Journal of Associated Medical Sciences 2026; 59(2): 63-71

JAMS
Journal of Associated
Medical Sciences

Scopus Indexed & Thai-Journal Citation Index Centre (TCI)

Journal of Associated Medical Sciences

Journal homepage: https://www.tci-thaijo.org/index.php/bulletinAMS/index

Effects of core strengthening exercises on inspiratory muscle strength and functional capacity among obese college students

Kaviya Muralidharan* and Santhosh Kumar Sankar

SRM College of Physiotherapy, Faculty of Medicine and Health Sciences (SRMIST), Kattankulathur, Tamil Nadu, India.

ARTICLE INFO

Article history:
Received 16 February 2025
Accepted as revised 14 January 2026
Available online 23 January 2026

Keywords:
Obesity, core strengthening exercise, inspiratory muscle training, maximal inspiratory pressure, functional capacity.

ABSTRACT

Background: Obesity weakens core muscles, impacting posture, balance, and respiratory function. Central obesity is particularly harmful due to its effect on visceral organs. Exercises targeting the core and respiratory muscles, such as inspiratory muscle training, are essential for managing obesity and enhancing functional capacity.

Objectives: To investigate the impact of core strengthening exercises on the strength of inspiratory muscles and overall functional capacity among obese college students.

Materials and methods: A 6-week experimental study was carried out involving 34 participants selected using convenience sampling methods. Individuals aged 18-25 years, regardless of gender, with a BMI exceeding 25 kg/m^2 were included in the study. Maximal inspiratory pressure was measured using a respiratory pressure meter, and the 6-minute walk test was used to measure functional capacity.

Results: The mean age of subjects was 20.85±1.63. The mean value of maximal inspiratory pressure (cmH$_2$O) pre-test was 95.09±9.58 and post-test was 95.85±9.39. The mean six-minute walk distance (metres) pre-test was 399.15±38.62 and post-test was 412.18±35.25. Both improvements were statistically significant (p=0.003 for MIP and p<0.001 for 6-MWTD)

Conclusion: A six-week core strengthening exercise programmme significantly increases the strength of inspiratory muscles and overall functional capacity among obese college students. These results support the clinical use of core exercises in obesity rehabilitation to enhance respiratory strength and physical function.

Introduction

Obesity is a critical global health issue characterized by the excessive accumulation of body fat in adipose tissue, leading to significant physiological and functional impairments. Risk factors for obesity include excessive caloric intake, alcohol consumption, physical inactivity, poor self-regulation, inadequate sleep, and chronic stress.[1] According to the World Health Organization (WHO), the prevalence of obesity has nearly tripled since 1975, affecting over 650 million adults globally. In India, 192 million people are currently affected. According to the WHO Asian classification, a BMI above 25 kg/m^2 qualifies as obese, with further subdivisions into Obese Class I (25-9.9) and Class II (>30).

Obesity is linked to a wide range of comorbidities, including hypertension, type 2 diabetes, cardiovascular diseases, obstructive sleep apnea, osteoarthritis,

---

* **Corresponding contributor.**
Author's Address: *SRM College of Physiotherapy, Faculty of Medicine and Health Sciences (SRMIST), Kattankulathur, Tamil Nadu, India.*
E-mail address: kaviyam3@srmist.edu.in
doi: 10.12982/JAMS.2026.037
E-ISSN: 2539-6056

anxiety, depression, and certain cancers. The pattern of fat distribution has a significant influence on disease risk.[2] Central or abdominal obesity, which involves the accumulation of visceral fat, poses a higher risk for metabolic and cardiovascular complications than peripheral obesity, which is more associated with subcutaneous fat. This makes central obesity particularly relevant when considering interventions that target functional and respiratory outcomes.[3]

Among the lesser-addressed consequences of obesity is its impact on the musculoskeletal and respiratory systems. The accumulation of abdominal fat can alter body mechanics and place excess strain on the core musculature. The core, comprising the abdominal, lumbar, pelvic, and deep spinal muscles, plays a pivotal role in maintaining posture, stability, and balance during movement. Weakness in these muscles may further compromise respiratory function, as they play a crucial role in supporting diaphragmatic movement and thoracic expansion. Strengthening the core is therefore not only essential for improving postural control but may also have implications for respiratory efficiency and endurance.[4]

