Metabolic and respiratory co-morbidities in obese patients before and after bariatric surgery in Al-Madinah Region, (western Saudi Arabia): A tertiary center experience

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Abstract

Background: Obesity is a global public health concern associated with numerous comorbidities in adolescent children and in adults. Bariatric surgery has emerged as an effective intervention for weight loss. Limited data exist on the prevalence of metabolic and respiratory comorbidities after bariatric surgery in Western Saudi Arabia.

Objective: This study aimed at determining the prevalence of co-morbidities in obese patients after bariatric surgery compared to before it in Al-Madinah region.

Patients and methods: A retrospective analysis was conducted on the medical records of obese patients who underwent bariatric surgery in Al-Madinah region. Data was collected and compared on diabetes mellitus, hypertension, hypercholesterolemia and asthma before and after surgery using Chi square.

Results: A total of 170 patients were included in this study. Statistically significant differences ($p<0.05$) were observed in the percentage prevalence of diabetes mellitus 79 (46.5%) pre-bariatric surgery versus 12 (7.1%) post-bariatric surgery, hypertension 73 (42.9%) pre-bariatric surgery versus 16 (9.4%) post-bariatric surgery, and asthma 20 (11.8%) pre-bariatric surgery versus 4 (2.6%) post-bariatric surgery. Although bariatric surgery decreased hypercholesterolemic condition, that was not significant ($p >0.05$) using Chi square. The impact of bariatric surgery on diabetes mellitus and hypertension according to levels of obesity showed that among cases with a BMI of

40 kg/m^2 or higher, there was a higher rate of clinical improvement and a greater likelihood of reducing medication dosages compared to cases with BMI < 40 kg/m^2.
Conclusion: Bariatric surgery reduced metabolic and respiratory co-morbidities prevalence in western Saudi Arabia.
Keywords: Bariatric surgery; BMI; Comorbidity, obesity; Western Saudi Arabia.

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Introduction

Obesity is a global epidemic in adolescent children and adults worldwide. According to WHO, more than 1.9 billion overweight and obese adults worldwide exist with 600 million are morbidly obese **(WHO , 2021)**. In our previous report, we highlighted the biochemical control of glycemia and lipidemia in diabetic patients and other health benefits conferred by bariatric surgery on obese diabetic patients in western Saudi Arabia **(Abdel-Rahman et al., 2024)**. Obesity incidence has increased so rapidly over the last two decades in developed and developing countries alike **(Ogden et al., 2014; WHO, 2021)**. In Saudi Arabia, obesity is as a significant public health issue ranging from 20% to 30.7% among men and women **(Madani et al., 2000)**. From 1995 and on, 30.7% of men are obese compared to 28.4% for women **(Al Othaimeen et al., 2007)**. About a quarter (5.5 million) of Saudi citizens are obese, of them 2.7% are morbidly obese **(Al-Nozha et al., 2005).**

Obesity is associated with a multitude of health consequences and quality of life issues **(Katzmarzyk and Janssen, 2004; Abilés et al., 2010)**. Obesity increases the risk of several diseases including diabetes **(Wild and Byrne, 2006)**, cardiovascular disease **(Wild and Byrne, 2006; Boden and Salehi, 2013)**, and certain tumors **(Kasim et al., 2005)**. Obesity worsens the quality of life of patients and minimizes productive work and increases funding for treating obese patients **(Bouchard and Bray, 2004; Bužgová et al., 2014; Farhud, 2015)**.

Bariatric surgery helps weight loss and the management of obesity-related co-morbidities **(Abilés et al., 2010)**. Several bariatric procedures cause greatly improved pre-existing diseases as diabetes **(Kim and Kim, 2016)**, and other associated co-morbidities. Moreover, bariatric surgery reduced weight effectively and reported co-morbidities after surgery both in the short-term postoperative period and in the long-term leading to decreased need for medications **(Crémieux et al., 2010; Hatoum et al., 2016)**.

This retrospective study addresses the prevalence of metabolic and respiratory comorbidities among obese patients in Al-Madinah region before and after bariatric surgery.

