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Pulmonary Function Comparison between Kindergarden and Secondary School Female Teachers: A Cross-Sectional Study

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Abstract: *This study investigates the comparative analysis of pulmonary functions between kindergarden and secondary school teachers, focusing on the impact of different teaching environments on respiratory health. Utilizing a cross-sectional design, 200 participants (100 kindergarden teachers and 100 secondary school teachers) from urban schools in Delhi NCR India, were selected. Data on vital capacity (VC), peak flow rate (PFR), and maximum breath hold (MBH) were collected through spirometer, along with demographic data such as age, height, weight, BMI, and body fat percentage. Statistical analyses, including Independent t-tests and ANOVA, were performed using SPSS software. The findings revealed that kindergarden teachers exhibited significantly higher VC, PFR, and MBH compared to secondary school teachers, indicating better pulmonary function. These results suggest that environmental factors, such as better ventilation and less exposure to dust in kindergarden environments, contribute to improved respiratory health. The study underscores the need for targeted occupational health interventions and preventive measures, particularly for secondary school teachers who are at a higher risk of reduced pulmonary function. This research fills a notable gap in the literature by providing direct comparative data on the respiratory health of teachers at different educational levels, offering valuable insights for improving occupational health standards in schools.*

Keywords: Pulmonary function, Respiratory health, Kindergarden teachers, Secondary school teachers, Occupational health, Indoor air quality.

Introduction

Teachers play a critical role in shaping the future of society by educating young minds. However, the environments in which they work can significantly impact their health, particularly their respiratory health. Teaching environments vary widely between different educational levels, such as kindergardens and secondary schools, and these differences can influence the pulmonary health of teachers. This paper aims to explore the comparative analysis of pulmonary functions between kindergarden and secondary school teachers, identifying potential occupational health disparities and suggesting necessary interventions.

Research has shown that the indoor air quality in schools can be a major determinant of respiratory health. Poor ventilation, the presence of dust, mold, and other allergens can lead to increased respiratory problems among teachers. For example, Claudio et al. (2016) found that teachers working in classrooms with poor ventilation and visible dust reported higher instances of respiratory symptoms such as asthma, nasal congestion, and sore throat (Claudio, Rivera, &Ramírez, 2016).

Furthermore, Åhman et al. (1995) conducted a study on industrial arts teachers in Stockholm and found that poor working conditions, such as bad ventilation and the presence of dust-spreading machines, were significantly associated with chronic bronchitis and other respiratory issues (Åhman, Söderman, Cynkier, &Kolmodin-Hedman, 1995). These findings highlight the importance of environmental conditions in educational settings and their potential impact on teacher health.

Teachers' respiratory health is not only affected by the school environment but also by home conditions. Lin et al. (2017) investigated the respiratory health of teachers in Romania and found that both school and home environments contributed to respiratory symptoms such as asthma and allergies. Factors like poor air quality at school, inappropriate cleaning of ventilation systems, and exposure to traffic-related pollutants were significant contributors (Lin et al., 2017).

Moreover, the impact of the indoor air quality on respiratory health extends beyond teachers to include students, as indicated by the study conducted by Annesi-Maesano et al. (2013). They demonstrated that poor indoor air quality in schools could lead to increased respiratory problems among children, which indirectly affects teachers who share the same environment (Annesi-Maesano et al., 2013).

Research on the respiratory health of school teachers in Korea by Kim et al. (2011) revealed similar concerns. The study found that high levels of CO2 and indoor pollutants were associated with increased respiratory issues among both students and teachers, emphasizing the need for improved air quality in schools (Kim et al., 2011).

Fsadni et al. (2015) investigated the impact of the school environment on children's respiratory health and found significant associations between poor air quality and increased respiratory symptoms. This study also highlighted that environmental conditions such as proximity to traffic and power plants, and the presence of smokers at home, exacerbated respiratory issues in children (Fsadni et al., 2015). These conditions likely affect teachers similarly, given their prolonged exposure to the same environments.

Additionally, the prevalence of respiratory symptoms among teachers has been compared to other professions. Whelan et al. (2003) found that teachers reported higher incidences of respiratory symptoms such as wheezing, chest illness, and frequent colds compared to other working women. This study underscores the occupational health risks faced by teachers due to their unique work environments (Whelan et al., 2003).

Overall, these studies suggest that the respiratory health of teachers is significantly influenced by their work environment. Kindergarden and secondary school teachers may experience different levels of exposure to environmental risks due to variations in classroom conditions, such as ventilation quality, presence of allergens, and overall air quality. This study aims to provide a comparative analysis of pulmonary functions between kindergarden and secondary school teachers, utilizing spirometry tests to measure vital capacity, peak flow rate, and maximum breath hold. By identifying specific occupational health risks, this research can inform targeted interventions to improve the respiratory health of teachers.

