RESEARCH ARTICLE

INTERNATIONAL JOURNAL OF KINANTHROPOMETRY

DOI: 10.34256/ijk2528

Post Covid-19 Body Composition And Pulmonary Function Among Young-To-Middle-Aged Adults In Karnataka, India : A Kinanthropometric Study

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DOI: https://doi.org/10.34256/ijk2439
Received: 14-03-2025; Revised: 27-07-2025; Accepted: 05-08-2025; Published: 19-08-2025

Abstract

Introduction: The interplay between body composition and respiratory health has gained renewed importance in the wake of COVID-19. In this cross-sectional kin anthropometric study, 536 adults aged 26–40 years from Dharwad and Ramanagara districts, Karnataka, who had recovered from COVID-19, were examined to assess the relationship between body composition and pulmonary function. **Methods**: Height, weight, and Body Mass Index (BMI) were measured alongside pulmonary function parameters like Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), and oxygen saturation (SpO_2) using standardized protocols. **Results:** Pearson correlation and Chi-square tests revealed a consistent inverse association between BMI and pulmonary function, with stronger correlations in females (FVC r = -0.585; FEV_1 r = -0.626; SpO_2 r = –0.170) than males (FVC r = -0.338; FEV_1 r = -0.584; SpO_2 r = -0.146), all statistically significant ($p < 0.05$). These findings indicate that elevated BMI adversely affects post-COVID respiratory recovery, particularly in women. **Conclusion:** Integrating BMI assessment into post-COVID follow-up care and adopting gender-sensitive rehabilitation strategies may improve long-term pulmonary outcomes.

Keywords: India, Post-COVID, Body Composition, Pulmonary Function, Kin-Anthropometry.

Composición corporal y función pulmonar post-COVID-19 en adultos jóvenes y de mediana edad en Karnataka, India: un estudio cineantropométrico

Resumen

Introducción: La interacción entre la composición corporal y la salud respiratoria ha cobrado renovada importancia tras la COVID-19. En este estudio antropométrico transversal, se examinó a 536 adultos de 26 a 40 años de los distritos de Dharwad y Ramanagara, Karnataka, que se habían recuperado de la COVID-19, para evaluar la relación entre la composición corporal y la función pulmonar. **Métodos:** Se midieron la altura, el peso y el índice de masa corporal (IMC), junto con parámetros de la función pulmonar como la capacidad vital forzada (CVF), el volumen espiratorio forzado en el primer segundo (VEF_1) y la saturación de oxígeno (SpO_2), utilizando protocolos estandarizados. **Resultados:** La correlación de Pearson y las pruebas de Chi-cuadrado revelaron una asociación inversa consistente entre el IMC y la función pulmonar, con correlaciones más fuertes en mujeres (FVC r = -0,585; FEV_1 r = -0,626; SpO_2 r = -0,170) que en hombres (FVC r = -0,338; FEV_1 r = -0,584; SpO_2 r = -0,146), todas estadísticamente significativas ($p < 0,05$). Estos hallazgos indican que un IMC elevado afecta negativamente la recuperación respiratoria pos-COVID, especialmente en mujeres. **Conclusión:** La integración de la evaluación del IMC en el seguimiento pos-COVID y la adopción de estrategias de rehabilitación con perspectiva de género pueden mejorar los resultados pulmonares a largo plazo.

Palabras Clave: India, Pos-COVID, Composición corporal, Función pulmonary, Antropometría kinestésica.

Introduction

Coronavirus Disease 2019 (COVID-19), caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), was first reported in Wuhan, China, in December 2019 and declared a pandemic by the World Health Organization on 11 March 2020 (Huang et al., 2020; WHO, 2020). The infection primarily affects the respiratory system but can also involve multiple organs, leading to acute and long-term complications (Guan et al., 2020). Even after recovery, a subset of individuals experiences persistent symptoms and functional impairments, now widely referred to as "long COVID" or post-acute sequelae of COVID-19 (Nalbandian et al., 2021). Understanding these long-term effects is crucial for developing effective rehabilitation and public health strategies (Carfi et al., 2020).

