (23.4)
≥2,367	65 (24.9)
Household characteristics (*n*=261)	
PPR	
≤2.5	132 (50.6)
>2.5	129 (49.4)
Separate kitchen	
No	231 (88.5)
Yes	30 (11.5)
Cooking aid	
Kerosene stove/challah	67 (31.8)
Liquefied petroleum gas	82 (38.9)
Both	60 (28.4)
None	2 (0.9)

W/D/S: Widowed/Divorced/Single, PPR: Person-per-room

of the households (88.5%) did not have any separate kitchen; thus, they had to cook in the small, poorly ventilated living room. In these households, the most used cooking aids were liquefied petroleum gas (LPG) (38.9%) and Kerosene stove/chullah (31.8%).

Among the 261 eligible elderly women for the spirometry test, 211 attended the assessment. The majority of the participants reported abnormalities in FVC and $FEV_{0.1}$. [Table 2]. Among the study participants, 43.1% and 22.3% did have a mild abnormality in FVC and $FEV_{0.1}$, respectively. The presence of a moderate level of chronic respiratory obstruction was reported among 8.1% of the participants. The prevalence rate of COPD was 0.152 as observed from this study.

The mean values of FVC, $FEV_{0.1}$, and $FEV_{0.1}$/FVC were the highest among the young-old age group. While FVC and $FEV_{0.1}$ were lowest among the oldest-old age group, $FEV_{0.1}$/FVC was the lowest among the old-old age group. [Table 3]. Statistically significant differences were observed among the age groups in terms of all lung function measures.

The FVC for participants of the oldest-old age group was reduced significantly compared to the young-old age group. [Table 4]. Significant differences exist in terms of $FEV_{0.1}$ between young-old versus old-old and young-old versus oldest-old age groups. $FEV_{0.1}$/FVC values significantly reduced among old-old participants compared to young-old participants.

Age-specific prevalence rates of lung function parameters were observed in Figure 1. A gradual increase in the prevalence of lung function abnormalities (in terms of FVC and $FEV_{0.1}$/FVC) was observed with increasing age cohorts. The prevalence of COPD was also increasing gradually over the age group and was the highest among the oldest-old elderly women.

Binary logistic regression, where FVC and $FEV_{0.1}$ were considered as dependent variables, and exploratory variables include PPR, PBF, pulse rate, and body weight. [Table 5]. Elderly women living in overcrowded households (i.e., PPR>2.5), and as well have increased PBF and pulse rates that were more prone to developing respiratory dysfunctions. Increasing body weight also increases the chance of having abnormalities related to $FEV_{0.1}$.

The relationship between household characteristics and physiological parameters with COPD is presented in Table 6. The result of logistic regression shows that the individuals living in overcrowded households were more prone to developing COPD; while the chance of developing COPD decreased among those who have separate kitchens in their households. Elderly women who use kerosene stoves, LPG, or both were approximately two to three times more prone to having COPD than those who do not use any cooking fuel. Increasing PBF increases the risk of developing COPD as well.

DISCUSSION

Aging inevitably impacts respiratory function, leading to a compromised breathing mechanism and reduced dynamic flow rates in spirometry tests. The present study aims to identify respiratory abnormalities and their associated factors among elderly women in resource-poor conditions, especially in slum settlements.

The demographic profile of the participants reveals a higher representation from the young-old age group, with a significant majority being widows, which exceeds the average frequency reported in several states (viz., Himachal Pradesh, Kerala, Maharashtra, Odisha, Punjab, Tamil Nadu, and West Bengal) of India with a higher proportion of the aged population.[19] The literacy rate indicates that many of them (54.4%) do not have any formal education. Elderly

Table 2: The profile of lung function parameters of study participants.

Variables (*n*=211)	FVC *n* (%)	$FEV_{0.1}$ *n* (%)	$FEV_{0.1}$/FVC *n* (%)	COPD *n* (%)	Prevalence rate of COPD
Normal	49 (23.2)	57 (27.0)	205 (97.2)	179 (84.8)	
Mild	91 (43.1)	47 (22.3)	-	6 (2.8)	
Moderate	56 (26.5)	41 (19.4)	5 (2.4)	17 (8.1)	0.152
Moderately severe	**na**	32 (15.2)	**na**	**na**	
Severe	15 (7.1)	23 (10.9)	1 (0.5)	6 (2.8)	
Very severe	**na**	11 (5.2)	-	3 (1.4)	

COPD: Chronic obstructive respiratory disease, FVC: Forced vital capacity, $FEV_{0.1}$: Forced expiratory volume in 1 second, na: Not applicable

Table 3: Lung function measures by elderly age groups.

