The Impact Of Obesity On Pulmonary Function

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ABSTRACT

Background: obesity generates a substantial worldwide health threat as it is being widely prevalent across the globe, including in Iraq, with notably among Baghdadi women. This rising prevalence of obesity has been associated with an increased incidence of various respiratory conditions.
Aim: This review highlights the special effect of obesity on respiratory parameters in healthy lung individuals and in individual with common pulmonary disease.
Method: This review was conducted through a comprehensive search of many literatures using electronic database.
Result: Literatures were selected based on effect of obesity on respiratory function in normal and respiratory diseased subjects.
Conclusion: Obesity primarily causes restrictive lung problems, but it can give rise to a slight obstructive difficulty, as exacerbation preexistent asthma. Pulmonary function is probably more directly impacted by central obesity. Forced vital capacity improves more in males than females after decreasing weight.

Keywords: Body Mass Index, Obesity; Overweight, Spirometry Parameters.

تأثير السمنة على وظائف الرئة

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الخلاصة

الخلفية: تُشكل السمنة تهديدًا صحيًا عالميًا كبيرًا لأنها منتشرة على نطاق واسع في جميع أنحاء العالم، بما في ذلك العراق، وخاصة بين نساء بغداد. وقد ارتبط هذا الانتشار المتزايد للسمنة بزيادة حدوث أمراض الجهاز التنفسي المختلفة.
الهدف: تُسلط هذه المراجعة الضوء على التأثير الخاص للسمنة على معايير الجهاز التنفسي لدى الأفراد الأصحاء والأفراد المصابين بأمراض الرئة الشائعة.
الطريقة: أُجريت هذه المراجعة من خلال بحث شامل في العديد من الدراسات البحثيه باستخدام قاعدة بيانات إلكترونية.
النتيجة: تم اختيار الدراسات البحثيه بناءً على تأثير السمنة على وظيفة الجهاز التنفسي لدى الأشخاص الأصحاء والمصابين بأمراض الجهاز التنفسي.
الاستنتاج: تُسبب السمنة في المقام الأول مشاكل رئوية تقييدية، ولكنها قد تؤدي إلى صعوبة انسداد طفيفة، مثل تفاقم الربو الموجود مسبقًا. من المرجح أن تتأثر وظائف الرئة بشكل مباشر بالسمنة المركزية. تتحسن السعة الحيوية القسرية لدى الذكور أكثر من الإناث بعد إنقاص الوزن.

الكلمات المفتاحية: مؤشر كتلة الجسم، السمنة، زيادة الوزن، معايير قياس التنفس.

INTRODUCTION

Overweight and obesity create a substantial global health hazard as both are being further presence in the worldwide [1,2]. In Iraq, nearly two-thirds of the 3916 participants to the Iraqi National Survey were also overweight or obese and particularly the obesity was highly prevalent among Baghdadi women [3,4].

Obesity is considered as a chronic, but non communicable disease [5]. It prompts obese people to a wide range of illnesses, which are frequently connected. This results in a higher likelihood of having two, four or more medical conditions

disease when compared to people with healthy weight [6]. Certain comorbid diseases that associated with obesity as diabetes mellitus, polycystic ovary syndrome, dyslipidaemia, hypertension, cardiovascular, neurological, chronic kidney disease, musculoskeletal, gastrointestinal, rheumatological disease, cancers, atopic dermatitis, gestational hypertension and mental disease as depression [7]. Eventually, obesity is known of its contribution in increasing mortality from many chronic diseases as well (as reviewed in Dixon 2024).

The increased prevalence of obesity raises the occurrence, illness and clinical manifestation of numerous respiratory conditions. Recently, the obesity's detrimental effects on lung health have been documented. As obesity is a significant risk factor and illness progress changer regarding asthma disease, sleep apnea (obstructive), hypoventilation syndrome in obese people, and also pulmonary hypertension [9]. The sequences of chronic type of obstructive pulmonary disease (COPD) also seem to be affected by obesity. Physical effects, adipose tissue mediators, or the quantity of adipose tissue can all demonstrate this affection (As reviewed in Dixon 2024).