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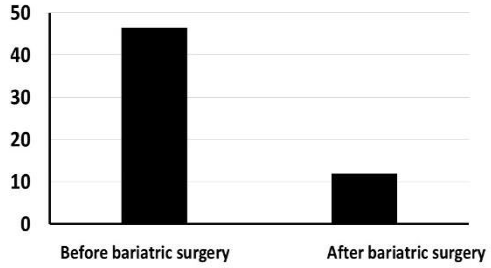
Patients and methods

Study design, setting, and duration

This retrospective cohort study took place at the Department of General Surgery, Division of Bariatric and Upper Gastrointestinal Unit, King Salman bin Abdulaziz Medical City, Al- Madinah, Saudi Arabia from November 2022 to April 2024 and utilized existing data from the hospital's archives involving a total of 170 patients. Data was collected retrospectively to analyse the improvements in co-morbidities before and after bariatric surgery.

Ethical Considerations: The study adhered to the principles of the Helsinki Declaration. Local ethical committee approval was obtained in accordance with the regulations of Taibah University Medical College for undergraduate students' research. Patients' privacy and confidentiality were maintained with human subject names stored in a password-protected database.

Fig.1. Bariatric surgery significantly



improved the diabetic condition. Bar graph showing chi square analysis of comparison of the diabetic condition before and after bariatric surgery on X-axis. Y-axis showing the pre- and post-bariatric surgery percentage of patients. Majority of the diabetic patients had improved after bariatric surgery and the comparison was statistically significant. Chi square test $p < 0.05$ was evident in many diabetic patients who got euglycemic condition.

Study Population and Sampling

A sample size of 170 patients was determined based on sample size calculations. The inclusion criteria were: obese patients with confirmed co-morbidities who underwent bariatric surgery at King Salman bin Abdulaziz Medical City hospital, with a one-year follow-up period. Subjects from diverse racial and ethnic backgrounds were included to ensure fair representation. The study excluded obese patients without co-morbidities, children below 14 years of age, and obese patients with and without co-morbidities outside Al- Madinah region.

Measurements

Data was randomly collected by selecting 170 patient samples from the medical records office of King Salman bin Abdulaziz Medical City hospital. These patients had undergone gastric sleeve surgery and had obesity along with one or more chronic diseases such as diabetes or hypertension. This study reviewed the improvement levels of these chronic diseases post-surgery.

Statistical analysis

Patients' data including age, sex, BMI, weight, lifestyle, diabetes mellitus, hypertension, and one-year follow-up information were collected using a data collection sheet. The data gathered was inputted into and assessed utilizing the Statistical Package for the Social Sciences (SPSS version 22.0; SPSS Inc., Chicago, IL). Data was presented using frequencies for categorical data. The prevalence of comorbidities among the studied cases before and after bariatric surgery, assessed at a one-year follow-up, was compared using the McNemar test. The comparison of the studied cases regarding the improvement of diabetes mellitus, hypertension, and lifestyle profile was conducted using chi-square test. These comparisons were made based on the variables of age, sex, and

BMI. The statistical significance level was set at $p < 0.05$.

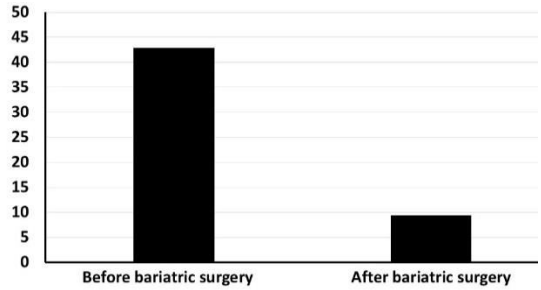


Fig.2. Normotensive systolic and diastolic blood pressure measurements were attained after bariatric surgery. Bar graph displaying chi square analysis of the hypertensive state on the X-axis before and after bariatric surgery. The percentage of patients before and after bariatric surgery is displayed on the Y-axis. Following bariatric surgery, the majority of patients having hypertension showed improvement, and the comparison was statistically significant with chi square test $p < 0.05$.

Results

The study analyzed data from 170 obese patients who underwent elective bariatric surgery between November 2022 and November 2023 in the Madinah Region, Saudi Arabia.

