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EFFECT OF OUTDOOR VERSUS INDOOR EXERCISE ENVIRONMENT ON PULMONARY FUNCTION IN YOUNG HEALTHY MALE ADULTS: A CROSS-SECTIONAL STUDY

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ABSTRACT **Background & Objectives:** Regular physical activity is known to enhance pulmonary function, but the role of the exercise environment remains less explored. This study aimed to compare the pulmonary function in young adults engaged in outdoor versus indoor exercise. **Methods:** A cross-sectional study was conducted at King George's Medical University, Lucknow, including 60 healthy adult male population. Out of 60 subjects , 30 were engaged in Green outdoor environment exercise , 30 were engaged in indoor environment exercise. Pulmonary function parameters were assessed using standard spirometry measuring FEV_1, FVC, and FEV_1/FVC ratio. Comparisons were analyzed using Unpaired t-tests. **Results:** FEV_1 , FVC and FEV1/FVC ratio values were significantly lower in indoor exercise group compared to outdoor exercise group (FEV_1: 3.01 ± 0.32 vs. 3.25 ± 0.15 L; FVC: 3.55 ± 0.29 vs. 3.76± 0.18 L and FEV_1/FVC ratio were 84.85±2.7 vs 86.22±2.3 L, p value is <0.05. **Interpretation & Conclusions:** Outdoor exercise subject have a statistically significant increase in pulmonary function parameter than indoor exercise group .These findings suggest outdoor exercise have more positive impact on pulmonary Functions parameters.

KEYWORDS : Indoor exercise, Outdoor exercise, Pulmonary Function, Spirometry, Duration, FEV_1, FVC, FEV1/FVC ratio.

INTRODUCTION

Physical exercise is essential part of a healthy lifestyle . Long-term exercise results in the overall growth in strength , metabolic power and muscle mass . Important factor that affect the outcome of physical exercise is depend on the environment in which person performed there exercise specifically , the natural versus built environment[1]. In year 2003 a term was coined is "GREEN EXERCISE" the meaning of this term is that physical activity in the presence of nature i.e. exercise performed in outdoor natural environment[2]. Physical exercise in natural environment help in promoting cognitive directed attention and social interaction , which affect the future exercise intentions[3]. Cognitive directed attention affect restoration of fatigue means cognitive ability by which a person been avoided by competing stimuli . Natural environment best promote this[4]. OPTIC FlOW – which is affected by movement regarding static scene . Means the expanding flow on retina caused by moving through an environment that form the representational basis of egomotion and it affect performance template. It affect fatigue and exertion in relation to expected performance[5]. During self-paced walking outdoor versus indoor, individual walk faster in outdoor than indoor environment. Individual have higher blood lactate concentration, heart rate and walking speed than indoor exercise performing person[6]. Comparing outcomes, outdoor versus indoor exercise , outcomes of outdoor exercise is more than indoor exercise . Endurance training aerobic exercise reduce smooth muscle tone of airways and increase expiratory flow. Due to aerobic exercise stretching of lung occurs which is associated with training induced stretching of smooth muscle that reduce airway resistance. As airway resistance decrease the airflow increase[7]. Due to exercise workload on respiratory muscle increases by which strong inspiration and expiration occurs, due to this reason ventilation increases that demands more blood flow to respiratory muscle, muscle also steal oxygen and blood flow from other muscle these adaptation help in promoting PULMONARY FUNCTION[8]. The pulmonary capacity and its volume differ according to age ,sex ,body mass index and type of exercise person performing .Type of lifestyle condition is also affect pulmonary function like smoking, and sedentary lifestyle alter it[9]. For the assessment of respiratory function-Pulmonary Function Test (PFT) is an important parameter. PFT gives the information about the size of pulmonary capillaries and idea about parenchyma , small and large airways . Running is one of the best aerobic exercise for enhancing pulmonary function[10].

MATERIALS & METHODS

Study Design And Setting

A cross-sectional observational study was conducted in the Department of Physiology, King George's Medical University, Lucknow, India, over one year (2023–2024).

Participants

A total of 60 participants were enrolled, comprising 30 outdoor running exercise subjects , 30 indoor (Treadmill running) exercise subjects. Age- and sex-matched, only healthy individuals are enrolled. Outdoor subject were recruited from the K.D Singh Babu Stadium Lucknow and Indoor subject recruited from Gym population. Written informed consent was obtained from all participants.

Inclusion Criteria-

Participants included in the study were engaged in exercise for more than 1 year, aged between 20-30 years. Only healthy male individuals were included in the study. Subject were non-smoker, non-alcoholic and not any disease.