Globally, pulmonary function has emerged as one of the most affected physiological domains (Mo et al., 2020). While clinical recovery is often confirmed through symptom resolution and negative diagnostic tests, evidence indicates that impairments such as reduced Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), and oxygen diffusion capacity may persist for months, even among individuals with mild or moderate illness (Zhao et al., 2020; Suppini et al., 2023).

Body composition, particularly Body Mass Index (BMI), plays a critical role in respiratory mechanics. Elevated BMI has been linked to restrictive ventilatory patterns, diminished thoracic compliance, and compromised gas exchange (Lazarus et al., 1985). Recent post- COVID findings suggest that BMI may independently predict long-term pulmonary outcomes, though the magnitude and direction of these effects vary by age, infection severity, and socio-environmental factors (Van Heerden et al., 2023).

Despite these advances, kin anthropometric studies examining the interplay between body composition and pulmonary function in non-hospitalized or mildly symptomatic post-COVID populations remain scarce in India. This is particularly relevant for young-to-middle-aged adults (26–40 years), a demographically and economically vital group whose recovery trajectories influence workforce productivity and public health planning.

Kin anthropometry, integrating anthropometric profiling with functional assessments, provides a comprehensive lens to evaluate post-COVID physiological performance. This study investigates the relationship between BMI and pulmonary function assessed via spirometric and oximetric parameters among recovered adults in Dharwad and Ramanagara districts of Karnataka, offering region-specific insights to inform post-pandemic health assessment and rehabilitation strategies.

Objectives

1. To assess the body composition (Height, Weight, and BMI) of adults aged 26–40 years post-COVID-19 in two districts of Karnataka.
2. To evaluate pulmonary function parameters (FVC, FEV_1, and SpO_2) among the same cohort.
3. To examine the relationship between body composition and pulmonary function.
4. To identify gender-wise variations, if any, in pulmonary function recovery post-COVID-19.
5. To suggest potential recommendations for post-COVID physical rehabilitation and monitoring.

Materials and Methods

Research Design

This study adopts a cross-sectional descriptive research design with a quantitative approach, situated within the framework of biological anthropology and kin anthropometry. It explores the post-COVID-19 complications by assessing pulmonary function and body composition specifically height, weight, and Body Mass Index (BMI) as key biological indicators. Focusing on young-to-middle-aged adults in Karnataka, the study investigates the correlation between anthropometric parameters and respiratory health outcomes using spirometric and oximetric measurements. In addition to examining post-infection physiological changes, the research accounts for gender-wise differences and region-specific health trends, contributing to a nuanced anthropological understanding of COVID-19 recovery patterns.

Study Area

The study was conducted in Dharwad and Ramanagara, two geographically distinct districts of Karnataka. India covering both districts enables the study to capture regional diversity in post-COVID experiences.

Study Population

This study focused on individuals aged 26 to 40 years residing in the districts of Dharwad and Ramanagara, who had contracted and recovered from COVID-19 during the first major wave of the pandemic (March 2020-February 2021). Participants were selected from various urban and rural localities within both districts to ensure diversity in socio-economic background and living conditions. This approach allowed for an in-depth assessment of post-COVID complications, particularly in relation to body composition and pulmonary function within this working-age population.

Sample Size and Sampling Method

The study is a part of a University Doctoral Research Project on COVID-19 transmission, symptoms, and post complications among adults aged 26 to 75 years. The sample size for this research is 536, of whom 352 were males and 184 were females, who are aged 26-40.