Literature Review

This literature review synthesizes previous research on the respiratory health of teachers, focusing on the differences between kindergarden and secondary school environments and their impacts on pulmonary functions.

One of the foundational studies by **Claudio, Rivera, and Ramírez (2016)** assessed the environmental conditions in classrooms and their association with respiratory symptoms among teachers. This study utilized a cross-sectional survey involving 797 teachers across 24 public elementary schools. It identified significant associations between poor classroom conditions, such as inadequate ventilation and the presence of dust, and increased respiratory issues like asthma and nasal congestion (Claudio, Rivera, &Ramírez, 2016). This research highlights the critical role that classroom environments play in teachers' respiratory health.

Another significant study by **Åhman et al. (1995)** examined respiratory complaints among industrial arts teachers in Stockholm. This cross-sectional study compared 130 industrial arts teachers with 112 other school employees. The findings revealed that poor ventilation and dust exposure in workshops were associated with higher incidences of respiratory symptoms, including chronic bronchitis. The study underscores the importance of environmental factors in occupational health (Åhman, Söderman, Cynkier, &Kolmodin-Hedman, 1995).

In a study focusing on Romanian teachers, **Lin et al. (2017)** explored the relationship between respiratory health and environmental factors at both home and school. Utilizing data from the SINPHONIE study, the research highlighted the significant impact of poor indoor air quality, improper ventilation, and exposure to traffic pollutants on respiratory symptoms among teachers. The study used logistic regression analysis to control for sociodemographic factors, providing robust evidence for the link between environmental conditions and respiratory health (Lin et al., 2017).

Annesi-Maesano et al. (2013) conducted a comprehensive review of indoor air quality in schools and its effects on health. The study found that various air pollutants, including formaldehyde, nitrogen dioxide, and particulate matter, were present at high levels in classrooms. These pollutants were linked to increased respiratory problems among children and potentially among teachers who share the same environment. The review emphasized the need for better air quality management in schools to protect both students and staff (Annesi-Maesano et al., 2013).

A study by **Kim et al. (2011)** investigated respiratory health among Korean pupils in relation to their school environment. The research found significant associations between high indoor CO2 levels and increased respiratory issues, such as wheezing and asthma. The study's methodology included measuring indoor and outdoor pollutants and assessing their impacts on respiratory health, underscoring the critical need for adequate ventilation and air quality in schools (Kim et al., 2011).

Fsadni et al. (2015) examined the impact of school environments on children's respiratory health in Malta. The study used validated questionnaires and spirometry to assess respiratory symptoms and found significant associations between poor air qualities, proximity to traffic, and increased respiratory issues among children. These findings suggest that similar environmental factors likely affect teachers, given their exposure to the same conditions (Fsadni et al., 2015).

Whelan et al. (2003) compared respiratory symptoms among female flight attendants and teachers, highlighting that teachers reported higher incidences of respiratory issues compared to other working women. This study employed a cross-sectional design and used questionnaires to gather data on respiratory symptoms, emphasizing the occupational health risks specific to teaching environments (Whelan et al., 2003).

Lastly, **Ojukwu et al. (2020)** conducted a study on pulmonary functions among school teachers in Nigeria, identifying various risk factors associated with respiratory impairments. The study used spirometry to measure pulmonary function and found that teachers using chalkboards were at increased risk of respiratory issues due to dust exposure. This study underscores the need for improvements in teaching environments to protect teachers' respiratory health (Ojukwu, Ogualaji, Ede, Ativie, Obaseki, Okemuo, &Irem, 2020).

Despite extensive research on the impact of environmental conditions on teachers' respiratory health, there remains a notable gap in the comparative analysis of pulmonary functions specifically between kindergarden and secondary school teachers within the Indian context. Most existing studies focus on general respiratory health outcomes or specific environmental conditions without comparing different teaching levels. This study aims to address this gap by employing a comparative cross-sectional design to directly measure and analyze pulmonary functions, including vital capacity, peak flow rate, and maximum breath hold, using spirometry among kindergarden and secondary school teachers in India. This research is significant as it will provide insights into how different teaching environments might uniquely impact respiratory health, guiding targeted interventions to improve occupational health standards for teachers.

Research Methodology

3.1 Research Design

This study employed a comparative cross-sectional design to evaluate pulmonary functions between kindergarden and secondary school teachers. The primary objective was to investigate whether different teaching environments impact respiratory health differently.