Exclusion Criteria

Individuals with a history of smoking were excluded from the study to avoid potential confounding effects on pulmonary function. Participants with pre-existing respiratory diseases such as asthma or chronic obstructive pulmonary disease (COPD). Additionally, individuals diagnosed with connective tissue disorders were excluded due to their potential impact on lung compliance and function. Participants who had undergone recent thoracic or abdominal surgery were not included, as postoperative changes could temporarily alter pulmonary parameters.

Study Procedure

Participants performed outdoor exercise and indoor exercise subject were between the ages of 20 and 30 year were randomly selected. The sample size was 60. After obtaining written informed consent from all group, a detailed history was collected and a general examination was undertaken. All participants were given a questionnaire seeking thorough personal and medical background information.

Data Collection

After recording the age (in years), sex, and duration of exercise in both groups, the height was measured without shoes using a wall-mounted measuring tape. Weight was measured in kg using an electronic weighing machine after removing the shoes.

Grouping based on exercise duration were categorized into two groups:

Group A: Outdoor exercise group -Duration >1 years

Group B: Indoor exercise-Duration > 1 years

Pulmonary Function Testing

Spirometry was performed using a calibrated desktop spirometer following ATS/ERS guidelines. Each subject performed three forced

expiratory maneuvers at 15-minute intervals, and the best reading was recorded. The following parameters were measured: Forced Expiratory Volume in 1 second (FEV_1), Forced Vital Capacity (FVC), FEV_1/FVC ratio.

Statistical Analysis

Data was analyzed using SPSS software. Continuous variables were expressed as mean ± SD. Between-group comparisons were made using unpaired t-test. A p-value <0.05 was considered statistically significant.

Ethics And Permissions

The study protocol was reviewed and approved by the Institutional Human Ethics Committee, KGMU, LUCKNOW . Every participant was provided a detailed information sheet explaining the study procedure, following which their queries, if any, were resolved. Subsequently, participants were enrolled after obtaining written informed consent.

RESULTS

Demographics

The study included 30 outdoor group subjects and 30 indoor groups subjects.

Age Distribution

The age range of participants was 20-30 years.

Comparison Of Pulmonary Function Between Groups

Mean FEV_1, FVC and FEV1/FVC ratio were significantly lower in the indoor exercise group than outdoor exercise group.

RESULTS

Table – 1 Intergroup Comparison Of FVC Level

Group	N	FVC		Unpaired T Test	
		Mean	SD	t-value	p-value
Outdoor Group	30	3.76	0.18	3.25	**0.002**
Indoor Group	30	3.55	0.29		

The comparison of Forced Vital Capacity (FVC) between the two groups using an unpaired t-test revealed a statistically significant difference (t = 3.25, p = 0.002). The Outdoor Group (n = 30) demonstrated a higher mean FVC value of 3.76 ± 0.18 compared to the Indoor Group (n = 30), which had a mean value of 3.55 ± 0.29. This indicates that individuals in the Outdoor Group had significantly better lung capacity than those in the Indoor Group.

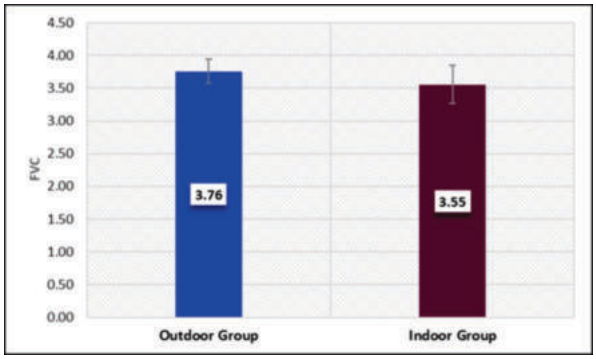
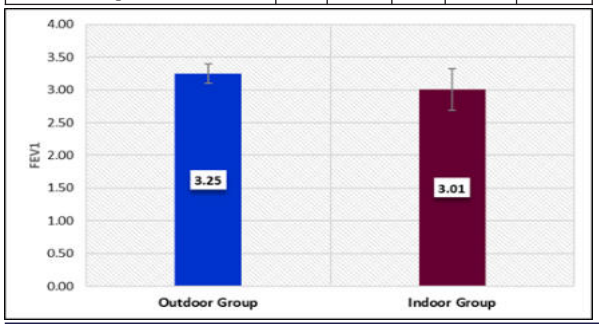


Table – 2 Intergroup Comparison Of FEV1 Level

Group	N	FEV1		unpaired t test	
		Mean	SD	t-value	p-value
Outdoor Group	30	3.25	0.15	3.77	**<0.001**
Indoor Group	30	3.01	0.32		



The comparison of Forced Expiratory Volume in one second (FEV_1) between the two groups showed a statistically significant difference (t = 3.77, p < 0.001). The Outdoor Group (n = 30) recorded a higher mean FEV_1 value of 3.25 ± 0.15, whereas the Indoor Group (n = 30) had a mean value of 3.01 ± 0.32. These results suggest that outdoor activity is associated with significantly better expiratory lung function compared to indoor activity.