Age cohorts (in years)	60–69 years (*n*=136)	70–79 years (*n*=58)	80+years (*n*=17)	ANOVA	
				F	*P*-value
FVC (lit.)	1.38±0.38	1.25±0.50	1.01±0.30	7.424	$0._{001}$
$FEV_{0.1}$ (lit.)	1.14±0.31	0.95±0.34	0.79±0.22	14.942	0.000
$FEV_{0.1}$/FVC	0.83±0.09	$0.78\pm_{0.1}2$	$0.80\pm_{0.1}3$	4.860	0.009

FVC: Forced vital capacity, $FEV_{0.1}$: Forced expiratory volume in 1 second, ANOVA: Analysis of variance

Table 4: Scheffe's test (*post hoc*) between and among age groups in terms of lung function parameters.

Age groups*	1 vs. 2	1 vs. 3	2 vs. 3
FVC (lit.)	0.118	0.002	0.102
$FEV_{0.1}$ (lit.)	0.000	0.000	0.191
$FEV_{0.1}$/FVC	0.010	0.558	0.762

FVC: Forced vital capacity, $FEV_{0.1}$: Forced expiratory volume in 1 second. *Age group 1 represents young-old (60–69 years), 2 represents old-old (70–79 years), and 3 represents oldest-old (80+years) participants

Table 5: Factors associated with lung function parameters among elderly women.

Dependent variable	Independent variables	Exp(β)	*P*-value
FVC	Constant	0.519	0.676
	Person-per-room		
	≤2.5	Reference category	
	>2.5	1.219	0.554
	Percent body fat (%)	1.027	0.462
	Pulse rate (per minute)	1.017	0.236
	Body weight (in kg)	0.519	0.676
$FEV_{0.1}$	Constant	0.513	0.651
	Person-per-room		
	≤2.5		
	>2.5	1.289	0.419
	Percent body fat (%)	1.016	0.627
	Pulse rate (per minute)	1.007	0.601
	Body weight (in kg)	1.006	0.733

FVC: Forced vital capacity, FEV0.1: Forced expiratory volume in 1 seconds

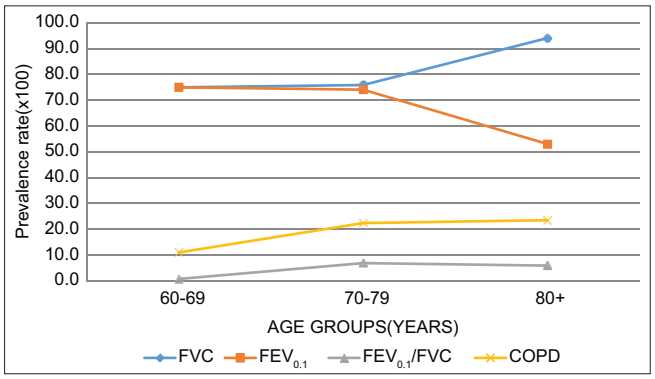

Figure 1: Age-specific prevalence rate of lung function parameters. FVC: Forced vital capacity, $FEV_{0.1}$: Forced expiratory volume in 1 second, CODP: Chronic obstructive pulmonary disease.

women who live in slum areas or resource-poor conditions have to work beyond their age of retirement to sustain their livelihood and for monetary support. It is also observed that 27.6% of participants still are engaged in gainful employment, and few of them receive additional earnings from governmental allowances, highlighting the economic challenges faced by elderly women in resource-poor conditions that corroborate with the study among Mukim Sepang elderly rural people by Sidik *et al.* (2004).[20] Living conditions in urban slum areas, characterized by substandard housing and overcrowding, emerge as significant concerns.[21] The prevalence of overcrowded households, as measured by the PPR ratio, exceeds global standards in the present sample, as well as they lack proper cooking facilities and sufficient ventilation systems that potentially contribute to respiratory health adversities. Few studies have found that examine the impact of exposure to smoke on lung function abnormalities. Barbosa *et al.* (2017) suggest that exposure to smoke

Table 6: Factors associated with COPD among the elderly women.

