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The effect of breathing exercises on respiratory function, anthropometric parameters, and functional exercise capacity in subjects with obesity: A scoping review

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Abstract:

Obesity is a chronic medical condition with a significant socioeconomic impact on health systems. Management of obesity primarily focuses on physical exercise combined with an appropriate diet. However, emerging evidence suggests that breathing exercises may serve as a complementary intervention in obesity management programs. This study aimed to summarize the available literature on the effects of breathing exercises on lung function, anthropometric parameters, and functional exercise capacity in subjects with obesity. A scoping review was conducted following the Joanna Briggs Institute (JBI) scoping review methodology. Studies in English or Persian were searched in Cochrane, ISI Web of Science, PubMed, Embase, Scopus, ScienceDirect, CINAHL, PEDro, Magiran, MOH thesis, MOH articles, Irandoc, and SID databases. Randomized controlled trials and quasi-experimental studies involving individuals with a Body Mass Index >30 kg/m², regardless of age, gender, or race, and implementing breathing exercises in any setting, country, or follow-up duration, were included. Of the 2,077 articles identified, 19 studies were included. Seventeen studies focused on lung function, ten studies evaluated anthropometric parameters and functional exercise capacity, 14 studies were conducted on adults, and five studies evaluated children and adolescents. Fifteen studies were from Asian and European countries, two from Brazil, one from Chile, and one from Africa. Various breathing exercises were used, with durations ranging from 3 days to 12 weeks. In 9 of 17 studies, breathing exercises improved lung function. Improvements in anthropometric parameters and functional exercise capacity were observed in 7 of 10 studies. Our findings indicate that breathing exercises can improve lung function, anthropometric parameters, and functional exercise capacity in subjects with obesity.

Keywords:

Anthropometry, breathing exercises, exercise tolerance, obesity, respiration

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Introduction

Obesity is characterized by the excessive accumulation of body fat[1] and is associated with chronic health conditions such as type 2 diabetes mellitus, heart disease, hyperlipidemia, hypertension, obstructive sleep apnea, and depression.[2] The prevalence of obesity has increased due to the consumption of energy-dense, nutrient-poor foods high in sugar and saturated fats, combined with reduced physical activity.[3] Data from the World Obesity Federation indicate that 158 million children and adolescents aged 5 to 19 years were obese in 2020, with projections of 206 million in 2025 and 254 million in 2030.[4] This rising prevalence highlights the urgent need for effective obesity management interventions.[5] The primary goal of obesity management is weight reduction. Physical activity and nutritional control are the main components of weight loss programs.[6,7] Although reducing energy intake is the most effective method for weight reduction, physical activity is crucial for long-term weight management.[2] Obesity imposes a significant burden on the respiratory system.[8,9] The increased oxygen cost of breathing in obesity results from competition between locomotor and respiratory muscles.[10] Individuals with obesity may be predisposed to respiratory muscle fatigue during physical activity, which is a potential mechanism for dyspnea during exertion.[11] Experiencing dyspnea during exercise can decrease the ability to tolerate physical activity.[12] As obesity increases respiratory demands, breathing exercises may reduce respiratory muscle fatigue and improve exercise tolerance.[13] Given the relationship between obesity and respiratory muscle function, respiratory muscle training should be considered in obesity management. Breathing exercises may improve respiratory muscle function, enhance physical activity tolerance, alleviate shortness of breath during physical activities, increase motivation for physical activity, and promote weight loss.[10,11,13–16] Various studies with different protocols and findings have been conducted in this field, but a search of scientific databases indicated that this evidence has not been systematically summarized. To the best of our knowledge, some studies have been conducted in Asian and European countries[10,13–26] but only one study was conducted in Africa.[11]. Two studies were conducted in Brazil,[27,28] and one study was conducted in Chile.[2] Most studies focused on adults,[2,11,13–17,19–21,24,25,27,28] while fewer studies were conducted on children and adolescents.[10,18,22,23,26] Three studies included only young women.[24,25,27] Four studies evaluated only young men,[10,19,22,23] and the gender of participations was not reported in four studies.[2,16,20,26] Various breathing exercises were used, including respiratory muscle endurance training,[2,10,11,22] inspiratory muscle strength training,[13–16,28] respiratory muscle interval training,[23] threshold or incentive spirometry,[18,20,21,27] diaphragmatic breathing,[17,25,26] Senobi breathing exercise,[24] breathing exercise with a wind instrument,[21] deep breathing training, and breathing with a tube.[19] The duration of breathing exercises ranged from 3 days to 12 weeks.[2,19,25] In the search process, the authors found only one systematic review that examined the effects of inspiratory muscle training in subjects with obesity. This study was limited only to incentive spirometry exercise; other types of breathing exercises were not studied. In addition, the study included a heterogeneous population (diabetic subjects with obesity and post-bariatric surgery patients).[5] Therefore, the exact effect of breathing exercises on obesity cannot be inferred. The objective of this scoping review was to systematically map the research on the effects of breathing exercises on lung function, anthropometric parameters, and functional exercise capacity in subjects with obesity.