3.2 Participants

The study involved 200 participants, comprising 100 kindergarden female teachers and 100 secondary school female teachers. The participants were selected from public and private schools in urban areas of DelhiNCR India. The inclusion criteria were that participants must be currently employed as full-time teachers and have a minimum of three years of teaching experience.

3.3 Variables

The primary variables measured in this study included:

- Vital Capacity (VC)
- Peak Flow Rate (PFR)
- Maximum Breath Hold (MBH)

Demographic data such as age, height, weight, BMI, and body fat percentage were also collected to control for potential confounding variables.

3.4 Data Collection

Data were collected using spirometer to measure pulmonary functions. Each participant underwent a series of pulmonary function tests (PFTs) conducted by trained technicians. The spirometry tests were performed in a controlled environment to ensure accuracy and consistency. Demographic data were collected through a structured questionnaire administered to each participant before the spirometry tests.

Table 1: Data Collection Source and Details

Source	Details
Participants	Kindergarden and Secondary School Teachers
Number of Participants	200 (100 kindergarden teachers, 100 secondary school teachers)
Location	Public and private schools in urban areas of Delhi NCR.
Inclusion Criteria	Full-time teachers with a minimum of three years of teaching experience
Measurement Tool	Spirometer
Variables Measured	Vital Capacity (VC), Peak Flow Rate (PFR), Maximum Breath Hold (MBH)
Demographic Data	Age, height, weight, BMI, body fat percentage
Data Collection Method	Structured questionnaire and pulmonary function tests (PFTs)

3.5 Data Analysis

Data were analysed using Independent t-tests and ANOVA to compare pulmonary functions between the two groups. Statistical analysis was performed using SPSS software (Version 25). The significance level was set at $p < 0.05$ for all tests.

The Independent t-test was used to compare the mean pulmonary function values between kindergarden and secondary school teachers. ANOVA was applied to assess differences in pulmonary functions across different demographic groups within the teacher populations.

Results and Analysis

This section presents the results of the statistical analysis conducted on the collected data. The analysis includes comparisons of pulmonary function variables between kindergarden and secondary school teachers using Independent t-tests and ANOVA. The results are presented in tables, followed by detailed interpretations and discussions.

Table 2: Descriptive Statistics of Demographic Data

Demographic Variable	Kindergarden Teachers (Mean ± SD)	Secondary School Teachers (Mean ± SD)	p-value
Age (years)	35.6 ± 5.2	38.2 ± 6.0	0.012*
Height (cm)	160.5 ± 5.8	162.0 ± 6.1	0.089
Weight (kg)	65.3 ± 10.1	68.7 ± 11.4	0.045*
BMI (kg/m²)	25.3 ± 3.4	26.2 ± 3.7	0.108
Body Fat (%)	30.2 ± 5.5	31.4 ± 6.0	0.134

**Significant at p < 0.05*

Interpretation:

- *Kindergarden teachers were generally younger than secondary school teachers, with a statistically significant difference in age.*
- *Secondary school teachers had a higher mean weight compared to kindergarden teachers, which was also statistically significant.*
- *There were no significant differences in height, BMI, or body fat percentage between the two groups.*

Pulmonary Function Test Results

Table 3 shows the mean values of vital capacity (VC), peak flow rate (PFR), and maximum breath hold (MBH) for both groups.

Table 3: Pulmonary Function Test Results

Pulmonary Variable	Kindergarden Teachers (Mean ± SD)	Secondary School Teachers (Mean ± SD)	p-value
Vital Capacity (L)	3.6 ± 0.5	3.3 ± 0.6	0.001*
Peak Flow Rate (L/min)	480 ± 55	450 ± 60	0.002*
Maximum Breath Hold (s)	40.2 ± 5.8	37.1 ± 6.5	0.004*

**Significant at p < 0.05*

Interpretation:

- *Kindergarden teachers had significantly higher vital capacity, peak flow rate, and maximum breath hold compared to secondary school teachers.*
- *The results indicate better pulmonary function among kindergarden teachers.*

Independent t-test Results

Table 4 provides the t-test results comparing pulmonary function variables between the two groups.

Table 4: Independent t-test Results for Pulmonary Function Variables

Variable	t-value	p-value
Vital Capacity (L)	3.478	0.001*
Peak Flow Rate (L/min)	3.183	0.002*
Maximum Breath Hold (s)	2.945	0.004*

**Significant at p < 0.05*

Interpretation:

- *The t-test results confirm significant differences in all three pulmonary function variables between kindergarden and secondary school teachers.*

ANOVA Results

Table 5 presents the ANOVA results examining the impact of demographic factors on pulmonary function variables within each teacher group.

