

## Obesity and its impact on the course of anesthesia

Jańczuk K.\*, Ślifirczyk A, Krukowska M, Kowalenko M.

Pope John Paul II State Higher School in Biała Podlaska, Faculty of Health Sciences and Social Sciences, Department of Emergency Medicine, Biała Podlaska, Poland

### ABSTRACT

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**Introduction:** Obesity is a major problem for millions of citizens. The treatment of obesity is a problem of nutritionists, psychologists, physical therapists, internists, surgeons, anesthesiologists, and many other specialists.

**Purpose:** To determine the influence of obesity on: blood pressure (systolic and diastolic), mean pressure (MAP), the scale of the risk of surgery (ASA) and saturation.

**Materials and methods:** The study was conducted among 200 patients. The research was prospective and was carried out in the general operating theatre in the Regional Specialist Hospital in Biała Podlaska between May 2011 and July 2012. The study was based on the anaesthetic documentation – anaesthetic information card, observation and

analysis of patient records. For the statistical calculations, we used Statistica 10.0 using NIR test. Differences at  $p < 0.05$  were identified as significant.

**Results:** The study did not confirm the significant impact of obesity on the deterioration of blood oxygenation. The surveyed men had significantly been higher preoperative absolute risk compared to women. A close relationship between an increased BMI and an increased risk associated with anesthesia was expressed in the ASA score chart.

**Conclusion:** This study proved that overweight and obesity significantly affected blood pressure (systolic, diastolic), and MAP.

**Key words:** the scale of the risk of surgery, systolic blood pressure, diastolic blood pressure, mean pressure, saturation

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**\*Corresponding author:**

Katarzyna Jańczuk

Pope John Paul II State Higher School in Biała Podlaska, Faculty of Health Sciences and Social Sciences  
Department of Emergency Medicine, Biała Podlaska, Poland

e-mail: [kjanczuk@gazeta.pl](mailto:kjanczuk@gazeta.pl)

Received: 12.08.2015

Accepted: 22.11.2015

Progress in Health Sciences

Vol. 5(2) 2015 pp 105-111

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## INTRODUCTION

According to a report by the World Health Organization (WHO) the problem of overweight concerns 1.6 billion people, and 522 mln are struggling with obesity. The accumulation of excessive fat tissue is not only a medical but social and economic problem as well, it appears necessary to take steps to normalize body weight. The definition of obesity is a condition in which the amount of the fat tissue in men is above 25% and in women over 30% of the body weight. Classification of BMI according to the WHO: normal weight - 18.5-24.9; overweight - 25-29.9; 1<sup>o</sup> degree obesity - 30 -34.9; 2<sup>o</sup> degree obesity - 35-39.9, and 3<sup>o</sup> degree obesity -40 and more [1].

Changes in the upper respiratory tract and in the construction of the head and neck, such as a large tongue, short thick neck, swollen throat structure, smaller mouth opening cause that the percentage of failed intubation in obese patients can reach 13%. Obesity causes many changes that affect a reduction in cardiovascular fitness. The advancement of the changes depends on the degree of obesity and on how long the patient is suffering from obesity. In obese young people who were overweight in childhood, circulation may be well adapted to obesity and usually clinical deviations from the norm are not observed, although the proportion of people with hypertension at a young age who are obese now in adulthood is greater than in patients with normal BMI [2- 4].

The aim of the study is to present the problem of obesity and to determine the extent to which obesity affects the process of general anesthesia. The subject of a detailed analysis is the impact of obesity on the risk associated with surgery.

## MATERIALS AND METHODS

The research was prospective and was carried out in the general operating theatre in the Regional Specialist Hospital in Biała Podlaska in the period from May 2011 to July 2012. The research was based on the anaesthetic documentation – anaesthesia chart, observation and the analysis of patients’ documents.