Obese people have a higher exposure to the infection of respiratory system, also more rates of hospitalization that happened with respiratory disease patients suffering from obesity, as matched to subjects with a healthy weight [9].

While many studies have investigated the relationship between obesity and lung function but they are fragmented aims. This review offering an impression into obesity affects the lung's natural physiology and function.

So the aim of this review is to highlights the special adverse effect of obesity on respiratory parameters in healthy lung individuals and in individual with common pulmonary diseases as this may lead to an inappropriate respiratory health and economic consequences. In addition to that, hopefully diagnosing the defect will aid in starting an urgent endeavor to prevent and control obesity to lessen the strain on the respiratory system and eventually on community economy.

METHOD

This review was conducted through a comprehensive search of many literatures using electronic database including Google Scholar. This review covered articles published from 2010 up to 2024. Literatures were selected based on relevance to the interesting topics. The selected articles were both original research articles and review papers.

DISCUSSION

As obesity is a global health problem and it disturbs lung function. This review required to address the inconsistency and fragmentation in studies evaluating the impact of obesity on lungs function.

Firstly this study described the physiological implications of obesity on the mechanics of the respiration as; the hallmark of obesity is the stiffness of lung and chest wall compliance. It was demonstrated that lung compliance is reduced in individuals with obesity. This looks closely relates to body mass index (BMI). In severe obesity tidal volumes are often decreased with a fast, shallow breathing follows configuration. This breathing pattern is probably appearing as result of increasing rigidity of pulmonary system (As reviewed in Salome 2010).

Obese people's diaphragm, lungs and chest cavity are mechanically compressed. This can lead to restrictive damage of the lung. Additionally, extra fat diminish entire respiratory system compliance, raises respiratory resistance, and lessens strength associated with the muscles of respiratory system. The functional quality of the lung with fat arrangement of the body has a strong correlation in obese as well as people with overweight, with more damage happened when fat store more in the chest area and abdomen [10,11].

Rezoagli E, et al. study approved the importance of emphasizing on BMI as well as the suitable position, as both must be considered for patient undergo respiratory mechanics investigation [12]. That is because the respiratory system's compression is caused by a weight potency relate to gravitational force as abdominal thrust up, chest compaction, or Trendelenburg position all end up to a decrease lung volume at end-expiratory phase [13-15].

Berra L, et al. demonstrated that the essential characteristics of physiological breathing in obesity is a high pleural pressure, resulting in atelectasis, high elasticity of the lung, expiratory flow limitation, and ineffective gas exchange. They also found that, following years there will be increasing an intention in that, a number of obese patients need mechanical ventilation [16].

The study of Littleton S W found that the respiratory rate of obese people is frequently increased with the intention of compensation for the ordinary low volumes of tidal type. Entire pulmonary system compliance is diminished. Lung volumes, and especially expiratory reserve volume (ERV), are the highest constantly impacted the parameters of respiratory system. Oxygenation may be impacted, possibly due to a complication of microatelectasis at the lung bases.

The resistance of respiratory airway is frequently amplified in persons with obesity, and this appears minimally partially connected to closure of smaller airways [17].

Secondly this study demonstrated the effect of obesity on ventilation and perfusion as ventilation distribution is normally altered in obesity, ending up in ventilation-perfusion imbalance. So, the ventilation is advantageous shifted to the area with low perfusion at the highest lung zones when the position of obese patients as upright-seated with severely reduced expiratory reserve volume (ERV), this leading to a reduced the oxygen tension in arterial blood during normal tidal breathing (As reviewed in Dixon 2018).

Then the study addressed variability and factors modulating impact of obesity on lung function considering factors such as body mass index and a fat distribution; the body mass index (BMI) serves as a mark for categorizing obesity.

It is calculated by taking the weight in units of kilograms and dividing it by the square of the height in units of meters, with the result articulated in kg/M^2.