Materials and Methods

Protocol and registration

A scoping review was conducted following the Joanna Briggs Institute (JBI) scoping review methodology.[29,30] This review was prepared in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) extension for Scoping Reviews.[31] The review protocol was registered in PROSPERO (International Prospective Register of Systematic Reviews – CRD42023445090).

Eligibility criteria

The PCC (Population, Concept, and Context) framework was used to define eligibility criteria. Published interventional studies (randomized controlled trials or quasi-experimental) involving breathing exercises, written in English or Persian, and conducted on subjects with obesity, regardless of age, gender, race, setting, country, or protocol, were included. Studies examining the effectiveness of breathing exercises before and after surgery, as well as abstracts, conference papers, editorials, letters to the editor, review studies, and case studies, were excluded.

Population: This review included studies conducted on subjects with obesity, regardless of gender, age, or race. Studies involving subjects without obesity or those with specific musculoskeletal, cardiopulmonary, metabolic, or neurological disorders were excluded.

Concept: Studies providing evidence on the effects of breathing exercises in subjects with obesity were included.

Context: Studies focusing on the effects of breathing exercises on lung function, anthropometric parameters, and functional exercise capacity were included.

Information sources

A comprehensive search was conducted on September 9, 2023, in Cochrane, ISI Web of Science, PubMed, Embase, Scopus, ScienceDirect, CINAHL, PEDro, Magiran, MOH thesis, MOH articles, Irandoc, and SID databases. The search was supplemented by contacting authors to identify relevant studies and by scanning the reference lists of relevant sources. The search strategies were drafted by an experienced librarian (AR) and refined through team discussion. The search covered all databases without date limitations and was repeated monthly until May 5, 2025.

Search

The search strategy included all identified main keywords and related terms. The main keywords were MeSH (Medical Subject Headings) terms for breathing exercises, respiratory function, anthropometric parameters, functional exercise capacity, and obesity (Appendix 1). Keywords were updated during the search process to align with the PCC framework. Two researchers independently performed the literature search.

Selection of sources of evidence

Following the search, all identified studies were exported into EndNote X8 (2016 Thomson Reuters, PA, USA), and duplicates were removed. Two researchers independently screened the titles and abstracts, excluding irrelevant studies. The full texts of the remaining studies were retrieved and assessed independently by two researchers to determine eligibility. Disagreements were resolved through team discussion. The reference lists of included studies were also screened for additional studies (hand search). Review studies were not included, but their reference lists were checked. If full-text access was unavailable, the corresponding or first author, or the journal editor, was contacted up to three times. If unsuccessful, the article was excluded. Reasons for exclusion were recorded. Quality appraisal of selected studies was not conducted, as this is not standard in scoping reviews, which aim to provide an overview of the literature.

Data extraction process

Studies passing the initial title and abstract screening and meeting eligibility criteria underwent full-text analysis. Relevant information was extracted by two independent researchers using a data-charting form designed to identify variables for extraction. The researchers independently charted the data, discussed results, and resolved disagreements through team discussion. Extracted data included article characteristics (corresponding author, study year, study population, number of subjects, and gender), type of breathing exercises, and related information when available (duration, frequency, intensity, outcome measures [respiratory function, anthropometric parameters, and functional exercise capacity], and main findings). These data were reported in a data-charting form.

Synthesis of results

The extracted data were synthesized to provide a descriptive overview of the literature on the effects of breathing exercises in subjects with obesity. A narrative synthesis approach, common in scoping reviews, was employed to summarize and explain the findings due to the heterogeneity of the evidence, which made statistical meta-analysis infeasible.

It should be noted that we did not use artificial intelligence-assisted technologies in the production of this study.

Results

Selection of sources of evidence

The search identified 2,077 studies from the mentioned databases. After removing 859 duplicates, 1,218 studies remained. By reviewing titles, 1,044 irrelevant studies were excluded. After reviewing abstracts of the remaining 174 studies, 159 were excluded for the following reasons: conference papers, editorials, letters to editors, or review studies (n=22); not focused on the objectives of this review (n=35); evaluation of the effects of breathing exercises before and after surgery (n=12); conducted on obese subjects with specific underlying diseases (n=66);