The study included 200 patients admitted to the operation suite, the patients were from urology, surgery and gynecology wards and were subjected to treatment lasting an average of 1.03 hours. All patients were under general endotracheal anesthesia. For the purpose of further analysis age categorization of the study group was carried out. The average age of the study group was 53.48 ± 18.76 years, while among women 52.54 ± 16.92 years and for men 54.50 ± 20.71 years (Table 1). The average height of the examined woman was 166 ± 8,34cm, while as to men 173 ± 8,58cm. The average weight of women in the study group was 76.44 ± 15.99 kg, men 80.02 ± 14.39 kg. Average BMI values for women are 27.65 ± 5.30 kg/m<sup>2</sup> and in the case of men 26.52 ± 4.06 kg/m<sup>2</sup>.

**Table 1.** Statement of average values of height, weight, BMI and age of examined patients

Variable	Sex	$\bar{x}$	SD	Min	Max
Age (years)	Females	52,54	16,92	24	87
	Males	54,50	20,71	17	89
Height (cm)	Females	166	8,34	150	190
	Males	173	8,58	159	189
Body weight(kg)	Females	76,44	15,99	50	115
	Males	80,02	14,39	50	112
BMI (kg/m <sup>2</sup> )	Females	27,65	5,30	20,02	43,28
	Males	26,52	4,06	19,53	35,16

$\bar{x}$  - average. SD –standrad deviation, min-minimum, max-maximum;

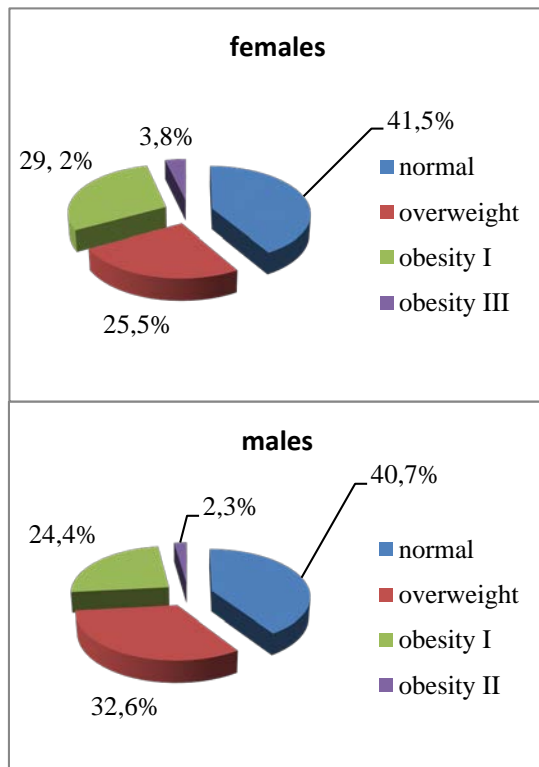
Depending on the classification of the BMI, examined patients were divided into three groups: patients with normal BMI, patients who are overweight and obese patients. Examined men with normal body weight accounted for 40.7% (n = 35), men who are overweight: 32.6% (n = 28), men with obesity of the 1st degree accounted for 24.4% (n = 20) and men with obesity of the 2nd degree: 2.3% (n = 2). (Fig. 1b).

Women with normal BMI dominate in the structure of body weight of women: 41.5% (n= 44). Almost every third woman had the 1st degree of obesity 29.2% (n = 38), and one in four was

overweight 25.5% (n = 29). Women with obesity of the 3rd grade accounted for 3.8% of the minimum percentage of women surveyed (Fig. 1a).

The analysis was made due to the parameters such as: blood pressure, mean MAP pressure, the scale of ASA, sex.

In order to qualify a patient for the surgery the scale developed by the American Society of Anesthesiology (ASA) has been used. It assesses the operational risk associated with the risk of serious complications or death of the patient during anesthesia or after it. In this system, on the basis of



**Figure 1.** BMI in women (a) and men (b).

preoperative evaluation, patients are classified to one of six groups [5,6]:

- ASA 1 – healthy patients;
- ASA 2 – patients with mild systemic disease, which does not compromise normal functioning;
- ASA 3 - patients with severe systemic disease, limiting normal functioning;
- ASA 4 - patients with severe systemic disease that is a constant threat to life;
- ASA 5 - dying patients who will not survive surgery;
- ASA 6 - patients with pronounced brain death whose organs are taken for transplantation;
- E - sudden or urgent surgery.