Table 1. Baseline characteristics of the studied cases (n= 170)

Characteristics	**n (%)**
Age in years; mean ± SD (Range)	36.9 ± 10.9 (14-64)
Age in years < 40 ≥ 40	101 (59.4) 69 (41.6)
Sex Male Female	 60 (35.3) 110 (64.7)
Weight in kg	116.1 ± 25.4 (70-192)
Height in cm	162.2 ± 9.6 (140-184)
Body mass index (kg/m^2); mean ± SD (Range)	43.7 ± 7.1 (31.1-78.9)
Body mass index (kg/m^2) < 40 ≥ 40	 45 (26.5) 125 (73.5)

* Data are presented by n (%) and mean ± SD

(**Table.1**) illustrates the distribution of the investigated cases based on their baseline characteristics. Females constituted approximately two-thirds (64.7%) of the study sample. On average, the participants had a weight of 116.1 ± 25.4 kg and a height of 162.2 ± 9.6 cm. The mean body mass index (BMI) was 43.7 ± 7.1 kg/m^2, with 73.5% of the cases having a BMI ≥ 40 kg/m^2.

Table 2. Lifestyle profile of the studied cases before surgery (n= 170)

Lifestyle	**n (%)**
Active smokers	29 (17.1%)
Sedentary life	14 (8.2%)
Active smokers and sedentary life	15 (8.8%)
Passive smokers and sedentary life	3 (1.8%)

(**Table.2**) presents the distribution of the examined cases based on their lifestyle profiles prior to surgery. Among the study participants, 17.1% were identified as active smokers. A sedentary lifestyle was reported by 8.2% of the individuals, while 8.8% reported both a sedentary lifestyle and active smoking. Additionally, 1.8% reported a

sedentary lifestyle combined with passive smoking.

Table 3. Effect of bariatric surgery on diabetes mellitus and hypertension by obesity among the studied cases

Variables	BMI < 40 kg/m^2	BMI ≥ 40 kg/m^2	p value
Diabetes mellitus			
Clinical improvement	5 (27.8%)	16 (32.7%)	0.64
Reduced medication dose	2 (11.1%)	9 (18.4%)	
Stop medication	11 (61.1%)	24 (49.4%)	
Total	18	49	
Hypertension			
Clinical improvement	3 (20.0%)	8 (19.0%)	0.88
Reduced medication dose	4 (26.7%)	14 (33.3%)	
Stop medication	8 (53.3%)	20 (47.6%)	
Total	15	42	

*Significant

(**Table.3**) presents the impact of bariatric surgery on diabetes mellitus and hypertension categorized by obesity among the investigated cases. Among cases with a BMI of 40 kg/m^2 or higher, there was a higher rate of clinical improvement and a greater likelihood of the reducing medication dosages.

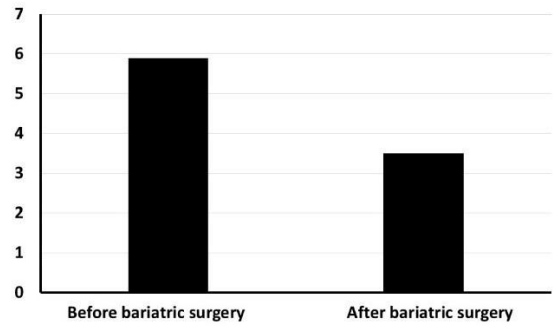


Fig.3. Hypercholesterolemia did not significantly decrease after bariatric surgery (p> 0.05). Bar graph showing the hypercholesterolemic status on the X-axis before and after bariatric surgery analysed using chi square method. On the Y-axis shows the percentage of hypercholesterolemic patients before and after bariatric surgery. Many patients with hypercholesterolemia showed improvement after bariatric surgery but the comparison was not statistically significant with chi square test p >0.05.