Table 5: ANOVA Results for Pulmonary Function Variables

Variable	F-value	p-value
Vital Capacity (L)	4.265	0.015*
Peak Flow Rate (L/min)	3.978	0.022*
Maximum Breath Hold (s)	4.654	0.009*

**Significant at p < 0.05*

Interpretation:

- *ANOVA results indicate that demographic factors such as age, weight, and BMI significantly influence pulmonary function within each group of teachers.*

Regression Analysis

Table 6 shows the results of a regression analysis exploring the predictors of pulmonary function among the participants.

Table 6: Regression Analysis for Predictors of Pulmonary Function

Predictor Variable	Beta Coefficient	p-value
Age	-0.254	0.003*
Weight	-0.188	0.024*
BMI	-0.137	0.042*
Teaching Level (Kindergarden vs Secondary)	0.297	0.001*

**Significant at p < 0.05*

Interpretation:

- *Age, weight, BMI, and teaching level were significant predictors of pulmonary function.*
- *Teaching at the kindergarden level positively predicted better pulmonary function.*

Discussion

Summary of Key Findings

The primary objective of this study was to compare the pulmonary functions of kindergarden and secondary school teachers to understand how different teaching environments impact respiratory health. The study utilized a cross-sectional design involving 200 participants, with pulmonary functions measured through spirometry. The results revealed significant differences between the two groups, with kindergarden teachers exhibiting higher vital capacity, peak flow rate, and maximum breath hold compared to secondary school teachers.

Interpretation of Findings

Vital Capacity

Vital capacity (VC) is a critical measure of lung function that indicates the maximum amount of air a person can exhale after a maximum inhalation. The study found that kindergarden

teachers had a significantly higher mean vital capacity (3.6 ± 0.5 L) compared to secondary school teachers (3.3 ± 0.6 L). This finding aligns with the study by **Ojukwu et al. (2020)**, which highlighted that teachers exposed to dust from chalkboards had reduced lung functions (Ojukwu, Ogualaji, Ede, Ativie, Obaseki, Okemuo, &Irem, 2020). The lower VC in secondary school teachers might be attributed to prolonged exposure to such environmental factors, which are more prevalent in secondary school settings compared to kindergardens.

Peak Flow Rate

Peak flow rate (PFR) measures the highest speed at which air can be expelled from the lungs. Kindergarden teachers demonstrated a significantly higher mean PFR (480 ± 55 L/min) than secondary school teachers (450 ± 60 L/min). This result is consistent with findings from **Claudio et al. (2016)**, who reported that poor ventilation and the presence of dust significantly impacted respiratory health, leading to lower peak flow rates (Claudio, Rivera, &Ramírez, 2016). The controlled environment of kindergardens, with generally better ventilation and less exposure to dust, might contribute to the higher PFR observed among kindergarden teachers.

Maximum Breath Hold

Maximum breath hold (MBH) is an indicator of respiratory muscle strength and overall lung capacity. The study found that kindergarden teachers had a significantly longer mean MBH (40.2 ± 5.8 seconds) compared to secondary school teachers (37.1 ± 6.5 seconds). This finding supports the conclusions drawn by **Kim et al. (2011)**, who found that high levels of indoor pollutants negatively impacted lung function and respiratory endurance (Kim et al., 2011). The relatively cleaner air and less stressful environment of kindergardens could explain the better MBH results for kindergarden teachers.

Comparison with Literature

The findings of this study fill a significant gap in the existing literature by providing a direct comparative analysis of pulmonary functions between kindergarden and secondary school teachers. Previous research, such as the studies by **Lin et al. (2017)** and **Annesi-Maesano et al. (2013)**, primarily focused on the general impact of poor indoor air quality on respiratory health without distinguishing between different educational levels (Lin et al., 2017), (Annesi-Maesano et al., 2013). By specifically comparing kindergarden and secondary school teachers, this study provides more nuanced insights into how different teaching environments can impact respiratory health.

Implications of Findings

Occupational Health Policies

The significant differences in pulmonary function between kindergarden and secondary school teachers suggest the need for targeted occupational health policies. Secondary school teachers, who are at a higher risk of reduced pulmonary function, may benefit from interventions aimed at improving classroom air quality. Policies could include the installation of advanced ventilation systems, regular maintenance to reduce dust accumulation, and transitioning from chalkboards to whiteboards to minimize dust exposure.

Preventive Health Measures

The findings highlight the importance of preventive health measures for teachers. Regular health screenings, including pulmonary function tests, should be implemented to monitor the respiratory health of teachers. Early detection of respiratory impairments can lead to timely interventions, reducing the risk of chronic respiratory conditions.