The examined patients were subjected to the action of the anesthetic. The apparatus used for anesthesia consisted of three basic components: the mixing and supply system of medical gases, anesthetic ventilator and patient monitoring systems. Measurements of systolic and diastolic blood pressure, and mean pressure MAP were carried out with an apparatus for measuring blood pressure. The patient's arm used for measuring pressure was at an angle of approximately 90 degrees to the body. The width of the cuff for measuring blood pressure accounted for 40% of the circumference of the arm.

In the experimental treatments under general anesthesia specialists used non-invasive

monitoring of arterial blood oxygenation via pulse oximeter. The degree of saturation of hemoglobin with oxygen (oxygen saturation- $SpO_2$ ) and heart rate were assessed [6].

Oxygenation of bariatric patients was carried out in Trendelenburg position also called HELP (Head-Elevated Laryngoscopy Position) with the operating table set up at an angle of at least 25-30 degrees [7,8].

Before induction of anesthesia, each patient was subject to pre-oxygenate, i.e. breathed for at least three minutes with 100% oxygen through an oxygen mask. Breathing pure oxygen allows for the assembly of larger amount of oxygen in the lungs – it can be used for longer-lasting apnea.

The examined parameters were written in the Excel file and subject to statistical analysis. For the statistical calculations we used Statistica 10.0 using NIR test. Differences for which  $p < 0.05$ , were identified as significant.

The ethics committee of Medical University in Białystok permitted for research and the director of the Regional Specialist Hospital in Biała Podlaska gave consent to analyse patients' medical records.

## RESULTS

Table 1 shows the mean systolic values taking into account gender and BMI. The maximum systolic blood pressure both in women and in the group of men was found in individuals with obesity. In people with normal weight and overweight the parameter is within the norm, ranged 121-137 mmHg. Statistical analysis indicates that body weight has a significant effect on systolic blood pressure in the study groups. The systolic blood pressure in obese patients was significantly higher compared to the overweight or a group of the normal weight, both in the group of men and women ( $p < 0.05$ ). The highest diastolic blood pressure was found in both obese men and women. Diastolic blood pressure differed significantly in the group of obese and overweight than people of normal weight irrespective of gender ( $p < 0.01$ ).

Analyzing the MAP the patients, we found significant differences ( $p < 0.001$ ) between women of normal weight and obese women and men who are overweight and obese men at (Table 2).

In obese patients, in addition to the underlying disease as obesity we can often encounter coexistence of other diseases which develop during long lasting weight problems. In the next part of the study we sought to prove whether obese patients are more burdened with other comorbidities than those of normal weight. Men with normal weight had a significantly ( $p < 0.001$ ) higher risk compared to women with normal BMI (Table 3).

**Table 2.** The analysis of the systolic, diastolic, and mean arterial pressure in the examined group, depending on body weight (NIR test,  $p < 0.001$ )

Variate	Sex	Body weight									P value
		Normal (NW)			Overweight (Ov)			Obesity (Ob)			
		NW	$\bar{x}$	SD	n	$\bar{x}$	Sd	n	$\bar{x}$	SD	
SBP	F	44	121.1	21.1	27	125.2	15.0	43	150.4	21.3	<0.001 NW vs. Ob <0.001 Ov vs. Ob
	M	35	131,0	18,7	28	137,5	24,0	26	150.4	28,0	<0.001 NW vs. Ob 0.032 Ov vs. Ob
DBP	F	44	79,8	8,5	27	78.6	9.1	43	94.0	11.4	<0.001 NW vs. Ob <0.001 Ov vs. Ob
	M	35	83.9	8.3	28	90.2	12.1	26	90.9	12.6	<0.001 NW vs. Ob 0.033 Ov vs. Ob

**Table 3.** The risk analysis of a surgery associated with the coexistence of diseases (ASA scale) depending on the weight-height rate (NIR test,  $p < 0.001$ )