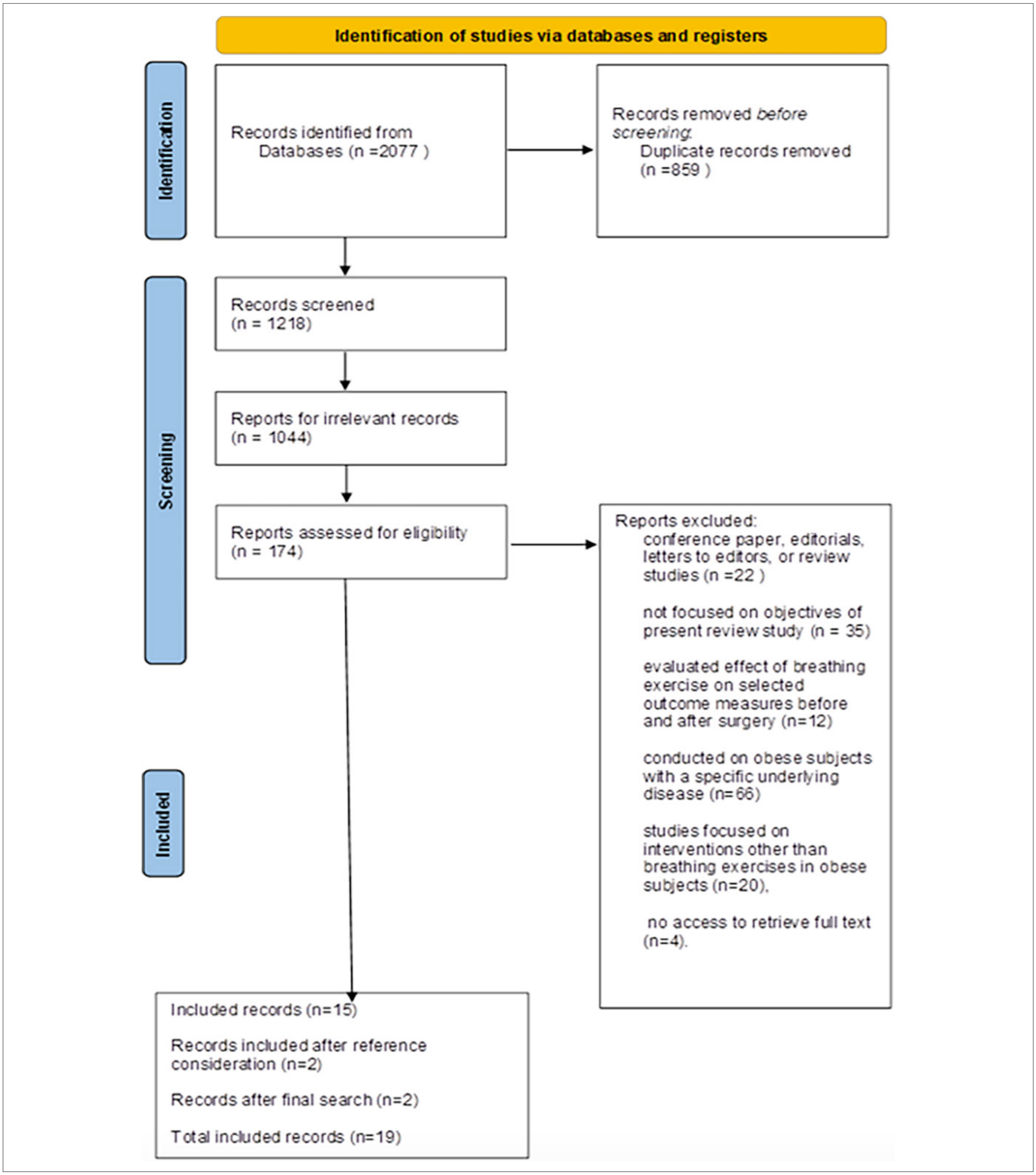

Figure 1: PRISMA 2020 flow diagram

focused on exercises other than breathing exercises in obese subjects (n=20); or no access to full text (n=4). Seven studies were identified from reference lists, but only two were included in the final analysis. Ultimately, 19 studies were deemed eligible for final analysis. This process is summarized in Figure 1.

Characteristics of sources of evidence

The included studies were published between 2006 and 2024, with most (n=10) published between 2010 and 2017. Studies originated from India,[16,20,21,25] Italy (n=3),[10,22,23] Brazil (n=2),[27,28] and Australia (n=2).[13,14] Others were from Chile, Egypt, France, Japan, Poland, Switzerland, Taiwan, and Thailand (n=8).[2,11,15,17–19,24,26] The studies included randomized controlled trials (n=16) and quasi-experimental studies (n=3). The included studies were conducted on both male and female subjects across different age groups. Eight studies included both men and women,[2,10,11,18,24–26,28] three studies included only women, [19,22,29] and four studies included only men.[10,20,21,27] In four studies, the gender of participants was not reported.[16,17,23,30] Regarding age, 73.6% (14/19) of the studies were conducted on adult subjects (over 18 years),[2,11,13–17,19–21,24,25,27,28] and 26.4% (5/19) on children and adolescences (under 18 years).[10,18,22,23,26] The youngest subjects were in a study by Kaeotawee[18] (8–15 years old), and the oldest were in a study by Abdelaal[17] (47–67 years old). We categorized studies according to intervention and outcomes as follows:

Intervention characteristics

The duration of breathing exercise sessions varied from 10 minutes[25] to 40 minutes.[16,21] Intervention protocols ranged from three days[25] to 12 weeks.[2,19] The frequency of breathing exercises ranged from once per week[13,17,18,26,27] to five days per week.[10,16,20–22] Intensity was based on maximum inspiratory pressure (MIP), maximum voluntary ventilation (MVV), and forced vital capacity (FVC). The intensity of breathing exercises in training groups was 30% of MIP,[27,28] 40% of MIP,[18,23] 55% of MIP,[13–15] 50–60% of MVV,[10] 60–80% of MVV,[11] and 50–60% of FVC.[22]

Considering the type of exercise, different forms of breathing exercises were used. In five studies, inspiratory muscle training (IMT) was used.[13–16,28] In four studies, respiratory muscle endurance training (RMET) was used.[2,10,11,22] In three studies, diaphragmatic breathing was used.[17,25,26] In three studies, an incentive spirometer was used.[18,20,21] In two studies, a threshold spirometer was used.[18,27] In one study, respiratory muscle interval training (RMIT; inspiratory and expiratory training) was used.[23] In one study, a wind instrument or flute was used.[21] In one study, inverse ratio breathing was used.[25] In one study, the Senobi breathing method was used.[24] Finally, in one study, deep breathing training and breathing training with a tube were used.[19]

Outcomes characteristics

Seventeen studies evaluated respiratory function pre- and post-intervention,[2,10,11,13,15–23,25–28] comparing 217 subjects in the control group with 352 in the intervention group. In ten studies, respiratory function (at least one spirometry parameter) improved post-intervention. [11,16,17,19–23,26,28] In six studies, respiratory function remained unchanged,[10,13,15,18,25,27] and one study did not report changes in respiratory function.[2] Spirometry tests were used in all studies to assess respiratory function.

Ten studies evaluated anthropometric parameters,[2,10,11,13,15,16,18,22–24] comparing 139 subjects in the control group with 161 in the intervention group. In seven studies, anthropometric parameters improved post-intervention. [2,10,11,18,22–24] In one study, no changes were observed,[15] and two studies did not report changes.[13,16] Anthropometric parameters included body mass index or body weight in nine studies,[2,10,11,15,16,18,22–24] body fat or fat mass in five studies,[2,15,22–24] and body circumferences in two studies.[2,18]

Ten studies assessed functional exercise capacity,[2,10,11,13–18,22] comparing 159 subjects in the control group with 192 in the intervention group. Eight studies reported improvements in functional exercise capacity,[2,11,13–18] while two studies reported no changes.[10,22] The 6-minute walk test (6MWT) was used to measure functional exercise capacity in all studies except two, which used VO2 max,[10,22] and one study that used both 6MWT and VO2 max.[16]

Results of individual sources of evidence

The characteristics of included studies, outcome measures (respiratory function, anthropometric parameters, and functional exercise capacity), and main findings are summarized in Appendix 1.

Synthesis of results

Villiot-Danger et al.,[11] Salvadego et al.,[23] Frank et al.,[2] and Alemayehu et al.[10] demonstrated that respiratory muscle endurance training at 50% of maximum voluntary ventilation, 60–80% of maximum voluntary ventilation, and 50–60% of forced vital capacity, respectively, improved exercise capacity and weight loss. Kaeotawee et al.[18] indicated that threshold inspiratory muscle training for eight weeks with 30 breaths had no significant effect on lung function. Rekha et al.[20] showed that four weeks of incentive spirometry with 15–20 repetitions improved lung function.

Studies by Edwards et al.,[13,14] Ponde et al.,[16] Kuo et al.,[15] Barbalho-Moulim et al.[27] and Tenório et al.[28] demonstrated that inspiratory muscle training at 30–80% of maximum inspiratory pressure for 2–12 weeks improved functional exercise capacity and inspiratory muscle strength, but spirometry parameters remained unchanged. Ved et al.[25] and Parra-Vera et al.[26] showed that 10–20 minutes of diaphragmatic breathing with a 1:2 inspiration-to-expiration ratio and 6–10 breaths for three days to eight weeks improved lung function in 15 obese female adults and 28 obese adolescents.

Rekha et al.[21] compared respiratory muscle training with a wind instrument to incentive spirometry (five days a week for five weeks, one session per day for 40 minutes) on pulmonary function and dyspnea among 40 subjects with obesity (aged 18–30 years). Results showed improvements in pulmonary function and dyspnea in both groups, with the wind instrument being more effective.

Salvadego et al.[23] demonstrated that respiratory muscle interval training (12 sessions over three weeks) in subjects with obesity reduced body mass index (BMI) compared to a sham group. Sato et al.[24] used the Senobi breathing method (deep abdominal breathing with trunk extension and upper limb elevation) in 40 obese females, showing significant reductions in body weight and fat after one month of 5-second inhalation and 5-second exhalation exercises.[29]

Kruk et al.[19] showed that three months of respiratory muscle training, including deep breathing and breathing through a tube, combined with 10–15 minutes of moderate-intensity walking in 60 overweight men, improved pulmonary function, particularly in the deep breathing group.[27]

Discussion

Summary of evidence

This scoping review systematically mapped research on the effects of breathing exercises on respiratory function, anthropometric parameters, and functional exercise capacity in subjects with obesity. The findings suggest that breathing exercises can improve these outcomes, serving as a key strategy to help obese individuals overcome breathlessness, which often leads to reduced participation in whole-body exercise programs.[23] These findings can be utilized by healthcare providers, patients, policymakers, and researchers. Breathing exercises may be recommended as part of the multidisciplinary management of obesity, alongside nutritional therapy and physical activity.