Bariatric surgery significantly decreased obesity-induced metabolic co-morbidities

Bariatric surgery significantly improved the diabetic condition (p< 0.05) in many diabetic patients and they got euglycemic condition. A total of 170 patients were included in this study. Statistically significant differences (p<0.05) were observed in the percentage prevalence of diabetes mellitus in 79 patients (46.5%) pre-bariatric surgery versus 12 patients (7.1%) post-bariatric surgery (**Fig.1**). Likewise, normotensive systolic and diastolic blood pressure measurements were attained after bariatric surgery where hypertension significantly decreased (p< 0.05) from 73 patients (42.9%) pre-bariatric surgery to 16 patients (9.4%) post-bariatric surgery (**Fig.2**). However, hypercholesterolemia did not significantly decrease after bariatric surgery (p> 0.05) Although bariatric

surgery decreased hypercholesterolemic condition from 10 patients (5.9%) to 6 patients (3.5%), that was not significant (p >0.05) (**Fig.3**). Interestingly, Bariatric surgery significantly improved the asthma condition (p< 0.05). Asthma was evident in 20 obese patients (11.8%) pre-bariatric surgery and decreased to 4 patients (2.6%) post-bariatric surgery (**Fig. 4**).

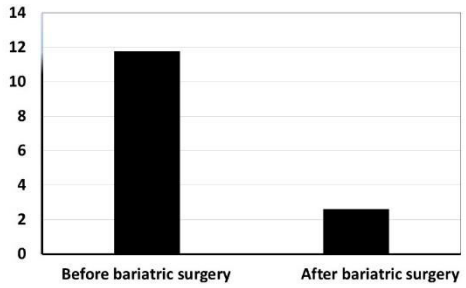


Fig.4. Bariatric surgery significantly improved the asthma condition (p< 0.05) in many obese patients and they got a normal condition. Bar graph showing the asthma state's chi square analysis on the X-axis both before and after bariatric surgery. On the Y-axis shows the percentage of asthma patients before and after bariatric surgery. Most patients with asthma showed improvement after bariatric surgery, and the comparison was statistically significant with chi square test p <0.05.

Discussion

In this retrospective study, the prevalence of co-morbidities among obese patients in Al-Madinah region before and after undergoing bariatric surgery was confirmed and significantly decreased after bariatric surgery (table 1).

Among the 170 patients included in this study, the baseline characteristics revealed that the majority of them were categorized as obese (26.5%) or morbidly obese (73.5%). Bariatric surgery is widely recognized as the most effective long-term treatment for weight loss, particularly among morbidly obese patients **(Kruseman et al., 2010)**. This is because lifestyle modifications alone often result in minimal weight loss in this population, and adherence to such modifications is frequently poor **(Assakran et al., 2023)**. Females constituted a significant majority, accounting for approximately two-thirds (64.7%) of the study sample. In previous published studies, more women underwent bariatric surgery compared to men. In a recent Saudi retrospective study conducted at King Fahad Specialist Hospital at Al-Qassim (Buraydah), Saudi Arabia on 520 patients who underwent bariatric surgery, 61% were females **(Assakran et al., 2023)**. Also, in a previous similar study on 794 surgery candidates **(Samuel et al., 2006)**, the sample of individuals seeking gastric bypass surgery was predominantly women (84.8%).

The most prevalent co-morbidity observed among the studied patients was diabetes mellitus, which affected 46.5% of the cases. This finding is consistent with the well-established association between obesity and diabetes given that obesity is a primary contributing factor to the onset of type 2 diabetes **(Wild and Byrne, 2006; Bell et al., 2014)**. Hypertension was the second most common comorbidity, affecting 42.9% of the cases. This finding is also in line with previous study that has demonstrated a strong link between obesity and hypertension **(Jiang et al., 2016; Shariq and McKenzie, 2020)**. Obesity generally decreases parasympathetic tone and increases sympathetic activity. These changes in autonomic activity are associated with increased heart rate, decreased heart rate variability, and reduced baroreflex sensitivity as well as hypertension **(Shariq and McKenzie, 2020)**. Other associated co-morbidities identified in this study

included cardiovascular diseases (5.3%), gastrointestinal diseases (3.5%), sleep apnoea (2.4%), and hypercholesterolemia (5.9%) (figures 1-4). In the literature, obesity was found as a risk factor for all these diseases **(Jehan et al., 2017; Peters et al., 2018; Barber et al., 2019; Nedunchezhiyan et al., 2022)**. These findings highlight the significant burden of comorbidities among individuals seeking bariatric surgery.