Obesity also contributes to a restrictive pulmonary pattern, characterized by reduced lung volumes, limited diaphragmatic excursion, and increased airway resistance. These changes can impair inspiratory muscle strength (IMS) and reduce overall functional capacity. As excess abdominal mass elevates the diaphragm and reduces lung compliance, the respiratory muscles must work harder, often resulting in fatigue and decreased exercise tolerance. Maximal inspiratory pressure (MIP), an indicator of IMS, is commonly reduced in individuals with higher BMI, especially those classified as obese or morbidly obese.[5]

Recent evidence supports the use of respiratory muscle training (RMT) in improving breathing efficiency and exercise tolerance in individuals with various chronic conditions, including obesity. A systematic review in 2021 reported lower MIP and MEP values in obese populations, emphasizez the need for interventions targeting respiratory muscle performance.[6] Functional capacity is defined as the ability to perform daily activities and physical tasks and is often compromised in obese individuals due to limited mobility, joint stress, and reduced cardiovascular endurance. The 6-minute walk test (6MWT) and VO_2 max are commonly used to assess this capacity and are negatively influenced by excess weight and inactivity.[7]

While previous research has explored respiratory training independently, there is limited evidence on the combined effect of core strengthening exercises on inspiratory muscle strength and functional capacity in obese populations, particularly among young adults. The core musculature's anatomical and functional proximity to the diaphragm suggests a potential synergistic effect that has not been fully explored in current literature. Establishing this link is important, especially in populations such as college students, where sedentary behaviors and early-onset obesity are prevalent.

This study aims to investigate the effects of a structured core strengthening exercise programme on inspiratory muscle strength and functional capacity among obese college students. By addressing the gap, this preliminary study may inform rehabilitation and preventive strategies targeted at young adults. The findings may offer practical implications for designing exercise protocols that enhance respiratory performance and physical function in this demographic.

Materials and methods

This study was a quasi-experimental study conducted over six weeks among 34 participants selected through convenience sampling. The sample size was calculated using the formula $N=Z^2 \cdot p \cdot q/d^2$, where Z=1.96 (95% confidence level), p=0.5 (assumed prevalence), q = 1-p=0.5, and d=0.168 (margin of error). Substituting the values: $N=(1.96)^2 \times (0.5 \times 0.5)/(0.168)^2 = 3.8416 \times 0.25/0.0282 = 0.9604/0.0282 = 34.06$; hence, the sample size was 34 participants.

Ethical approval for this study was obtained from the Institutional Ethics Committee of SRM Medical College Hospital and Research Centre on 25/04/2024 (IEC Clearance No. SRMIEC-ST0224-1149). Before data collection, the trial was prospectively registered with the Clinical Trial Registry of India (CTRI) under the registration number CTRI/2024/07/070549. All procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, and no changes were made to the study protocol after registration with CTRI.

The participant flow in this study was presented using the CONSORT 2010 Guidelines (Figure 1). Subjects aged 18-25 years, both male and female, with a BMI above 25 kg/m^2 based on the WHO Asian BMI classification[8] and an abdominal circumference greater than 102 cm for men and greater than 88 cm for women, were included in the study. Subjects with acute injuries (such as muscle strains, ligament sprains, or fractures), severe back pain, hypertension, diagnosed cardiovascular or pulmonary diseases, and recent abdominal or spinal surgeries were excluded from the study. Before the study, informed consent was obtained from the individuals after they were explained the procedure. Written informed consent was obtained from each participant following a comprehensive oral briefing about the study's aims, procedures, and ethical safeguards. The demographic data were obtained from the participants, including age, gender, height, weight, BMI, and waist circumference, which were documented prior to the commencement of the exercise protocol. The intervention sessions were supervised by trained physiotherapists. This was an open-label study with no blinding of participants, assessors, or intervention providers.

Prereading was taken by assessing the inspiratory muscle strength and functional capacity using a respiratory pressure meter and the 6MWT during the first week. Maximal inspiratory pressure was assessed with participants seated upright, feet flat on the floor, and wearing a nasal clip. Each participant performed three maximal inspiratory efforts starting from residual volume, with each effort lasting at least one second. A one-minute rest interval was provided between attempts, and the highest-pressure value was recorded.