Nineteen studies with various protocols, published between 2006 and 2024, were identified. Most studies originated from India, Italy, Brazil, Australia, Japan, Switzerland, Taiwan, Egypt, Chile, France, Poland, and Thailand. Approximately 26.4% of studies focused on children and adolescents, while 73.6% involved adults. Given the importance of obesity management from an early age, further studies are needed on children and adolescents. Most studies were conducted in Asian and European countries; additional research in other regions, such as Africa, is recommended due to differences in lifestyle and nutritional conditions.

Various breathing exercises were used, including respiratory muscle endurance training,[2,10,11,22] inspiratory muscle strength training,[13–16,28] respiratory muscle interval training,[23] threshold or incentive spirometry,[26] diaphragmatic breathing,[19,25,30] Senobi breathing exercise,[29] breathing exercise with a wind instrument,[21] and deep breathing training or breathing with a tube.[27] The duration of breathing exercises ranged from three days to 12 weeks (three months).[2,19,27] Seventeen studies examined lung function, with eight reporting improvements in spirometry parameters. For example, four weeks of inspiratory muscle training with an incentive spirometer improved lung volumes and reduced dyspnea in 25 subjects with obesity.[20] Another study showed that three weeks of respiratory muscle endurance training (50–60% of FVC) improved lung function.[10] The authors suggested that such training prevents respiratory muscle fatigue, reduces sympathetic vasoconstriction in locomotor muscles, and increases muscle oxygen availability, thereby improving lung function.[22] Six weeks of inspiratory muscle training combined with aerobic exercise also improved lung function compared to aerobic exercise alone, likely due to enhanced diaphragm function, reduced accessory muscle recruitment, and improved breathing patterns.[16]

Some studies reported increased type II muscle fibers and reduced type I fibers in obese subjects, with training increasing the proportion and size of type II fibers.[16] Diaphragmatic breathing exercises stimulate an increase in the proportion and size of type II muscle fibers, which favors the development of muscle strength, optimizes neuromuscular recruitment, and generates faster contractions.

In addition, diaphragmatic breathing exercises promote muscle oxygenation and reduce lactate production by the respiratory muscles, preventing fatigue. Activation of the respiratory muscles improves expansion of the rib cage, which is reflected in the effective mobilization of lung volumes and overall improvement in lung function.[17,25,26]

In a study by Salvadego et al.,[23] respiratory muscle interval training (inspiratory and expiratory muscle training) for 12 weeks at an intensity of 40% maximal inspiratory and expiratory pressure in adolescent and young obese men was shown to increase lung volumes. Increased lung volumes are indicators of improved respiratory function and respiratory muscle unloading. Respiratory responses presumably induce metabolic improvements and reduce the perception of breathlessness. The proposed mechanism behind this link is a change in respiratory and locomotor muscle blood flow associated with changes in the work of breathing. Unloaded breathing can lead to decreased blood flow to the accessory respiratory muscles and increased blood flow to the exercising limbs. In another study, it was shown that inverse ratio breathing exercises (inspiration for four seconds and expiration for two seconds) can help increase lung volumes. During inverse ratio ventilation, inspiration time is longer than expiration time, which increases mean airway pressure. Increased mean airway pressure improves alveolar stability and recruitment, decreases dead space ventilation, and enhances oxygenation. However, since expiration time is shorter than inspiration time, alveoli may not have sufficient time to empty during exhalation, causing gas trapping in the lungs. As a result, more surface area is available for gas exchange and ventilation, leading to improved lung volumes.[25]

In a study by Kruk et al.,[19] it was shown that three months of deep breathing training and breathing training with a tube (Positive Expiratory Pressure Mask), consisting of 4–8 second inhalations and 4–8 second exhalations with emphasis on proper diaphragmatic use during inspiration, combined with 10–15 minutes of moderate-intensity walking in 60 overweight men, improved spirometry and pyrometry parameters. These included respiratory exchange ratio (RER), breathing frequency (Bf), tidal volume (TV), minute ventilation (VE), forced vital capacity, maximal voluntary ventilation, peak inspiratory pressure (INSPp), peak expiratory pressure (EXPp), holding pressure during inspiration (HPinsp), and holding pressure during expiration (HPiexp), particularly in the deep breathing group.[19] It can be concluded that in subjects with obesity, deep breathing appeared superior to tube breathing in improving pulmonary function, likely due to reduced lung restriction and enhanced breathing capacity.[19]