In this study, many diabetic patients experienced a significant improvement in their diabetic status ($p<0.05$) following bariatric surgery, leading to euglycemic conditions. This study covered 170 patients in total. Figure 1 shows statistically significant changes ($p<0.05$) between the percentage prevalence of diabetes mellitus in 79 patients and 12 patients (7.1%) (46.5%) before and after bariatric surgery, respectively. Similar results were seen in normotensive systolic and diastolic blood pressure readings following bariatric surgery, with hypertension markedly declining ($p<0.05$) in 16 patients (9.4%) after surgery compared to 73 patients (42.9%) prior to the procedure (Figure 2). Nevertheless, following bariatric surgery, hypercholesterolemia did not significantly decline ($p>0.05$). While the number of patients with hypercholesterolemia following bariatric surgery decreased from 10 (5.9%) to 6 (3.5%), and the difference was not statistically significant ($p >0.05$) (Figure 3). Remarkably, bariatric surgery considerably improved the asthma condition ($p< 0.05$) in 20 obese patients (11.8%) pre-bariatric surgery and they got a normal condition versus 4 patients (2.6%) who did not improve post-bariatric surgery (Figure 4)

Addressing lifestyle factors, such as smoking behaviour and sedentary habits, as part of comprehensive weight management and health improvement strategies for individuals seeking bariatric surgery, the current study revealed that 17.1% of the patients were identified as active smokers while a sedentary lifestyle was reported by 8.2% of the individuals, and interestingly, 8.8% of the participants reported both a sedentary lifestyle and active smoking (table 2). A sedentary lifestyle is linked to a higher likelihood of obesity, cardiovascular disease, type 2 diabetes, and various other health issues **(Park et al., 2020)**. Moreover, smoking is well-known to have detrimental effects on the overall health and is associated with various health conditions including cardiovascular diseases **(Gallucci et al., 2020)**, respiratory problems **(Tiotiu et al., 2021)** and certain types of cancer including leukaemia **(Shi et al., 2019)**. The synergistic effects of sedentary behaviour and smoking increases developing chronic diseases and poor health outcomes. In addition, 1.8% of the participants reported a sedentary lifestyle combined with passive smoking. Passive smoking causes detrimental health effects as increased risk of respiratory problems, cardiovascular diseases, and lung cancer **(Smith, 2003)**.

Our study confirmed the benefits of bariatric surgery to diabetes mellitus, hypertension, asthma when comparing pre- and post-operative data. Similar results were reported in a previous study carried out by Pories et al. **(Pories et al., 1987)** revealed that among the studied 141 patients with type 2 diabetes or impaired glucose tolerance, all but two patients became euglycemic within 10 days after bariatric surgery. A longer follow-up period demonstrated that 83% of patients with pre-operative type 2 diabetes and 99% of those with

impaired glucose intolerance were able to maintain normal levels of plasma glucose, $HgA1_C$ and insulin **(Pories et al., 1987)**. Interestingly, a Swedish obesity study demonstrated that 72% of patients had complete resolution of type 2 diabetes compared with 21% of control patients 2 years after surgery **(Sjöström et al., 2000)**, and a decrease in systolic blood pressure by an average of 11.4±19.0 mm Hg and diastolic blood pressure by 7.0±11.0 mm Hg **(Sjöström et al., 2000)**. Furthermore, decreased prevalence of hypercholesterolemia post-bariatric surgery in our study agrees with another meta-analysis study that reported a significant decreases in total cholesterol, low-density lipoprotein cholesterol, and triglycerides , as well as a notable increase in high-density lipoprotein cholesterol (6.9mg/dL) at their one-year follow-up compared to their initial levels **(Heffron et al., 2016)**.

In this study, among cases with a BMI of 40 kg/m^2 or higher, there was a higher rate of clinical improvement and a greater likelihood of reducing medication dosages. This suggests that bariatric surgery is particularly effective in managing diabetes mellitus and hypertension in individuals with severe obesity (table 3). These findings were consistent with the International Diabetes Federation statement for obese Type 2 diabetes undergoing bariatric surgery **(Dixon et al., 2011)**. This suggests that bariatric surgery is particularly effective in managing diabetes mellitus and hypertension in individuals with severe obesity.