Table – 3 Intergroup Comparison Of FEV1/FVC Ratio

Group	N	FEV1/FVC RATIO		unpaired t test	
		Mean	SD	t-value	p-value
Outdoor Group	30	86.22	2.30	2.12	**0.038**
Indoor Group	30	84.85	2.70		

The comparison of the FEV_1/FVC ratio between the two groups revealed a statistically significant difference (t = 2.12, p = 0.038). The Outdoor Group (n = 30) had a higher mean ratio of 86.22 ± 2.30, while the Indoor Group (n = 30) recorded a mean ratio of 84.85 ± 2.70. This indicates that individuals in the Outdoor Group exhibited slightly better overall pulmonary function efficiency compared to those in the Indoor Group.

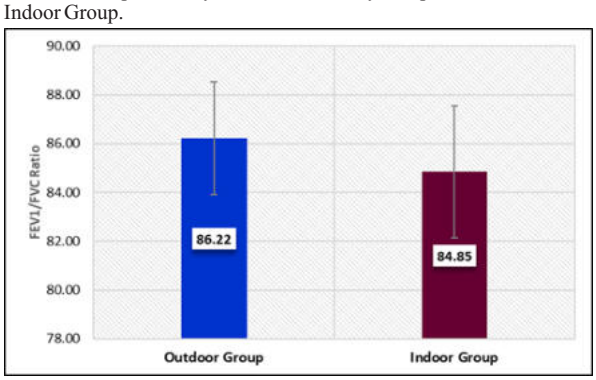
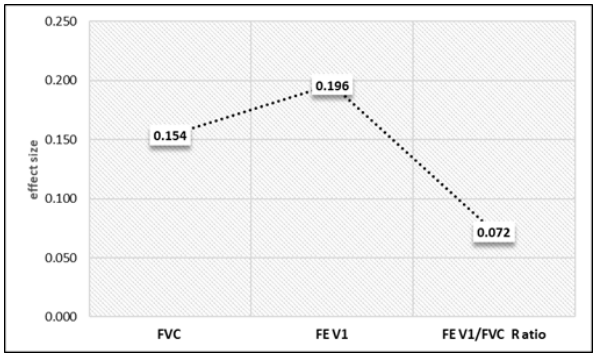


Table – 4 Multivariate Analysis Showing Relationship Of Outcome Variables With Group Type

Outcome Variable	Effect Variable	B	SE	t	p-value	effect size
FVC	Intercept	3.55	0.04	80.16	**<0.001**	0.991
	Outdoor Group	0.20	0.06	3.25	**0.002**	0.154
	Indoor Group	Ref.				
FEV1	Intercept	3.01	0.04	66.89	**<0.001**	0.987
	Outdoor Group	0.24	0.06	3.77	**<0.001**	0.196
	Indoor Group	Ref.				
FEV1/ FVC RATIO	Intercept	84.85	0.46	185.40	**<0.001**	0.998
	Outdoor Group	1.37	0.65	2.12	**0.038**	0.072
	Indoor Group	Ref.				



The multivariate analysis examining the relationship between outcome variables and group type demonstrated that group type significantly influenced pulmonary function parameters. For Forced Vital Capacity (FVC), the intercept value for the Indoor Group was 3.55 (SE = 0.04, t = 80.16, p < 0.001, effect size = 0.991), while the Outdoor Group showed a significant positive effect of 0.20 units (SE = 0.06, t = 3.25, p = 0.002, effect size = 0.154), indicating higher FVC among outdoor participants. Similarly, for Forced Expiratory Volume in one second (FEV_1), the intercept for the Indoor Group was 3.01 (SE = 0.04, t = 66.89, p < 0.001, effect size = 0.987), and the Outdoor Group demonstrated a significant increase of 0.24 units (SE = 0.06, t = 3.77, p < 0.001, effect size = 0.196). For the FEV_1/FVC ratio, the intercept for the Indoor Group was 84.85 (SE = 0.46, t = 185.40, p < 0.001, effect

size = 0.998), with the Outdoor Group showing a smaller but statistically significant increase of 1.37 units (SE = 0.65, t = 2.12, p = 0.038, effect size = 0.072). Overall, these results indicate that participation in outdoor activities was associated with significantly better lung function outcomes compared to indoor activities, with the strongest effect observed for FEV_1.

DISCUSSION

The Aim of this study to compare the pulmonary function of young adults engaged in green outdoor versus indoor exercise, with specific focus on Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), and the FEV1/FVC ratio. The results of this study revealed that there were significant differences in FEV1 , FVC and FEV1/FVC ratio between subjects engaged in outdoor versus indoor environment exercise.