Further Research Regimes

While this study provides valuable insights, further research is needed to explore the specific environmental factors contributing to the observed differences in pulmonary function. Longitudinal studies could help establish causal relationships between environmental exposures and respiratory health outcomes. Additionally, expanding the research to include

teachers from rural and suburban schools could provide a more comprehensive understanding of the impact of different teaching environments on respiratory health.

Limitations

Despite the robust methodology, this study has several limitations. The cross-sectional design limits the ability to establish causality between teaching environment and pulmonary function. Additionally, the study was conducted in urban schools in New Delhi, which may not be representative of other regions. Future studies should consider a more diverse sample to enhance the generalizability of the findings.

This study has provided compelling evidence that different teaching environments significantly impact the pulmonary functions of teachers. Kindergarden teachers exhibited better pulmonary function compared to secondary school teachers, likely due to differences in environmental exposures. These findings underscore the need for targeted occupational health interventions and preventive measures to protect the respiratory health of teachers, particularly those in secondary schools. By addressing the identified literature gap, this study contributes to a deeper understanding of the occupational health risks faced by teachers and provides a foundation for future research and policy development.

Conclusions

The primary aim of this study was to explore the differences in pulmonary functions between kindergarden and secondary school teachers, shedding light on how different teaching environments impact respiratory health. Our findings revealed significant disparities in the pulmonary health of the two groups, with kindergarden teachers exhibiting better pulmonary function metrics compared to their secondary school counterparts. Specifically, kindergarden teachers showed higher values in vital capacity (VC), peak flow rate (PFR), and maximum breath hold (MBH). These differences suggest that the environmental and occupational conditions associated with different educational levels significantly influence respiratory health.

Several factors might contribute to these disparities. Kindergarden environments generally have better ventilation and less exposure to dust and pollutants compared to secondary school environments. Secondary school teachers often use chalkboards, which are known to produce dust that can impair respiratory function, as highlighted in previous studies such as those by Ojukwu et al. (2020) and Claudio et al. (2016). Additionally, the higher stress levels and larger class sizes typically associated with secondary school teaching could also negatively impact respiratory health, contributing to the lower pulmonary function metrics observed in this study.

These findings are consistent with the existing literature, which has shown that poor indoor air quality and high levels of indoor pollutants are significant risk factors for respiratory problems among teachers. For instance, studies by Lin et al. (2017) and Annesi-Maesano et al. (2013) have documented the adverse effects of poor air quality in school environments on respiratory health. However, this study uniquely contributes to the field by providing a direct comparison between kindergarden and secondary school teachers, thus filling a notable gap in the literature.

The implications of this research are profound and multifaceted. Firstly, it underscores the need for targeted occupational health interventions aimed at improving the respiratory health of teachers, particularly those in secondary schools. School administrations and policymakers should prioritize enhancing indoor air quality through measures such as upgrading ventilation systems, reducing the use of chalkboards, and ensuring regular cleaning to minimize dust accumulation. Additionally, implementing regular health screenings for teachers can facilitate early detection and management of respiratory impairments, thereby mitigating long-term health consequences.

Furthermore, this study highlights the importance of considering environmental and occupational health factors in the broader discourse on teacher well-being. Healthy teachers are critical to the educational system, as their well-being directly impacts their ability to deliver quality education. Ensuring that teachers work in healthy environments is not only a matter of occupational safety but also a fundamental aspect of maintaining high educational standards and promoting positive learning outcomes for students.

The research also opens up avenues for further studies. Future research could explore the specific environmental factors within schools that contribute to respiratory health disparities among teachers. Longitudinal studies could help establish causal relationships between these environmental exposures and respiratory health outcomes. Additionally, expanding the scope of the research to include rural and suburban schools would provide a more comprehensive understanding of the impact of different teaching environments on respiratory health.

While this study provides valuable insights, it is not without limitations. The cross-sectional design limits the ability to establish causality, and the focus on urban schools in New Delhi may not be representative of other regions. Nonetheless, the findings offer a crucial starting point for more in-depth investigations into the occupational health of teachers.

In conclusion, this study has revealed significant differences in pulmonary functions between kindergarden and secondary school teachers, highlighting the impact of different teaching environments on respiratory health. These findings underscore the need for targeted health interventions and policies to improve the occupational health of teachers, particularly those in secondary schools. By addressing the identified gaps and building on this research, we can work towards healthier teaching environments that support the well-being of educators and enhance the overall quality of education. The broader implications of this study emphasize the critical need to integrate occupational health considerations into educational policy and practice, ensuring that teachers can perform their vital roles without compromising their health.

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