Prediction equations for maximal respiratory pressure (PImax) [9,10]

Men: 142-(1.03×Age in years)

Women: -43+(0.71×Height in centimeter)

The six-minute walk test was carried out in a 30-metre hallway with cones marking each end, where participants were instructed to walk as far as possible within a six-minute period. To ensure consistency, standardized encouragement was provided, as it can influence performance, and the testing area was kept quiet with resuscitation equipment available for safety. At the end of the test, the total distance covered was recorded. Reference prediction equations proposed by Vaish *et al.* were used to interpret results, with the formula for females being 6MWD=856.55-16.08×age in years) and for males, 6MWD=681.97-(19.99×age in years)+(206×height in meters).[11] Following baseline testing, participants underwent a structured core strengthening program over six weeks, with three sessions per week, designed according to the FITT principle described by Kibler *et al.*[12] Each session lasted 15 to 30 minutes, performed at moderate intensity with progressive repetitions and sets. The exercise protocol focused on core strengthening movements, including knee planks and elbow planks (Figures 2. and 3.), pelvic bridges (Figure 4), crunches (Figure 5.), and reverse crunches (Figure 6). Before each session, a warm-up routine consisting of breathing exercises, spinal twists, cat-cow stretches, pelvic tilts, and arm circles was performed. The cool-down included cat-cow stretches, seated forward folds, and the child's pose to promote recovery. Details of the exercise protocol by week are presented in Table 1.

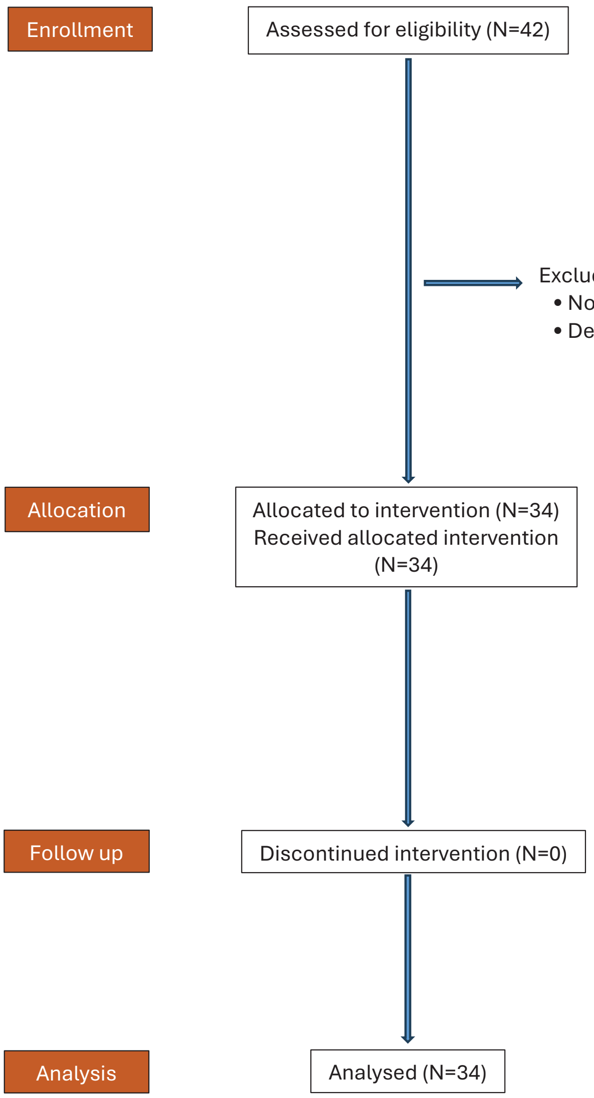

Figure 1. *The CONSORT diagram.*

Table 1. Core strengthening exercises protocol.