Our study represents a significant contribution to the existing literature as it is the first to examine the prevalence of comorbidities in obese patients before and after bariatric surgery in Al-Madinah region, Saudi Arabia.

However, it is important to acknowledge the limitations of this study. Being a single centre experience, and its retrospective nature.

Conclusion

Bariatric surgery decreased obesity-associated comorbidities as diabetes mellitus, hypertension, asthma and hypercholesterolemia particularly in severe obesity.

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Conflict of interest

The authors declare that they have no competing interests.

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References

- **Abdel-Rahman I, Alharbi AA, Alsaedi MZ, Alharbi NMA, Al-Mughassil SB, Al-Bahar ZA, et al. (2024).** Significant Promising Effects of Bariatric Surgery on the Biochemical Control of Glycemia and Lipidemia in Diabetic Patients in Western Saudi Arabia: A Tertiary Center Experience and a Retrospective Study. Cureus, 16(1)1-13.
- **Abilés V, Rodríguez-Ruiz S, Abilés J, Mellado C, García A, Pérez de la Cruz A, et al. (2010).** Psychological characteristics of morbidly obese candidates for bariatric surgery. Obesity Surgery, 20:161-167.
- **Al-Nozha MM, Al-Mazrou YY, Al-Maatouq MA, Arafah MR, Khalil MZ, Khan NB, et al. (2005).** Obesity in Saudi Arabia. Saudi Medical Journal, 26:824-829.
- **Al Othaimeen A, Al Nozha M, Osman AJ. (2007).** Obesity: an

emerging problem in Saudi Arabia. Analysis of data from the National Nutrition Survey. East Mediterr Health Journal, 13:441-8

- **Assakran BS, Khalid R, Bennasser T, Alsaif M, Alsawyan W, Alsaleem H, et al. (2023).** Prevalence and Risk Factors of Anemia in Patients After Bariatric Surgery in Qassim Region, King Fahad Specialist Hospital. Cureus, 8;15(6): 1-10
- **Barber TM, Hanson P, Weickert MO, Franks SJ (2019).** Obesity and polycystic ovary syndrome: implications for pathogenesis and novel management strategies. Clin Med Insights Reprod Health, 13:1-9
- **Bell JA, Kivimaki M, Hamer MJ. (2014).** Metabolically healthy obesity and risk of incident type 2 diabetes: a meta-analysis of prospective cohort studies. Obesity review, 15:504-515.
- **Boden G, Salehi SJ. (2013).** Why does obesity increase the risk for cardiovascular disease? Current pharmaceutical design, 19:5678-5683.
- **Bouchard C, Bray GA. (2004).** Handbook of obesity: etiology and pathophysiology: Marcel Dekker. New York: 41–77. 35.
- **Bužgová R, Bužga M, Holéczy PJ. (2014)** Health-related quality of life in morbid obesity: the impact of laparoscopic sleeve gastrectomy. Central European Journal of Medicine, 9:374-381.
- **Crémieux PY, Ledoux S, Clerici C, Cremieux F, Buessing MJ (2010)** The impact of bariatric surgery on comorbidities and medication use among obese patients. Obesity surgery, 20:861-870.
- **Dixon JB, Zimmet P, Alberti KG, Rubino F. (2011)** International Diabetes Federation Taskforce on Epidemiology and Prevention. Bariatric surgery: an IDF statement for obese Type 2 diabetes. Diabet Med, 20:628-42
- **Farhud DD (2015)** Impact of lifestyle on health, Iranian Journal of Public Health, 44:1442.
- **Gallucci G, Tartarone A, Lerose R, Lalinga AV, Capobianco AM. (2020)** Cardiovascular risk of smoking and benefits of smoking cessation. Journal of Thoracic diseases, 12:3866.
- **Hatoum IJ, Blackstone R, Hunter TD, Francis DM, Steinbuch M, Harris JL, et al. (2016).** Clinical factors associated with remission of obesity-related comorbidities after bariatric surgery. JAMA surgery, 151:130-137.
- **Heffron SP, Parikh A, Volodarskiy A, Ren-Fielding C, Schwartzbard A, Nicholson J, et al. (2016).** Changes in lipid profile of obese patients following contemporary bariatric surgery: a meta-analysis. American Journal of Medicine, 129:952-959.
- **Jehan S, Zizi F, Pandi-Perumal SR, Wall S, Auguste E, Myers AK, et al. (2017).** Obstructive sleep apnea and obesity: implications for public health. Sleep Medicine Disorders, 1(4):00019
- **Jiang SZ, Lu W, Zong XF, Ruan HY, Liu YJ. (2016).** Obesity and hypertension. Experimental and Therapeutic Medicine, 12:2395-2399.
- **Kasim K, Levallois P, Abdous B, Auger P, Johnson KCJCc, control. (2005).** Lifestyle factors and the risk of adult leukemia in Canada. Cancer Causes Control, 16:489-500.
- **Katzmarzyk PT, Janssen IJ. (2004).** The economic costs associated with physical inactivity