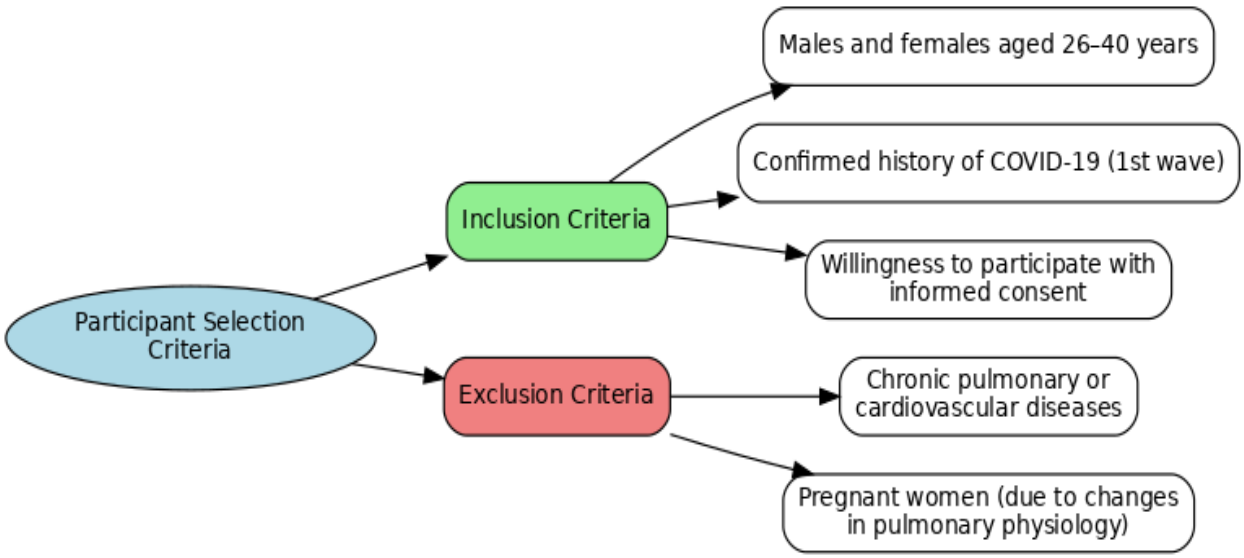

Figure 1. Flowchart of Participant Selection Criteria

The original sample size for the broader study was calculated using the Open Epi Sample Size Calculator, targeting approximately 1217 individuals to ensure statistical robustness across age groups and variables. From this total, 536 individuals fell within the selected 26–40 age cohort and were included in the present analysis.

A snowball sampling method was used to recruit participants. This non-probability sampling technique was particularly suited to the COVID-19 context due to several practical constraints, such as limited access to comprehensive health records, participant hesitation due to stigma or privacy concerns, and the dispersed nature of recovered individuals across urban and rural settings. Snowball sampling enabled the researchers to reach a diverse pool of participants through peer referral, increasing trust and participation, especially in communities less likely to engage in formal research. This method facilitated in-depth exploration of post-COVID complications among a representative sample of young-to-middle-aged adults.

Tools and Instruments

Physical Characteristics in terms of Height and weight were measured with the methods described in ISAK manual of International Society for the Advancement of Kianthropometry (Esparza-Ros et al, 2019). The study utilized a stadiometer to measure height, a digital weighing scale for body mass, and BMI calculations for nutritional status.

Pulmonary function Tests were assessed using a calibrated digital spirometer to record Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV_1). A pulse oximeter was employed to measure peripheral oxygen saturation (SpO_2) at rest. All instruments (Figure 2) were calibrated prior to use, and WHO-recommended hygiene protocols were followed for all measurements.