A BMI spanning from 18.5 to 24.9 is classified as standard weight. A BMI of 25.0 or more than this is classified as excess weight. A BMI of 30.0 or above is classified as obesity [18].

Regarding regional fat distribution: obesity can be classified into two primary categories: central and peripheral.

Central obesity often referred to as abdominal or android obesity is characterized by a heightened buildup of fat in the thorax, abdomen, and visceral organs, leading to an apple-shaped physique.

In contrast, peripheral obesity, referred to as gynoid obesity, is defined by fat accumulation in the hips along with thighs, and in limbs, as well as subcutaneous tissue, directing toward a pear-shaped trunk.

This differentiation is significant. The impact of android obesity on pulmonary mechanics is likely to be more direct than that of gynoid obesity (As reviewed in Dixon 2018).

The earlier discussed physiological changes of obesity may lead to obstructive sleep apnoea and hypoventilation syndrome by the following mechanism; the excessive adiposity inside both the abdominal and thoracic cavities leads to an increase the pressure inside them.

This leads to a slow down expansion of the lung and this eventually impact function of the lung, causing hypoventilation and along with ventilation–perfusion disequilibrium.

Obstructive sleep apnoea is the most common sleep-disordered breathing in obese patient due to fat buildup around the upper airways can lead to airway collapse [19].

Young R. et al. demonstrated that, the incidence of obstructive type of sleep apnoea as well as hypopnoea syndrome along with obesity hypoventilation syndrome is increasing with increasing obesity and life expectancy [20].

This study demonstrated as well, the clinical influence of adiposity changes and obesity in term of pulmonary function parameters in subjects without chronic lung disease by reviewing the following articles.

The study was conducted by Park1 Y, et al.[21] in 2001 as a least first year baseline and ending in 2014 as a highest follow-up year. The total number of 5011 participants (without chronic lung disease) in this study were recruited as a sample of both male and female individuals from the population of South Koreans, (45% male), their age between 40–69 years, their residency at two distinct areas: either Ansan (urban) or Ansung (rural). The study relied on “community based-prospective-cohort”. The study had subsequent duration with a median of 8 years.

During this fallow up both spirometry along with bio-electrical impedance analysis were achieved twice per year. The analysis of data was done by using “multivariate linear mixed regression” in order to know prolonged relationship between variations in adiposity and lung function.

The study revealed that: Adiposity was linked to the prolonged-term impairment of lung function, as the fat mass index “(FMI; fat mass divided by the square of height in meters)” was inversely connected with forced expiratory volume in 1^{st} second alongside with forced vital capacity both in men and women (this declines in estimated both FEV1 and FVC of up to −38.2 mL and −31.8 mL, respectively in men) (the decline in estimated both FEV1 and FVC of up to -17.8ml, -27.8 ml respectively in women). This post correcting for baseline age as well as height, residential area in addition to smoking exposure (pack-years, men only) alongside with initial adiposity indices, and first lung function.

However waist hip ratio (WHR) was also reciprocally connected with FVC and FEV1 but in men only. This study showed as well that, the group with an increasing ratio of waist hip revealed faster decline in FVC as well as FEV1 than that group with a decreasing WHR among the groups of fat-losing and gaining.

This indicating toward central kind of fatness distinctly lessen respiratory role in Asian general population with middle of age .45 This paper did not specifically select obese individuals to talk about obesity relationship with lung function, but instead it emphases on “fat mass index and waist-to-hip ratio” as indicators towards adiposity disturbing lung function [21].

Yu-En , et al. were conducted “a large longitudinal study on a total of 9059 participants with no subjective histories of smoking and lung disease as asthma, bronchitis, or emphysema from the Taiwan Biobank”. These participants were tested again 4 years later [22]. The forced expiratory volume in 1st second (FEV1) along with forced vital capacity (FVC) were assessed using spirometry. Variation in FEV1/FVC ratio from baseline to follow-up was computed. Elevated obesity-related index values such as “the lipid accumulation product (LAP), body roundness index (BRI), conicity index (CI), body adiposity index (BAI), abdominal volume index (AVI), body mass index (BMI), waist–hip ratio (WHR), and waist-to-height ratio (WHR)” these were linked to improved initial lung function and a swift decline in lung function, along with minimal changes in FEV1/FVC, during the follow-up after 4 years [22].