and obesity in Canada: an update. Canadian Journal of Applied Physiology, 29:90-115.

- **Kim SB, Kim SM. (2016).** Short-term analysis of food tolerance and quality of life after laparoscopic greater curvature plication. Yonsei Medical Journal, 57:430-440.
- **Kruseman M, Leimgruber A, Zumbach F, Golay AJ. (2010).** Dietary, weight, and psychological changes among patients with obesity, 8 years after gastric bypass. Journal of the American Dietetic Association, .110:527-534.
- **Madani KA, Al-Amoudi NS, Kumosani TA (2000)** The state of nutrition in Saudi Arabia. Nutrition and Helth, 14:17-31.
- **Nedunchezhiyan U, Varughese I, Sun AR, Wu X, Crawford R, Prasadam IJ. (2022).** Obesity, inflammation, and immune system in osteoarthritis. Frontiers in Immunology, 13:907750.
- **Ogden CL, Carroll MD, Kit BK, Flegal KM. (2014).** Prevalence of childhood and adult obesity in the United States, 2011-2012. JAMA, 311:806-814.
- **Park JH, Moon JH, Kim HJ, Kong MH. (2020).** Sedentary lifestyle: overview of updated evidence of potential health risks. Korean Journal of Family Medicine, 41:365.
- **Peters U, Dixon AE, Forno EJJoA, immunology C. (2018).** Obesity and asthma. The Journal of Allergy and Clinical Immunology, 141:1169-1179.
- **Pories WJ, Caro J, Flickinger EG, Meelheim HD, Swanson MS (1987)** The control of diabetes mellitus (NIDDM) in the morbidly obese with the Greenville Gastric Bypass. Annals of Surgery, 206:316.
- **Samuel I, Mason EE, Renquist KE, Huang YH, Zimmerman MB, Jamal MJ. (2006).** Bariatric surgery trends: an 18-year report from the International Bariatric Surgery Registry. American Journal of Surgery, 192:657-662.
- **Shariq OA, McKenzie TJ. (2020).** Obesity-related hypertension: a review of pathophysiology, management, and the role of metabolic surgery. Gland surgery, 9:80.
- **Shi H, Shao X, Hong YJ. (2019).** Association between cigarette smoking and the susceptibility of acute myeloid leukemia: a systematic review and meta-analysis. Eur Rev Med Pharmacol Sci, 23:10049-10057.
- **Sjöström CD, Peltonen M, Wedel H, Sjöström LJ. (2000).** Differentiated long-term effects of intentional weight loss on diabetes and hypertension. Hypertension, 36:20-25.
- **Smith GD. (2003).** Effect of passive smoking on health. British Medical Journal, 326: 1048-1049.
- **Tiotiu A, Ioan I, Wirth N, Romero-Fernandez R, González-Barcala FJ. (2021).** The impact of tobacco smoking on adult asthma outcomes. Int J Environ Res Public Health, 18:992
- **Wild SH, Byrne CD. (2006).** Risk factors for diabetes and coronary heart disease. BMJ, 333:1009-1011.
- **World Health Organization WHO. (2021).** Nutrition, overweight and obesity: factsheet on Sustainable Development Goals (SDGs): health targets. In: World Health Organization. Regional Office for Europe. Accessed in 25/9/2024.https://iris.who.int/bitstream/handle/10665/341982/WHO-EURO-2021-2574-42330-58595-eng.pdf