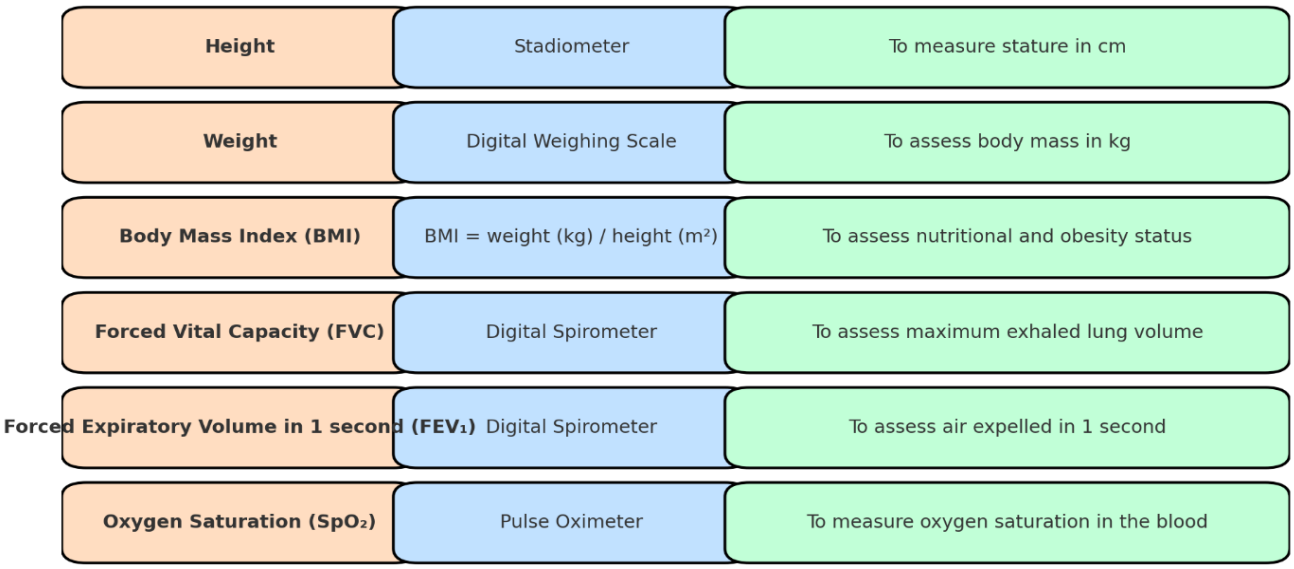

Figure 2. Overview of Physiological Parameters and Measurement Tools

Data Collection Procedure

Data was collected through direct field visits to households using structured interview schedules. As fieldwork is the hallmark of anthropological research, this approach enabled the researcher to engage closely with participants in their natural settings, ensuring contextually grounded and culturally sensitive data collection. Participants were first briefed about the study and taken oral consent. Anthropometric measurements were taken following ISAK standards. Pulmonary function was assessed using a portable digital spirometer, following ATS/ERS spirometry guidelines (Miller et al., 2005). SpO_2 readings were recorded using a pulse oximeter, ensuring the participant was at rest during the reading.

Ethical Considerations

The study adhered to strict ethical standards to protect participant rights and welfare. Informed oral consent was obtained after explaining the study's purpose and procedures. Participation was entirely voluntary, with the right to withdraw at any time during the interview. Anonymity and confidentiality were strictly maintained.

Data Analysis

The collected data were entered and processed using Microsoft Excel for statistical analysis. Descriptive statistics, including mean and standard deviation (SD), were computed for key anthropometric variables such as height and weight to summarize central tendencies and variability within the sample. To examine the relationship between Body Mass Index (BMI) and pulmonary function variables like Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), and oxygen saturation (SpO_2), Pearson correlation coefficients (r) were calculated. Additionally, Chi-square tests were performed to assess the association between categorized BMI levels and grouped pulmonary parameters. A p-value of less than 0.05 was considered statistically significant.

Results

Table 1. Gender-wise Mean and Standard Deviation for Height and Weight

Gender	Height (m)Mean ± SD	Weight (kg)Mean ± SD
Male	1.68 ± 0.099	63.31 ± 12.20
Female	1.59 ± 0.085	55.14 ± 9.12