Dependent variable	Independent variables	Exp(β)	*P*-value
COPD	Constant	0.000	0.999
	Person-per-room		
	≤2.5	Reference category	
	>2.5	1.086	0.840
	Separate kitchen		
	No	Reference category	
	Yes	0.283	0.238
	Cooking fuel		
	None	Reference category	
	Kerosene stove/chullah	3.794	0.999
	LPG	2.114	0.999
	Both kerosene stove and LPG	2.087	0.999
	Percent body fat (%)	1.047	0.257
	Pulse rate (per minute)	0.992	0.653
	Body weight (in kg)	0.969	0.165

COPD: Chronic obstructive respiratory disease, LPG: Liquefied petroleum gas

produced by wood stoves and coal is associated with high mortality rates from COPD, even though the predominant use of kerosene and LPG as cooking fuels is also found.[22] The observed prevalence of COPD among elderly women in the study stands at 15.2%, which is significantly higher than the national average of 3.49%.[23] Forced vital capacity and forced expiratory volume difficulties are prevalent, with a notable proportion reporting abnormal values. Only 23.2% and 27.0% of the study participants reported having normal FVC and $FEV_{0.1}$ values, respectively. This aligns with existing literature indicating a decline in FVC, $FEV_{0.1}$, and vital capacity among older adults of both sexes.[24] Likewise, a study in Busan, South Korea, among elderly women corresponds with the present findings that suggest a significant difference in the mean values of lung function parameters among three elderly age cohorts.[25] Thus, this study establishes a clear relationship between age and the increasing prevalence of lung function abnormalities.

Similarly, few studies indicate that the use of biomass or exposure to smoke causes respiratory abnormalities among elderly individuals.[22] In this study, we observe that the use of kerosene and LPG as cooking fuel increases the risk of developing COPD among elderly women. Besides this, PPR ratio remains an important predictor of respiratory dysfunction, emphasizing the role of household overcrowding. Moreover, the study also delves into the relationship between body composition and respiratory function, noting a significant correlation between body mass index, PBF, and certain lung function parameters.[26] Elevated PBF and pulse rate are identified as factors increasing the likelihood of respiratory abnormalities among the study participants.

The study has certain limitations that merit further consideration. First, the utilization of purposive sampling may introduce selection bias, as participants were chosen based on specific criteria, potentially limiting the generalizability of the findings to a broader population. Additionally, due to the study's geographic confinement to urban Kolkata, comparisons with non-slum-dwelling elderly populations were not feasible. While the study emphasizes the health conditions of vulnerable elderly women, there is also a need to explore the challenges faced by older men to enhance the overall understanding of health in this age group. Furthermore, the cross-sectional design precludes the determination of long-term consequences. Nevertheless, this study has its strength in terms of addressing crucial aspects of research by focusing on the respiratory health of elderly women in urban slums, providing contextually relevant insights.

CONCLUSION

Thus, the result of the present study indicates that respiratory dysfunction increases remarkably with age. Prolonged exposure to socioeconomic stress and poor health conditions coupled with unhygienic living conditions in urban slums may cause respiratory impairments among elderly women. These factors are a few of the plethora of factors that may cause respiratory dysfunction. However, we have to consider other relevant aspects to have a greater insight into this phenomenon. Furthermore, as the global population continues to age, these findings contribute to the growing body of knowledge essential for formulating targeted public health strategies and policies geared toward promoting active and healthy aging.

Authors' contributions

Anushka Ghosh and Susmita Mukhopadhyay conceived the study idea and methodology. Anushka Ghosh played a key role in data collection, statistical analysis, and data interpretation. Anushka Ghosh was the primary contributor to manuscript writing. Susmita Mukhopadhyay and Barun Mukhopadhyay provided critical revisions to the manuscript and supervised the study. All authors reviewed and approved the final manuscript.

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Ethical approval

Institutional ethical approval for the study was obtained from "The Review Committee for Protection of Research Risks to Humans," Indian Statistical Institute, Kolkata (ISI Ethics Clearance no. ISI-IEC/2018/10/02A).

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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