Outdoor vs. Indoor Exercise

The results of this study showed that participants who engaged in green outdoor exercise had significantly better pulmonary function parameters compared to indoor exercise group. Outdoor exerciser group have higher values of FVC, FEV1 and FEV1/FVC ratio. According to study done by Park et al. In there study they found that subjects performing moderate-intensity exercise in forest environments had greater improvements in FEV1 and FVC than those exercising indoors. Also in this study, both FVC and FEV1 parameters demonstrated statistically significant differences between the indoor and outdoor exercise groups, that shows type of exercise environment may influence lung volumes and expiratory capacity. This could be associated to various factors such as differences in air quality, exercise intensity, or environmental stimuli, which may enhanced pulmonary function in the outdoor group[11]. According to a study done by Gladwell et al. 2013, exposure to a natural outdoor environment has promote deeper breathing and that results increased lung expansion, its due to cleaner air, more variable terrain, and the influence of natural stimuli that encourage more vigorous physical activity[12]. According to a study done by Pretty et al. in year 2005 , outdoor settings often involve greater variability in environmental resistance (e.g., wind and uneven terrain), which may act as a mild respiratory challenge, that enhancing pulmonary capacity over time[13]. According to study of Nieuwenhuijsen et.al., Indoor environments may contain pollutants such as dust, mold, or volatile organic compounds that can mildly irritate the airways, even in healthy individuals. In contrast, outdoor green spaces have cleaner, more oxygen-rich air (assuming low urban pollution), which reduces airway resistance and supports better lung function[14]. According to study of Song et.al., Green spaces provide not only physical exercise but also environmental benefits such as improved air quality and reduced pollutants, which may enhance lung function and overall health. Furthermore, the natural surroundings and stress-reducing elements of outdoor environments have contributed to improved respiratory performance[15]. According to study of Park et.al., Nature-based environments helps to reduce sympathetic nervous system activity and lower cortisol levels, contributing to a more relaxed breathing pattern and improved parasympathetic tone. This can indirectly enhance pulmonary performance by reducing bronchoconstriction associated with stress[16].

Limitation

The study did not control for participants' dietary intake, which could have affected their energy levels, recovery, and overall respiratory performance. Nutritional status, particularly antioxidant intake, plays a significant role in respiratory health and may have varied among participants, potentially influencing pulmonary outcomes . Although exercise duration and type were standardized, individual differences in pace and exertion levels may have varied. Some participants may have exerted themselves more intensely, influencing improvements in pulmonary function independent of the exercise environment. A lack of real-time monitoring of exercise intensity limits the precision in assessing the true impact of indoor versus outdoor settings. Outdoor exercise sessions were subject to fluctuations in environmental air quality, including levels of pollutants. These fluctuations were not measured. Its known that exposure to pollutants is affect lung function, this introduces potential variability in results.

CONCLUSION

This study supports the hypothesis that both exercise and environmental factors play a significant role in improving pulmonary function in young adults. Specifically, it underscores the superior benefits of green outdoor exercise over indoor exercise in enhancing pulmonary parameters such as FVC, FEV1 and FEV1/FVC ratio. Furthermore, engaging in regular physical activity, regardless of setting, offers substantial improvements in lung health compared to a sedentary lifestyle. Future research could explore the underlying mechanisms behind these differences, particularly focusing on environmental factors and the physiological adaptations that occur as a result of different exercise settings. By highlighting the significance of outdoor exercise, this study provides valuable insights for promoting healthier lifestyles, encouraging young adults to engage in physical activity, and considering the environmental quality of exercise settings. In the present study, both FVC, FEV1 and FEV1/FVC ratio values demonstrated statistically significant differences between the indoor and outdoor exercise groups there mean value for outdoor group FVC is 3.76±0.18, there mean FVC for indoor group is 3.55±0.29 and for outdoor group mean FEV1 is 3.25±0.15 , Indoor exercise group mean FEV1 is 3.01±0.32 and FEV1/FVC ratio also show a significant difference between mean value of both group. The FEV1/FVC ratio for outdoor exercise group is 86.22±2.30 and for indoor exercise group is 84.85±2.7. As a result, the null hypothesis for all the parameters was rejected ($p < 0.05$) indicating that the type of exercise environment may influence lung volumes and expiratory capacity. This could be attributed to various factors such as differences in air quality, exercise intensity, or environmental exposure, which may have enhanced pulmonary function in the outdoor group. Based on the results of the Unpaired t-test, the null hypotheses for FVC, FEV1 and FEV1/FVC were rejected, as the p-values were found to be statistically significant ($p < 0.05$). This indicates a significant difference in these lung function parameters between the two exercise groups.

DECLARATION

Human subjects: Consent was obtained or waived by all participants in this study. Institutional Human Ethics Committee, issued approval. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.There is no Conflicts of interest:. Financial relationships: All authors have declared that they have no financial relationships at present or past with previous with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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