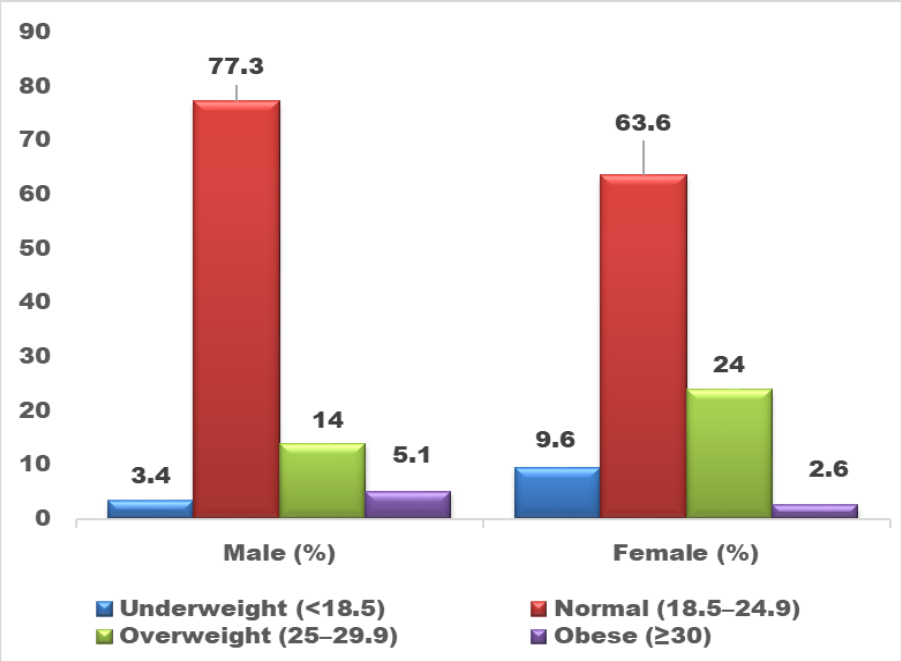

Figure 3. Gender-wise Distribution of BMI Categories among Post-COVID Adults (Aged 26–40) in percentages.

Table 2. Participant Profile Table

Variable	Category	Frequency (n)	Male N (%)	Female N (%)	Total (%)
Total Participants	Sex	536	349(65.1)	187(34.8)	100
BMI Category	Underweight (<18.5)	30	12(3.4)	18(4.2)	5.5
	Normal (18.5–24.9)	389	270(77.3)	119(63.6)	72.5
	Overweight (25–29.9)	94	49(14)	45(24)	17.5
	Obese (≥30)	23	18(5.1)	5(2.6)	4.2
FVC (L)	≥3	468	308(88.2)	160(85.5)	87.3
	<3	68	41(11.7)	27(14.4)	12.6
FEV1(L)	≥2	460	304(87.1)	157(83.9)	85.8
	<2	76	45(12.8)	30(16)	14.1
Spo2 (%)	≥95	529	344(98.5)	183(97.8)	98.6
	<95	7	5(1.43)	4(2.1)	1.3

Table 3. Correlation and Significance of BMI with Pulmonary Function Parameters by Gender

Gender	Variable	FVC (L) r	FEV_1 (L) r	SpO_2 (%) r	p-value (Chi-square)
Male	BMI	-0.33	-0.58	-0.14	<0.001
Female	BMI	-0.58	-0.62	-0.17	<0.001

The mean height and weight of male participants were 1.68 ± 0.099 m and 63.31 ± 12.20 kg, respectively. For females, the mean height and weight were 1.59 ± 0.085 m and 55.14 ± 9.12 kg, respectively (Table 1).

A total of 536 participants were included in the study, comprising 349 males (65.1%) and 187 females (34.8%). Regarding BMI classification, 5.5% were underweight (males: 3.4%; females: 4.2%), 72.5% had normal BMI (males: 77.3%; females: 63.6%), 17.5% were overweight (males: 14%; females: 24%), and 4.2% were classified as obese (males: 5.1%; females: 2.6%). In terms of Forced Vital Capacity (FVC), 87.3% of participants had values ≥3 L (males: 88.2%; females: 85.5%), while 12.6% had FVC <3 L. Forced Expiratory Volume in 1 second (FEV_1), 85.8% had values ≥2 L (males: 87.1%; females: 83.9%), and 14.1% had values <2 L. As for SpO_2 levels, the majority (98.6%) recorded ≥95% oxygen saturation (males: 98.5%; females: 97.8%), while only 1.3% had values <95% (Table 2).

The relationship between Body Mass Index (BMI) and key pulmonary outcomes Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), and peripheral oxygen saturation (SpO_2) was assessed using both Pearson correlation coefficients (r) and Chi-square (χ^2) tests to determine strength, direction, and significance of associations (Table 3).