Svartengren M, et al. were examined the effect of body mass index alongside with central obesity on lung characterization by measuring waist circumference as well as self-reported physical activity by performing EpiHealth cohort study. A 22743 subjects participated in this study, about 12791 of them were women, they aged between 45 and 75 years. Engaging in physical effort was assessed using a questionnaire. This study revealed all of obesity, central obesity, and a lack of physical activity were linked to reduced forced expiratory volume in 1st second as well as forced vital capacity. Nevertheless, the relationship between BMI and lung function relies on the existence of central fatness. Regardless of fatness, there exists a connection between physical effort and lung function [23].

The study conducted by Peralta GP et al. pointed to assess trajectories of lung function in 3,673 adult participants aged between 20 and 44 years, focusing on weight change profiles as part of the "population-based European Community Respiratory Health Survey". It utilized repeated assessments of weight, forced vital capacity, alongside with forced expiratory volume in one second across three study periods: 1991–1993, 1999–2003, and 2010–2014, until participants reached ages up to 39 and 67. The subjects were categorized into weight change outlines relied on their initial body mass index and fluctuations of weight covered a span of 20 years. The findings indicated that moderate as (0.25–1 kg/year) and high as (>1 kg/year) weight addition over two decades were linked to accelerated declines in FVC and FEV1, while losing weight was accompanying with a lessening in the rate related decline. The study emphasized the importance of managing weight gain to preserve optimal lung function throughout adulthood [24].

Then this study went through genetically determined BMI and its effect on lung function; Liu J, et al. This study chosen genetic tools relied on their related "large-scale genome-wide association studies". They revealed that, there is a significant statistical indication of an underlying reason of connection concerning BMI with lung function. As they proposed, a greater BMI is genetically determined, causing worse lung function (FVC and FEV1). Increased BMI-adjusted waist hip ratio might end to lesser FVC value. Greater BMI and BMI-adjusted WHR were expected to lead a greater FEV1/FVC [25]. This study had intervention as decreasing weight of people body or decreasing their body fat accumulating at central part of the body, might help as a planned objective to improve their lung function, alongside with decreasing their facing to the respiratory diseases risk [25].

Additionally, this study discussed the obesity's adverse effect on asthma; The "A population-based adult asthma cohort" study was conducted by Barón N B, et al. and it was carried out between1986-2001 and at follow-up between2012-2014.

The number of asthmatic participants was 945, 48, 5% women with overweight or obesity. The participants were those living in the northernmost county of Sweden.

The participant underwent clinical examinations such as spirometry and measurement of height and weight.

These processes were done two times at the study entry and at follow-up.

In this study the body mass index change was examined yearly in relation to the annual drop in FEV1, FVC and FEV1/FVC independently in asthmatic patients who had a normally ranged weight and overweight/obesity at the study record.

This study revealed that the augmented body mass index is associated with a faster decrease in forced expiratory in the first second (FEV1) and forced vital capacity (FVC) but it did not appear in FEV1/FVC in participants who had asthma. This relationship between both BMI change and deterioration in FEV1 is more potent amongst those asthmatic with overweight or obesity (-25ml) when compared them with asthmatic normal weight (-15ml). So this study recommended reaching a standard weight with normal range must be instructed since it is vital foundation in controlling asthmatic cases to prevent extra lung function deterioration in the elongated time [26].

Liu J, et al. revealed as well that an increased BMI-adjusted waist-hip ratio might have a more risk of asthma.

They advised patients to reduce their weight or central body fat in order to decrease their risk for facing respiratory diseases [25].