In 13 studies, the effect of breathing exercises on respiratory muscle strength was investigated by measuring maximum inspiratory pressure and maximum expiratory pressure.[2,11,13–20,26–28] Except for two studies,[2,11] respiratory muscle strength improved in the others. Respiratory muscle training stimulates structural remodeling of type I and type II fibers and increases the proportion and size of type II muscle fibers, which favors the development of muscle strength, optimizes neuromuscular recruitment, and generates faster contractions.[16,26] In studies where respiratory muscle strength did not improve, submaximal intensity endurance training (50% or 60–80% MVV) was used, though it enhanced respiratory muscle endurance.[2,11] In five studies, it was reported that respiratory function did not improve with breathing exercises. In these studies, the intensity of breathing exercises was set at 30%, 40%, or 55% of maximum inspiratory pressure[13,15,18,27] and 50–60% of maximum voluntary ventilation.[10] This may be related to the fact that improvements in respiratory muscular efficiency were insufficient to modify ventilation mechanics.[28]

In 5 of 17 studies, no change in any spirometry parameter was observed.[10,13,15,18,27] These studies included the use of incentive and threshold spirometry with 30 breaths per minute,[18] inspiratory muscle training at 30%,[27] 40%,[18] and 55%[13] of maximum inspiratory pressure, and respiratory muscle endurance training at 55–60% of maximum voluntary ventilation.[10] The duration of these exercises varied from 2 weeks,[27] 3 weeks,[10] 4 weeks,[13] 6 weeks,[15] to 8 weeks.[18]

Anthropometric parameters improved in 7 out of 10 studies, likely due to reduced dyspnea, enhanced respiratory muscle strength, lower oxygen consumption, and reduced respiratory fatigue, which motivated increased physical activity.[10,16,20,22,23] Respiratory muscle training also improved rib cage expansion, lung compliance, and reduced airway resistance.[25,26] As a result, these factors gave obese subjects more motivation and energy to engage in physical activity. In one study, no change in anthropometric parameters (BMI and body fat percentage) or pulmonary function was observed after breathing exercises.[15] Inspiratory muscle training at 55% of maximum inspiratory pressure for six weeks was used in this study.

In ten studies, the effect of breathing exercises on functional exercise capacity was evaluated. Functional exercise capacity improved in eight out of ten studies. In two studies, it was measured by VO_{2max}.[10,22] In one study, this parameter was measured by both the 6MWT and VO_{2max};[15] and in the other seven studies, by the 6MWT.[2,11–14,26,27] Breathing exercises appear to reduce overall exercise energy demands and respiratory work, decrease lactate production in ventilatory muscles during exercise, enhance the use of circulating lactate as metabolic fuel, increase blood flow to exercising legs, and thereby improve functional exercise capacity.[10,15,22] The 6MWT improved in all studies,[2,11–15,26,27] which can be a strong indicator of increased physical activity and exercise tolerance in subjects with obesity. Improved functional exercise capacity can help subjects with obesity continue exercising with greater motivation and ability, supporting weight loss. In two studies, functional exercise capacity was measured with VO_{2max}, and no improvement was observed.[10,22] Although VO_{2max} did not change significantly in these two studies, reductions in oxygen consumption and dyspnea after intervention can be considered indirect indicators of improved functional exercise capacity.[10,22] Breathing exercises can reduce exercise intolerance, promote weight reduction, and serve as a preparatory strategy for physical training programs in subjects with obesity.[12,13] Differences in results may be related to the following points. VO_{2max}, as an index of cardiorespiratory fitness, is the maximal oxygen uptake during a progressive treadmill or cycling test conducted to exhaustion.[32] In contrast, the 6MWT is a submaximal test in which subjects are instructed to walk as fast as possible for six minutes.[33] The VO_{2max} test appears to be more demanding and energy-consuming for subjects with obesity compared with the 6MWT.

There were some limitations in these studies. For example, some were conducted only on young women[24,25,27] or young men.[10,19,22,23] The gender of participants was not reported in some studies.[16,20,26,28] Sample sizes were very small in certain studies, making analysis of the final results difficult.[10,11,13,22,23] The duration of breathing exercises was relatively short in some studies,[10,11,13,14,20–25,27] and a clear treatment protocol (intensity, repetition, frequency) of breathing exercises was not explained in four studies.[14,17,24,28] Most exercises focused on inspiratory (endurance or resistance) training, with less emphasis on expiratory exercises. Although structural changes in the thorax and rib cage occur in subjects with obesity, previous studies did not fully examine the effects of breathing exercises on lung function, anthropometric parameters, and functional exercise capacity in this population.

No adverse events were reported for breathing exercises, suggesting safety in healthy subjects with obesity, though caution is needed for those with specific conditions (e.g., cardiac, respiratory, or diabetes). Breathing exercises may benefit individuals unable to tolerate exercise training or perform outdoor activities[12,16] and could enhance adherence to physical activity prescriptions, particularly in children and adolescents.[7,11]

The results support breathing exercises as a key component in multidisciplinary obesity management alongside diet and physical activity.[6] They can inform physical therapy planning and clinical guidelines and highlight areas for future research.