Week	Exercise	Rep	Sets	Rest time between sets (second)
1-2	Knee plank	10	2	60
	Bridges	12	2	60
	Crunches	15	2	60
	Reverse crunches	12	2	60
3-4	Elbow plank	12	3	60
	Bridges	15	3	60
	Crunches	20	3	60
	Reverse crunches	15	3	60
5-6	Elbow plank	15	3	60
	Pelvic bridges	18	3	60
	Crunches	20	3	60
	Reverse plank	12	3	60

***Note:** Rep: repetitions, Sets: number of sets completed per exercise. All exercises were performed under physiotherapist supervision. Rest time between each set was standardized at 60 seconds. Exercise intensity and technique were monitored to ensure safety, and progression was introduced every two weeks as shown in the table.*

Statistical analysis

The collected data were analyzed using IBM SPSS v22.0 to assess all parameters, including descriptive statistics, mean, and standard deviation of maximal inspiratory pressure and the six-minute walk test. The paired t-test was used to compare pre- and post-intervention outcomes. The assumption for paired t-tests, including normality of distribution, were assessed using Shapiro Wilk tests and visual inspection of Q-Q plots. A $p<0.05$ was considered statistically significant. All relevant p-values are reported alongside outcome data in the results section.

Results

A total of 34 obese college students participated in the study, with a mean age of 20.85±1.63 years. The participants had a mean height of 173.50±5.34 cm, weight of 90.36±9.43 kg, and BMI of 30.03±2.94 kg/m^2. Most participants were classified as Class I obesity (61.76%), while 38.24% were classified as Class II obesity. Following the 6-week core strengthening program, a statistically significant improvement in maximal inspiratory pressure (MIP) was observed, increasing from 95.09±9.58 cmH$_2$O at baseline to 95.85±9.39 cmH$_2$O post-intervention (mean difference = -1.24; 95% CI: -3.25 to -0.28; p=0.003). Functional capacity also improved significantly, with the 6-minute walk distance increasing from 399.15±38.62 m to 412.18±35.25 m (mean difference=-16.03; 95% CI: -10.02 to -8.82; p<0.001) as illustrated in Table 3. Predicted values compared with actual pre- and post-test values are presented in Table 4 and demonstrate changes consistently with the effects of the intervention.

***Figure 2.** Knee plank-starting position, engaging abdominal and core muscles. In a kneeling stance with hands shoulder width apart, the body is kept straight from knees to head while maintaining an isometric core contraction. This exercise primarily targets the rectus abdominis and transverse abdominis, and the hold is maintained for 20-60 seconds with gradual progression.*

Figure 3. *Elbow plank-advanced plank targeting deep core stabilizers. With forearms under the shoulders and legs extended, the body is held in a straight line while contracting the core, glutes, and shoulder stabilizers. This advanced plank targets deep core muscles and deltoids, ensuring hips do not pike or sag.*

Figure 4. *Pelvic bridges-exercise strengthening gluteal and lower back muscles. Supine with knees bent and feet hip-width apart, lift hips to form a straight line from knees to shoulders, keeping the pelvis stable. Targets glutes, erector spinae, and hamstrings; exhale up, inhale down, 12-15 reps, 2-3 sets.*

Figure 5. *Crunches-Abdominal exercise to build core endurance. Supine position with knees bent and hands behind the head or on the chest, lift the shoulders by contracting the abdominals and return with control. This exercise targets the rectus abdominis and is performed for 15-20 repetitions.*

Figure 6. *Reverse crunches-movement focusing on lower abdominal activation. Lying supine with hips and knees at 90°, lift the pelvis and draw the knees toward the chest, then lower with control. This exercise targets the lower rectus abdominis and transverse abdominis, performed for 12-15 repetitions.*

Table 2. Demographic characteristics.

Variable	Value
Age (years)	20.85±1.63
Height (cm)	173.50±5.34
Weight (kg)	90.36±9.43
BMI (kg/m^2)	30.03±2.94
Waist circumference (cm)	106.56±5.14
Gender, N (%)	Male: 29 (85.3%), Female: 5 (14.7%)
Obesity Class, N (%)	Class I: 21 (61.76%), Class II: 13 (38.24%)

***Note:** BMI: body mass index, mean±SD for continuous variables and frequency (%) for categorical variables.*

Table 3. Pre- and post- intervention comparison of the inspiratory muscle strength and functional capacity.