Scott HA, et al. conducted a meta-analysis study which included 40 studies. From their searching, they found that: sputum neutrophils and blood neutrophil counts were higher in obese than non-obese asthmatics.

The count of eosinophils at bronchial submucosal and sputum interleukin 5 was higher in obese subjects.

On the other hand, a fractional exhaled nitric oxide was lesser in obesity. Blood C reactive protein, interleukin 6 and leptin were similarly higher in obese people. That means obese asthmatics obtain an unlike arrangement of inflammation as matched to asthmatic participants who were non-obese [27].

Alqarni A A, et al. retrospective study was carried out in pulmonary clinics of multicenter in Saudi Arabia.

The authors retrieved the demographic information alongside with their spirometry results of 684 patients characterized as adulthood diagnosed as asthma.

The study was carried out between January 2016 and October 2022. Seventy four percent of patients were female, with forty seven plus minus sixteen years of age. The prevalence percentage of asthmatic overweight or obese participants was 31.1 and 46.0, respectively. They found a noteworthy drop in spirometry results in obese participants who had asthma compared with asthmatic participants who had normal weights.

They demonstrated negative correlation of body mass index with "forced vital capacity, forced expiratory volume in one second, forced expiratory flow at 25–75% as well as peak expiratory flow". They recommended weight loss as part of the treatment strategy aimed patients who complain from asthma disease to develop lung function [28].

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study showed that, in severe asthmatic patients who had fatness, the corticosteroid drug resistance ought to be inspected, as corticosteroid is essential for maintenance management and relief of asthma. They found greater dosage of inhaled-type corticosteroid is described to preserve adequate regulation of asthma symptom in obese persons when compared to the dose in thin persons (As reviewed in Tashiro 2023).

This means that obese patients are exposed to more drug side effect and more economically burden.

Eventually the study reviewed the articles conducted to investigate the impact of losing weight on lung mechanics and function; De Soomer K, et al.

study demonstrated the relations between intense losing weight or increase and respiratory function within the same people.

They found that weight alteration changes pulmonary-related function further in males than in females. Regarding males, forced vital capacity improved "an average of 1.4% predicted per unit of body mass index" post decreased weight and the reverse post weight addition; this compared with women that had a minor change of about 0.9 percentage predicted / unit of body mass index. Losing weight faintly improved the ratio of forced expiratory volume in 1st second to FVC and diminished the specific airway resistance, while the contrary happened with additional weight. This study concluded that; the negative impact of obese weight on lung function is a passive characteristic, and it is a reversible problem [29,30].

This study recommends that, in order to preserve optimal lung function, we advise persisting in controlling weight. Also, in order to prevent deterioration of asthmatic patients, they are advised to maintain their weight within normal. Additionally, losing weight reduces asthmatic patients' exposure to the side effects of their treatment medication and lessens their financial strain. So this makes weight loss crucial for asthma treatment regimens.

CONCLUSION

Obesity primarily causes restrictive lung problems, but it can give rise to slight obstructive difficulties; in particular it can exacerbate preexisting obstructive respiratory conditions like asthma. Pulmonary function is probably more directly impacted by central obesity. Forced vital capacity improves more in males than females after decreasing weight.

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Conflict of Interest

Nothing in the current article.

Authors Contibution

First author conceptualized literature search and writing. Second author contributed with literature validation, editing, and supervision.