The main reason for the inability to perform a meta-analysis was the variety of treatment protocols, heterogeneity of target groups, and outcome measurements. As mentioned, different breathing exercises with different protocols were used. In some studies, different groups participated (only men, only women, elderly, or children and adolescents). For example, RMET was used for 3–4 weeks, 3–4 days per week, and at 60–80% of MVV in one study,[11] while RMET was applied for 3–4 weeks, 5 days per week, and at 50–60% of FVC in another.[22] RMET was also used for 12 weeks at 50% of MVV in the study by Frank et al.[2] IMT was used with different protocols: 8 weeks at 40% of MIP;[18] 2–4 weeks at 30% of MIP;[27] 4 weeks at 55% of MIP;[13,14] 3 weeks at 40% of MIP;[23] 6 weeks at 55% of MIP;[15] and 12 weeks at 30% of MIP.[28] Diaphragmatic (abdominal) breathing was also applied with different protocols: 1 month,[24] 3 days,[25] 8 weeks,[26] and 3 months.[19] Incentive or threshold spirometry was used for 5 weeks, 5 days per week;[21] 8 weeks, twice daily;[18] 2–4 weeks, 6 days per week;[27] and 4 weeks, 5 days per week.[20] There was also variation in outcome measurements. For evaluating anthropometric parameters, BMI, body weight (BW), or body mass (BM) were considered in seven studies,[2,10,11,15,18,22,23] while body fat percentage, fat-free mass (FFM), or fat mass (FM) were assessed in three studies.[22–24]

According to the results of the studies, the following treatment protocols can be suggested for breathing exercises in subjects with obesity: respiratory muscle endurance training with high intensity (60–80% of maximum voluntary ventilation or 50–60% of forced vital capacity, for 12–30 minutes over 3–5 weeks) is effective in improving lung function, anthropometric parameters, and 6MWT performance.[11,22] Due to the variety of treatment protocols for inspiratory muscle training, we cannot suggest a standardized protocol for these exercises. However, it appears that inspiratory muscle training is not effective for lung function and anthropometric parameters at low intensity (30–55% of maximum inspiratory pressure), but it can improve 6MWT performance.[13,15,18,27,28] Expiratory muscle training, at 40% of maximum expiratory pressure with 25 breaths per minute, performed over 3 weeks and 4 days per week,[23] can be effective in improving lung function and anthropometric parameters. Diaphragmatic breathing exercises, consisting of 2–8 seconds of inspiration and 2–8 seconds of expiration, for 10–20 minutes per day, 3–5 days per week, and over 4–8 weeks, can improve lung function, anthropometric parameters, and 6MWT.[17,19,21,24–26] Incentive spirometry exercises, performed as 10–30 breaths with 3 seconds of inspiration and expiration, 5 days per week for 4–8 weeks, can improve lung function and 6MWT.[18,20] Future studies should be conducted with larger sample sizes and include both genders. More research with longer durations of breathing exercise is recommended. Further studies comparing the effects of different types of breathing exercises (e.g., expiratory exercises, segmental breathing exercises) on obesity are required. Specific guidelines for optimal breathing exercises in obesity are needed to reduce variability between studies.

Strengths and limitations

This review's strengths include a comprehensive literature search (last conducted on May 5, 2025) and a rigorous methodology based on a pre-developed protocol. Limitations include limited generalizability beyond healthy subjects with obesity and the inability to perform meta-analysis due to intervention variability. The lack of quality appraisal, typical in scoping reviews, also limits comparisons. Further research is needed on breathing exercises in subjects with obesity who also have specific diseases.

Conclusion

Breathing exercises can improve lung function, anthropometric parameters, and functional exercise capacity in subjects with obesity. They may be recommended as an adjunct therapy alongside increased physical activity and nutritional control.

Ethics Committee Approval

The study was approved by the Isfahan University of Medical Sciences and Health Services Ethics Committee (No: IR.MUI.REC.1402.030, Date: 29/11/2023).

Conflicts of Interest Statement

The authors have no conflicts of interest to declare.

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No AI technologies utilized.

Author Contributions

Concept – F.A., T.R., C.J., F.B.; Design – T.R., C.J., A.R., F.B.; Supervision – F.B.; Resource – T.R., F.B.; Data Collection and/or Processing - F.A., Z.S.R., F.B.; Analysis and/or Interpretation - F.A., Z.S.R., F.B.; Literature Review – F.A., T.R., C.J., A.R., Z.S.R., F.B.; Writing – F.A., T.R., C.J., A.R., Z.S.R., F.B.; Critical Review – F.A., T.R., C.J., A.R., Z.S.R., F.B.