Outcome measure	Pre-test (Mean±SD)	Post-test (Mean±SD)	Mean difference	95% CI	t (df)	*p* value
MIP (cmH$_2$O)	95.09±9.58	95.85±9.39	-1.24	-3.25 to -0.28	33	0.003
6MWD (m)	399.15±38.62	412.18±35.25	-16.03	-10.02 to -8.82	33	<0.001

***Note:** MIP: maximum inspiratory pressure, 6MWD: 6-minute walk test distance (meters), m: meter. Paired t-test, p<0.05 was considered statistically significant.*

Table 4. Predicted and actual values of MIP and functional capacity (6MWD).

Outcome measure	Predicted value	Actual pre-test	Actual post-test
MIP (cmH$_2$O)	114.16	95.09±9.58	95.85±9.39
6MWD (m)	611.95	399.15±38.62	412.18±35.25

***Note:** MIP: maximum inspiratory pressure,6MWD: 6-minute walk distance, m: meter. Mean±SD.*

Discussion

The core strengthening exercises lead to improvement in the outcomes of Maximum inspiratory pressure and Functional capacity among obese individuals over 6 weeks. The observed improvements in MIP and functional performance may be attributed to the activation and enhanced coordination of the deep trunk muscles, facilitated by targeted core strengthening exercises, especially those muscles essential for supporting diaphragmatic movement and ensuring postural stability. With enhanced neuromuscular control of the core, participants presumably attained greater trunk stabilization efficiency, subsequently promoting improved breathing mechanics. This enhanced stability may have diminished dependence on compensatory and ineffective respiratory patterns frequently observed in obesity, facilitating a greater role for diaphragmatic breathing. As a result, the increased efficiency of inspiratory muscle activity most likely contributed to observable improvements in Inspiratory muscle strength and overall functional capacity, indicating greater integration of respiratory and postural functions during physical activity.

The overall respiratory compliance is diminished by as much as two-thirds of the standard value in individuals with obesity. This is partly caused by a reduction in lung compliance, which may be connected to the higher pulmonary blood volume observed in obese people. However, the primary cause is a decrease in chest wall compliance due to fat accumulation in and around the ribs, diaphragm, and abdomen. Compared to nonobese people, recumbency significantly lowers total respiratory compliance in obese people. This decrease is primarily attributable to reduced chest wall compliance, although an increase in respiratory resistance may also be a contributing factor.[13] Given that reduced chest wall compliance and increased respiratory resistance place a greater mechanical load on breathing, obese individuals often experience earlier fatigue and reduced movement efficiency, which directly influences their overall functional capacity.

Research has shown that obesity is associated with notable alterations in gait mechanics, including reduced walking speed, shortened stride length, and increased step breadth, which collectively reflect adaptations to the excess body mass and altered body biomechanics seen in this population. In addition to these changes, obese individuals often demonstrate impairments in postural stability, which can compromise balance control and contribute to a heightened risk of falls during both static and dynamic activities. These movement limitations are further compounded by the respiratory mechanical restrictions commonly observed in obesity, such as reduced chest wall compliance and increased work of breathing. Together, these musculoskeletal and respiratory constraints may result in a decrease in overall functional performance and an increase in energy expenditure during daily activities[14], which can accelerate the onset of fatigue, limit participation in physical tasks, and negatively impact overall physical independence and quality of life.

The main findings of this study are that core strengthening exercises resulted in a statistically significant increase in MIP from 95.09±9.58 cmH_2O to 95.85±9.39 cmH_2O (p=0.003). Although the absolute change of 0.76 cmH_2O may appear modest, it reflects improved diaphragmatic activation and endurance, which are clinically relevant in populations at risk for respiratory complications. Even small increases in MIP can be meaningful in preventing progression to respiratory muscle fatigue, especially in obese individuals. The improvement in MIP aligns with findings reported in the literature, which have enhanced pulmonary capacity and respiratory muscle power following core strengthening exercises in adults with substance use disorder[15] and increased peak inspiratory and expiratory pressures in children with bronchiectasis following core stability exercises. These results support the physiological rationale that core musculature provides structural support to respiratory function by stabilizing the trunk and facilitating diaphragmatic movement.[16]