REFERENCES

1. Shafiee A, Nakhaee Z, Bahri RA, Amini MJ, Salehi A, Jafarabady K, Seighali N, Rashidian P, Fathi H, Esmaeilpur Abianeh F, Omran SP. Global prevalence of obesity and overweight among medical students: A systematic review and meta-analysis. BMC Public Health. 2024 Jun 24; 24(1):1673. doi: 10.1186/s12889-024-19184-4.
2. Obesity and overweight. World Health Organization. Published June 9, 2021. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
3. Jasim HM, Abdul Hussein HM, Al-Kaseer EA. Obesity among females in Al-Sader city Baghdad, Iraq, 2017. J Fac Med Baghdad [Internet]. 2018 Sep. 2 [cited 2024 Dec. 30]; 60(2):105-7.Available from: https://iqjmc.uobaghdad.edu.iq/index.php/19JFacMedBaghdad36/article/view/15
4. Pengpid S, Peltzer K. Overweight and obesity among adults in Iraq: prevalence and correlates from a National Survey in 2015. International journal of environmental research and public health. 2021 Apr 15; 18(8):4198. doi: 10.3390/ijerph18084198
5. Jastreboff AM, Kotz CM, Kahan S, Kelly AS, Heymsfield SB. Obesity as a disease: the obesity society 2018 position statement. Obesity. 2019 Jan; 27(1):7-9. doi: 10.1002/oby.22378.
6. Kivimäki M, Strandberg T, Pentti J, Nyberg ST, Frank P, Jokela M, et al. Body-mass index and risk of obesity-related complex multimorbidity: An observational multicohort study. Lancet Diabetes Endocrinol.2022; 10:253-63. doi: 10.1016/S2213-8587(22)00033-X.
7. Lam BC, Lim AY, Chan SL, Yum MP, Koh NS, Finkelstein EA. The impact of obesity: a narrative review. Singapore medical journal. 2023 Mar 1; 64(3):163-71. doi: 10.11622/smedj.2023036.
8. Dixon AE, Bhatawadekar SA. Obesity, Lung Function, and Lung Disease. In Handbook of Obesity-Volume 1 2024 (pp. 548-555). CRC Press. doi: 10.1201/9781003437673-63.
9. Dixon AE, Peters U. The effect of obesity on lung function. Expert Review of Respiratory Medicine. 2018 Sep; 12(9):755-767.doi: 10.1080/17476348.2018.1506331.
10. Salome CM, King GG, Berend N. Physiology of obesity and effects on lung function. Journal of applied physiology. 2010 Jan; 108(1): 206-11. doi: 10.1152/japplphysiol.00918.2009.
11. Mafort TT, Rufino R, Costa CH, Lopes AJ. Obesity: systemic and pulmonary complications, biochemical abnormalities, and impairment of lung function. Multidisciplinary respiratory medicine. 2016 Dec; 11:1-1. doi: 10.1186/s40248-016-0078-7.
12. Rezoagli E, Bastia L. Obesity Enhances the Gravity Effect on the Respiratory System: The Importance of Monitoring Lung Mechanics. Chest. 2024 Mar 1; 165(3):475-7. doi: 10.1016/j.chest.2023.09.022.
13. Rezoagli E, Bastia L, Brochard L, Bellani G. Physical manoeuvres in patients with ARDS and low compliance: bedside approaches to detect lung hyperinflation and optimise mechanical ventilation. European Respiratory Journal. 2023 May 1; 61(5). doi: 10.1183/13993003.00319-2023
14. Rezoagli E, Bastia L, Grassi A, Chieregato A, Langer T, Grasselli G, et al. Paradoxical effect of chest wall compression on respiratory system compliance: a multicenter case series of patients with ARDS, with multimodal assessment. Chest. 2021 Oct 1; 160(4):1335-9. doi: 10.1016/j.chest.2021.05.578.
15. Bastia L, Rezoagli E, Guarnieri M, Engelberts D, Forlini C, Marrazzo F, et al. External chest-wall compression in prolonged COVID-19 ARDS with low-compliance: a physiological study. Ann Intensive Care. 2022 Apr 12; 12(1):35. doi: 10.1186/s13613-022-01008-6. PMID: 35412161; PMCID: PMC9003155.
16. Berra L, Grassi LG. Obesity and Mechanical Ventilation. InObesity and Lung Disease: A Guide to Pathophysiology, Evaluation, and Management 2024 May 28 (pp. 365-385). Cham: Springer International Publishing. doi: 10.1007/978-3-030-83692-1_16.
17. Littleton SW. Impact of obesity on respiratory function. Respirology. 2012 Jan; 17(1):43-9. doi: 10.1111/j.1440-1843.2011.02014.x.
18. Expert WH. Committee on Physical Status. The use and interpretation of anthropometry. Report of WHO expert committee. Geneva: WHO. 1995;854: 1-452. Available from: https://www.who.int/publications/i/item/9241208546.
19. Brock JM, Billeter A, Müller-Stich BP, Herth F. Obesity and the Lung: What We Know Today. Respiration. 2020; 99(10):856-866. doi: 10.1159/000509735.
20. Young R, Benjamin A. The assessment and management of obstructive sleep apnoea–hypopnoea syndrome and obesity hypoventilation syndrome in obesity. Clinical Medicine.2023Jul1; 23(4):372-9. doi: 10.7861/clinmed.2023-0152.
21. Park Y, Kim J, Kim YS, Leem AY, Jo J, Chung K,et al. Longitudinal association between adiposity changes and lung function deterioration. Respiratory research. 2023 Feb 7; 24(1):44. https://doi.org/10.1186/s12931-023-02322-8.