BMI and FVC Relationship

Males: The correlation between BMI and FVC was found to be moderately negative (r=-0.338; $p < 0.001$), indicating that higher BMI values are associated with lower FVC in post-COVID males. The Chi-square test confirmed this association was highly significant, suggesting that BMI is a statistically significant factor influencing FVC levels among males.

Females*:* The correlation was stronger in females, with a strong negative correlation (r = -0.585; $p < 0.001$). The Chi-square value further validated the significant association. This highlights that in females, increased body mass has a greater adverse impact on lung volume compared to males.

Interpretation*:* In both sexes, as BMI increases, lung capacity as measured by FVC tends to decrease, with a more pronounced effect observed among females.

BMI and FEV_1 Relationship

Males: A strong negative correlation was observed between BMI and FEV_1 (r = -0.584; $p < 0.001$), suggesting that greater BMI is associated with significantly reduced expiratory airflow in post-COVID male participants. This is statistically supported by the Chi-square result, indicating a robust association.

Females: An even stronger correlation was found in females (r =-0.626; $p < 0.001$), indicating that excess body mass leads to greater impairment of expiratory lung function in women. The Chi-square test reaffirmed this finding.

Interpretation*:* These results demonstrate that overweight and obese individuals particularly females are more likely to experience post-COVID reductions in FEV_1, reflecting airflow limitation and potential risk of obstructive pulmonary issues.

BMI and SpO_2 Relationship

Males: A weak but statistically significant negative correlation was observed between BMI and oxygen saturation (SpO_2) (r = -0.146; $p < 0.001$). The association was supported by the Chi-square test, suggesting that higher BMI may be linked to slight reductions in peripheral oxygen levels, even if not clinically severe.

Females*:* The correlation was slightly stronger (r = -0.170; $p < 0.001$) with a very significant Chi-square value, implying that females with higher BMI tend to have marginally lower SpO_2 levels.

Interpretation: Although the correlations are weak, the statistical significance suggests that BMI may subtly influence oxygen saturation, potentially due to compromised respiratory mechanics in individuals with higher adiposity.

Overall Interpretation

Across all three respiratory parameters, FVC, FEV_1, and SpO_2 a consistent inverse relationship with BMI was observed. These relationships were statistically significant for both males and females, but the effects were more pronounced in females, especially for FVC and FEV_1.

The results emphasize that higher BMI is associated with reduced pulmonary function, with implications for post-COVID-19 rehabilitation and risk stratification. These patterns are also supported by extremely low p-values from Chi-square tests, confirming the robustness and reliability of the observed associations.

Discussion

This study examined the association between Body Mass Index (BMI) and pulmonary function specifically FVC, FEV_1, and SpO_2 among post-COVID-19 young adults. We found significant negative correlations: for males, BMI correlated with FVC ($r = -0.34$), FEV_1 ($r = -0.58$), and SpO_2 ($r = -0.15$); for females, these correlations were stronger at -0.59, -0.63, and -0.17, respectively (all $p < 0.001$). These data indicate that higher BMI is associated with poorer lung function, and the effect was more pronounced in females.

Our results align with established findings from India and elsewhere. An Indian cross-sectional study in the NCR region showed that obese individuals had significantly reduced FEV_1 and PEFR, with body fat percentage negatively correlated with pulmonary function ($p < 0.01$) Although that study focused on general adults, our data demonstrate consistent patterns in post-COVID recovery populations, suggesting an additive impact of infection on respiratory mechanics (Kamal et al., 2022). Similarly, among adults in Xi'an, China (Wu wt al. 2023), both FVC and FEV_1 were significantly lower in overweight and obese individuals compared to those with normal BMI, reflecting consistent patterns across diverse populations (Wang et al., 2017). In another regional study, correlations were slightly milder: BMI showed negative associations with FVC ($r \approx -0.33$, $p < 0.001$) and FEV_1 ($r \approx -0.28$, $p < 0.001$) in obese cases (Younus, Usman, & Jawed, 2018) notably, the magnitude of correlation observed in our sample especially among females exceeds these earlier estimates, emphasizing a heightened impact of BMI on respiratory parameters in the post-COVID context.