Beyond the respiratory mechanics, these physiological changes have significant effects on functional ability. Enhanced trunk stability and more effective diaphragmatic movement can decrease the perceived effort of breathing during exertion, enabling individuals to maintain activity for extended periods. As a result, these modifications may manifest as measurable enhancements in submaximal exercise performance, as evidenced by advancements in the 6-Minute Walk Test (6MWT), a broadly recognised indicator of functional capacity. Functional capacity, as assessed by the 6MWT, also showed significant improvement in this study. The mean distance increased from 399.15±38.62 meters to 35.25±412.18 meters (p<0.001), demonstrating enhanced endurance and physical performance. Obesity often limits mobility and reduces cardiopulmonary efficiency due to excess body weight and poor muscle function. Research findings reported that obese individuals, including children, exhibited reduced functional capacity compared to their non-obese peers, consistent with the baseline values seen in our participants.[17,18]

Our findings are supported by the literature, which demonstrated that a six-week core strengthening program markedly enhanced both inspiratory strength and functional capacity in patients with chronic kidney disease undergoing hemodialysis and individuals with asthma.[19,20] These studies emphasize the broader applicability of core-focused interventions in improving respiratory and functional outcomes across various clinical populations. Physiologically, core strengthening exercises enhance the coordination and strength of the diaphragm and intercostal muscles, reduce chest wall resistance, and improve postural control, all of which contribute to better respiratory function. Obesity imposes a restrictive load on the respiratory system, and improvements in MIP reflect a partial reversal of this dysfunction. Functional capacity also benefits from improved balance, mobility, and muscular endurance, which are outcomes associated with enhanced core stability.

Despite the positive findings, this study has several limitations. The sample size was relatively small and limited to a single age group (18-25 years) and educational setting, which reduced the generalizability of the results. The short intervention period (six weeks) may not capture long-term benefits or the sustainability of the improvements. The absence of a control group limits the ability to attribute all changes solely to the intervention. Future studies should consider larger, randomized controlled designs with longer follow-up periods, and include objective assessments of physical activity and adherence to exercise protocols.

In conclusion, the significant improvements in inspiratory muscle strength and functional capacity observed in this study highlight the value of core strengthening exercises as a non-pharmacological strategy in the management of obesity. These findings support the inclusion of core-focused physical activity in university wellness programmes, rehabilitation protocols, and public health initiatives aimed at reducing obesity-related complications and promoting functional independence in young adults.

Conclusion

The results of this study demonstrate that enhancements in core stability are associated with improved respiratory function and functional capacity in obese individuals. Specifically, improvements in maximal inspiratory pressure (MIP) and enhanced walking capacity on the 6MWT indicate significant physiological and functional advancements. According to these findings, core-focused therapies enhance respiratory strength and general functional performance, which have clinically significant advantages.

Ethical approval

Ethical approval was obtained from the Institutional Ethics Committee of SRM Medical College Hospital and Research Centre on 25.04.2024. The ethical clearance number is SRMIEC-ST0224-1149.

Clinical implication

The findings suggest that core strengthening exercises may serve as a practical and cost-effective intervention to improve inspiratory muscle performance and functional capacity in obese individuals. Incorporating such exercises into routine rehabilitation programs may help address common functional limitations in this population and enhance overall movement efficiency and respiratory function.

Conflict of interest

The authors declare no conflict of interest with respect to the research, authorship and /or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

CRediT authorship contribution statement

Kaviya Muralidharan: conceptualisation, methodology, investigation, data curation, formal analysis, writing: original draft, review and edit, project administration, supervision; **Santhosh Kumar**: investigation, data curation, formal analysis, validation, writing: review and edit.

Acknowledgements

The authors would like to express their sincere gratitude to SRM College of Physiotherapy for providing the necessary facilities, institutional support, and a conducive academic environment to carry out this research. We also extend our heartfelt thanks to the students who willingly participated in this study for their time, cooperation, and valuable contribution, without which this research would not have been possible.

References

[1] World Health Organization. Obesity and overweight [Internet]. WHO; 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

[2] GBD 2019 risk factors collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. Lancet. 2020; 396(10258): 1223-49. doi:10.1016/S0140-6736(20)30752-2.