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Appendix 1: Characteristics of sources of evidence

Study	Year	Type	Participants	Mean age	Outcomes	Intervention	Results
Rekha et al.[21]	2021	Case-control	40 (M=23, F=17)	23.3	Lung function	Wind instrument (flute) group Incentive spirometer group	Lung function: Improved in group A (flute)
Villiot-Danger et al.[11]	2010	Case-control	20 (M=8, F=12)	42.05	Anthropometric parameters Lung function Functional exercise capacity	RMET group Control group	Lung function: No change except for VC BMI: Similar BMI reduction in both groups 6MWT: Improvement
Salvadego et al.[22]	2017	Case-control	17 (M=17)	16.05	Anthropometric parameters Lung function Functional exercise capacity	RMET + body mass reduction program group Body mass reduction program group	Spirometry variables: Increased BMI and free fat mass: Significant decreases VO_{2max}: No change
Abdelaal et al.[17]	2017	RCT	50 (M=22, F=28)	53.7	Lung function Functional exercise capacity	Experimental group Control group	Lung function: Improved 6-Minute walk test: Improvement
Kaeotawee et al.[18]	2022	RCT	60 (M=42, F=18)	12.4	Anthropometric parameters Lung function Functional exercise capacity	IMT group IS group Control group	Lung function: No change WC/Ht: significantly greater in IMT group 6-Minute walk test: Improvement in IS group
Barbalho-Moulim et al.[27]	2011	RCT	32 (F=32)	35.4	Lung function	Threshold IMT group Control group	Lung function: No change
Edwards et al.[13]	2012	RCT	15 (M=7, F=8)	52	Lung function Anthropometric parameters Functional exercise capacity	IMT group Placebo group	Lung function: No change 6MWT: Improvement
Salvadego et al.[23]	2022	RCT	17 (M=17)	17.5	Lung function Anthropometric parameters	RMIT group Control group	Lung volumes: Improved BMI, BM, FM, FFM: Significant decreases in both groups
Frank et al.[2]	2010	RCT	26 (M=6, F=20)	33	Lung function Functional exercise capacity Anthropometric parameters	EN group RMET+EN group	Lung function: Not reported Weight loss: Significant and similar changes in both groups 6MWT: Improved
Kuo et al.[15]	2019	RCT	28 (M=7, F=21)	37.5	Lung function Functional exercise capacity Anthropometric parameters	IMT group Control group	Pulmonary function: No change Body composition: No change 6MWT: Improved
Tenório et al.[28]	2013	RCT	31 (gender not reported)	35.6	Lung function	IMT group Control group	Only FIV_1: Significantly improved
Alemayehu et al.[10]	2018	RCT	16 (M=16)	16.5	Anthropometric parameters Functional exercise capacity Lung function	RMET group Control group	Spirometry variables: No change BM: Similar reduction VO_{2peak}: No change
Edwards et al.[14]	2016	RCT	67 (M=37, F=30)	47	Functional exercise capacity	IMT group Placebo group	6MWT: Significantly improved
Sato et al.[24]	2010	RCT	40 (F=40)	45	Anthropometric parameters	Healthy group Obese group	Obese group: Significant loss of body fat and weight after exercise
Rekha et al.[20]	2013	RCT	47 (gender not reported)	28.8	Lung function	IMT group Control group	Spirometry variables: Improvement
Ponde et al.[16]	2021	RCT	60 (gender not reported)	30	Functional exercise capacity Lung function Anthropometric parameters	Group A: IMT + walking Group B: walking only	VO_{2max}, 6MWT: Improvement in group A BMI: Not reported MIP: Improvement in group A

Appendix 1: Cont.

Study	Year	Type	Participants	Mean age	Outcomes	Intervention	Results
Ved et al.[25]	2022	RCT	30 (F=30)	43.3	Lung function	Group A: diaphragmatic breathing Group B: inverse ratio breathing	Both exercises were effective in improving pulmonary functions, but there were no significant differences between the two groups
Parra-Vera et al.[26]	2024	Case-control	28 (gender not reported)	16.5	Lung function	RMT group Control group	Significant improvements in spirometry and pymometry variables in the RMT group
Kruk et al.[19]	2006	RCT	60 (M=60)	46.3	Lung function	Deep breathing group Breathing with tube group+ moderate-intensity walking	Significant improvements in spirometry and pymometry variables in the deep breathing group

F: Female, M: Male, RCT: Randomized control trial, BMI: Body mass index, RMT: Respiratory muscle training, RMET: Respiratory muscle endurance training, 6MWT: Six-minute walk test, VO_{2max} or VO_{2peak}: Maximal oxygen consumption, IMT: Inspiratory muscle training, IS: Incentive spirometry, WC/Ht: Waist circumference-to-height ratio, RMIT: Respiratory muscle interval training, EN: Exercise and nutrition, BM: Body mass, FM: Fat mass, FFM: Fat-free mass, VC: Vital capacity, MIP: Maximum inspiratory pressure, MEP: Maximum expiratory pressure, FIV_1: Forced inspiratory volume in 1 second