22. Hsu YE, Chen SC, Geng JH, Wu DW, Wu PY, Huang JC. Obesity-related indices are associated with longitudinal changes in lung function: a large Taiwanese population follow-up study. Nutrients. 2021 Nov 12;13(11):4055. doi: 10.3390/NU13114055.
23.Svartengren M, Cai GH, Malinovschi A, Theorell-Haglöw J, Janson C, Elmståhl S, et al. The impact of body mass index, central obesity and physical activity on lung function: results of the EpiHealth study. ERJ Open Research. 2020 Oct 1; 6(4). doi: 10.1183/23120541.00380-2020.
24. Peralta GP, Marcon A, Carsin AE, Abramson MJ, Accordini S, Amaral AF, et al. Body mass index and weight change are associated with adult lung function trajectories: the prospective ECRHS study. Thorax. 2020 Apr 1; 75(4):313-20. doi: 10.1136/thoraxjnl-2019-214460.
25. Liu J, Xu H, Cupples LA, O' Connor GT, Liu CT. The impact of obesity on lung function measurements and respiratory disease: A Mendelian randomization study. Ann Hum Genet. 2023 Jul;87(4):174-183. doi: 10.1111/ahg.12506.
26. Bermúdez Barón N, Kankaanranta H, Hedman L, Andersson M, Stridsman C, Lindberg A, et al. Body mass index increase: a risk factor for forced expiratory volume in 1 s decline for overweight and obese adults with asthma. ERJ Open Res. 2022 Oct 24;8(4):00110-2022. doi: 10.1183/23120541.00110-2022.
27. Scott HA, Ng SH, McLoughlin RF, Valkenborghs SR, Nair P, Brown AC, et al. Effect of obesity on airway and systemic inflammation in adults with asthma: a systematic review and meta-analysis. Thorax. 2023 Oct; 78(10):957-965. doi: 10.1136/thorax-2022-219268.
28. Alqarni AA, Aldhahir AM, Siraj RA, Alqahtani JS, Alshehri HH, Alshamrani AM, et al. Prevalence of Overweight and Obesity and Their Impact on Spirometry Parameters in Patients with Asthma: A Multicentre, Retrospective Study. J Clin Med. 2023 Feb 25; 12(5):1843. doi: 10.3390/jcm12051843.
29.Tashiro H, Kurihara Y, Kuwahara Y, Takahashi K. Impact of obesity in asthma: Possible future therapies. Allergol Int. 2024 Jan; 73(1):48-57. doi: 10.1016/j.alit.2023.08.007.
30. De Soomer K, Vaerenberg H, Weyler J, Pauwels E, Cuypers H, Verbraecken J, et al. Effects of Weight Change and Weight Cycling on Lung Function in Overweight and Obese Adults. Ann Am Thorac Soc. 2024 Jan; 21(1):47-55. doi: 10.1513/AnnalsATS.202212-1026OC.