[3] Després JP. Body fat distribution and risk of cardiovascular disease: an update. Circulation. 2012; 126(10): 1301-13. doi:10.1161/CIRCULATIONAHA.111.067264.

[4] McGill SM. Core training: evidence translating to better performance and injury prevention. Strength Cond J. 2010; 32(3): 33-46. doi:10.1519/SSC.0b013e3181df4521.

[5] Caicedo-Trujillo S, Torres-Castro R, Vasconcello-Castillo L, Solis-Navarro L, Sanchez-Ramirez D, Núñez-Cortés R, et al. Inspiratory muscle training in patients with obesity: a systematic review and meta-analysis. Front Med (Lausanne). 2023; 10: 1284689.doi:10.3389/fmed.2023.1284689.

[6] Torun E, Cakir E, Ozgüç F, Ozgen IT. The effect of obesity degree on childhood pulmonary function tests. Balkan Med J. 2014; 31(3): 235-8. doi: 10.5152/balkanmedj.2014.13101.

[7] Vincent HK, Vincent KR, Lamb KM. Obesity and mobility disability in the older adult. Obes Rev. 2010; 11(8): 568-79. doi: 10.1111/j.1467-789X.2009.00703.x.

[8] WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet. 2004; 363(9403): 157-63. doi:10.1016/S0140-6736(03)15268-3.

[9] Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis. 1969; 99(5): 696-702. doi:10.1164/arrd.1969.99.5.696.

[10] Evans JA, Whitelaw WA. The assessment of maximal respiratory mouth pressures in adults. Respir Care. 2009; 54(10): 1348-59.

[11] Vaish H, Gupta S, Sharma S. Six minute walk distance and six minute walk work in young adults aged 18-25 years. Int J Pharm Med Res. 2017;5(3):464-8. https://www.researchgate.net/publication/328274875.

[12] Kibler WB, Press J, Sciascia A. The role of core stability in athletic function. Sports Med. 2006; 36(3): 189-98. doi:10.2165/00007256-200636030-00001.

[13] Parameswaran K, Todd DC, Soth M. Altered respiratory physiology in obesity. Can Respir J. 2006; 13(4): 203-10. doi: 10.1155/2006/834786.

[14] Lai PP, Leung AK, Li AN, Zhang M. Three-dimensional gait analysis of obese adults. Clin Biomech (Bristol). 2008; 23(Suppl 1): S2-6. doi: 10.1016/j.clinbiomech.2008.02.004.

[15] Mustafaoglu R, Demir R, Demirci AC, Yigit Z. Effects of core stabilization exercises on pulmonary function, respiratory muscle strength, and functional capacity in adolescents with substance use disorder: randomized controlled trial. Pediatr Pulmonol. 2019; 54(7): 100211. doi:10.1002/ppul.24330.

[16] Vardar-Yagli N, Saglam M, Caik-Kutukcu E, Inal-Ince D, Arikan H, Kiper N. Effects of core stabilization training on balance, functional capacity, and respiratory muscle strength in children with bronchiectasis. Eur Respir J. 2014; 44(Suppl 58): P4279. doi:10.1183/13993003/erj.44.Suppl_58.P4279.

[17] Özgen İT, Çakır E, Torun E, Güleş A, Hepokur MN, Cesur Y. Relationship Between Functional Exercise Capacity and Lung Functions in Obese Chidren. J Clin Res Pediatr Endocrinol. 2015;7(3):217–21. doi:10.4274/jcrpe.1990.

[18] O'Donnell DE, Laveneziana P. The clinical importance of dynamic lung hyperinflation in COPD. COPD. 2006;3(4):219-32. doi:10.1080/15412550600977478.

[19] Waghmare PD, Das AK, Diwate AD. Effect of six-week core strengthening exercises on inspiratory

muscle strength and functional capacity in patients with chronic kidney disease undergoing haemodialysis. Int J Community Med Public Health. 2025; 11(3): 1311-3. doi.org/10.18203/2394-6040.ijcmph20240637.

[20] Develi E, Subasi F, Aslan GK, Bingol Z. The effects of core stabilization training on dynamic balance and pulmonary parameters in patients with asthma. J Back Musculoskelet Rehabil. 2021; 34(4): 639-48. doi:10.3233/BMR-191803.