Findings from Eastern India found that BMI and weight were positively correlated with lung volumes up to a BMI of 30, after which FEV_1/FVC ratio declined (Alam & Samui, 2021). This supports the concept of a non-linear relationship between BMI and lung function, which is especially relevant in our post-COVID sample where obesity is associated with a sharp decline.

A broader meta-analysis affirmed that obesity is consistently linked with reduced FEV_1 and FVC and restrictive pulmonary patterns across populations (Bhatti et al., 2019). Critical global reviews attribute these mechanical impairments to factors such as increased thoracoabdominal fat, reduced chest wall compliance, and diaphragmatic restriction. Post-COVID pulmonary impairment is well-documented in follow-up studies. One study of discharged patients reported over 30% with impaired pulmonary function one-year post-infection, especially among those with higher BMI. This aligns with our suggestion that BMI may exacerbate long-term respiratory sequelae following COVID-19 (Rajotiya et al., 2024).

A study of 207 post-COVID Indian subjects (average age ~49 years) revealed substantial lung function deficits: 35% had restrictive defects (TLC < 80%), 44% had impaired diffusion capacity (DLCO < 80%), and reductions in FVC%, TLC%, DLCO%, and minimum SpO_2 during a 6-minute walk test were statistically significant ($p \leq 0.001$) in those with prior pneumonia compared to mild cases (Christopher et al., 2024). Interestingly, some research on healthy non-smoking individuals from Saudi Arabia found no significant differences in FEV_1 or FVC between obese and normal-weight groups (Al Ghobain, 2012) contrasting with the data of the present study. The present study speculate that the post-COVID condition may unmask or exacerbate respiratory dysfunctions that may not manifest in fully healthy obese individuals, amplifying BMI's detectable impact. While SpO_2 correlations were weaker, they remain significant. Small declines in oxygen saturation with increasing BMI may indicate subtle early ventilation–perfusion inefficiency, which is especially relevant in post-viral lung healing. Gender differences observed may be explained by female-specific fat distribution, lower baseline lung volumes, and differential respiratory muscle strength, making overweight females more vulnerable to post-COVID respiratory compromise.

Thus it can be established for the present study that elevated BMI is significantly associated with reduced pulmonary function in post-COVID young adults. Not only that, a stronger effects in females highlight the need for gender-sensitive respiratory assessment. So, routine BMI screening and weight-management strategies should be integrated into post-COVID rehabilitation protocols.

The present study recommends routine assessment of BMI and related anthropometric characteristics of indicators should be incorporated into post-COVID follow-up evaluations to identify individuals at greater risk of pulmonary impairment. Pulmonary rehabilitation programs should be designed with specific protocols for underweight and obese individuals to optimize respiratory recovery and improve lung function. Future research should focus on long-term pulmonary monitoring (beyond 6 months post-infection) to track recovery trends and understand the enduring impact of COVID-19 on respiratory health. Incorporating Ki anthropometric analysis in community-based studies will provide deeper insight into how physical structure interacts with disease outcomes, particularly in respiratory recovery. Policymakers should leverage region-specific data to craft localized public health strategies that address post-COVID care more effectively, accounting for regional variations in BMI and recovery outcomes.

Conclusion

The present study reveals a significant inverse relationship between BMI and pulmonary function parameters (FVC, FEV_1, and SpO_2) in post-COVID-19 individuals, with more pronounced effects in females. As BMI increases, lung function and oxygen saturation tend to decline, underscoring the burden of excess body weight on respiratory recovery following COVID-19 infection. These findings suggest that anthropometric factors like BMI are critical determinants of post-COVID respiratory outcomes and should not be overlooked during rehabilitation or risk assessment. Notably, females with higher BMI appear to be more vulnerable to pulmonary compromise, indicating a potential need for sex-specific interventions. The use of both correlation and Chi-square analyses provided a comprehensive understanding of these associations, confirming not only the strength and direction of the relationships but also their statistical significance.

In summary, BMI is an important predictor of pulmonary function in the post-COVID period and should be integrated into post-recovery evaluation protocols.

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Funding

The doctoral research of the corresponding author is funded by the University Grants Commission, Govt of India.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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