Sex	Body weight									P value
	Normal (NW)			Overweight (Ov)			Obesity (Ob)			
	N	$\bar{x}$	Sd	n	$\bar{x}$	SD	n	$\bar{x}$	SD	
Females	44	1.6	0.7	27	2.0	0.6	43	2.5	0.6	<0.001 NW vs. Ob 0.002 Ov vs. Ob
Males	35	2.2	0.9	28	2.0	0.8	26	2.7	0.8	0.005 NW vs. Ob <0.001 for Ov and Ob

The next estimated variable is oxygen saturation, the value of saturation for one hour at 10 minute intervals (Table 4).

In the surveyed group of women and men

no significant relationship was found. We can only note that with the growth of weight-height rate, the saturation value decreases. Blood oxygen level during surgery was within normal range.

**Table 4.** Average values of saturation of the examined patients in respective lengths of time by gender and size of the weight – height index

	10'		20'		30'		40'		50'		60'	
	F	M	F	M	F	M	F	M	F	M	F	M
Normal	98,1	97,6	98,3	97,7	98,3	97,5	98,2	97,6	98,2	97,8	98,2	97,5
Overweight	97,2	97,8	97,4	97,7	97,7	97,8	97,6	97,5	97,8	98,0	97,6	97,7
Obesity	96,9	96,0	96,9	96,0	97,3	96,4	97,2	96,2	97,3	96,6	97,3	96,2

## DISCUSSION

Obesity is subject to excessive development of excessive growth of fat tissue much above normal values established for age, gender and race. Obesity is a chronic disease with a strong tendency for familial occurrence that enhance environmental factors such as lack of physical activity in

combination with a high-calorie diet and cheap, poor quality food [9-13].

Patients whose BMI is above 35, described as extremely obese (morbidly obese) are at particularly high risk of anesthesia due to many burdens and comorbidities, especially circulatory and respiratory and metabolic changes. These

include: hypertension, diabetes, heart failure and respiratory disorders either central or peripheral.

In addition, altered metabolism, impaired plasma proteins relationships, changes in blood pH, and finally impaired function of liver and kidney affect the pharmacology of agents used in anesthesia. To conduct safely anesthesia during surgery in obese patients an anesthesiologist is required to have a lot of experience and technical knowledge [12,14].

Obesity is the most important risk factor for hypertension [11]. It is estimated that 80% of the cases of arterial hypertension in Poland, is associated with an increase of body weight. The impact of obesity on the risk of developing hypertension is particularly strongly expressed in young women [15-18]. The relationship between blood pressure and the risk of cardiovascular events is continuous, constant and independent of other risk factors. The higher the blood pressure cause a greater risk of heart attack, heart failure, stroke, and kidney disease [10,19].

One of the aims of this study was to determine whether body weight has an effect on blood pressure. The analysis clearly shows that body weight has a significant effect on systolic, diastolic, and the MAP in the study groups.

The highest systolic blood pressure both in women and in the group of men was found in patients with obesity. In people with normal weight and overweight the parameter is within the normal range between 121 mmHg - 137mmHg. The highest diastolic blood pressure was also found in both obese men and women. Diastolic blood pressure is statistically significantly different in the group of obese and overweight from people with normal weight.

World Health Organization report of 2002 on the promotion of healthy lifestyles and minimizing the health risks indicates direct relations with high blood pressure and overweight and obesity. The small reduction in BMI leads to a reduction in blood pressure as well as the risk of other diseases e.g. diabetes type 2 [20].

The study also examined whether obesity is associated with deterioration of blood oxygen saturation. Świątkowska et al. [17] described impairment of ventilation in obese people. With the increase of body weight, the basic energy demand raises, and so the oxygen consumption does. Obesity decreases the compliance of the chest wall and diaphragm, which causes ventilation disorders, more frequently exertional dyspnoea and dyspnoea at rest. In such cases small bronchioles close, accompanied by abnormal proportions between ventilation and perfusion. The decrease of compliance of lower respiratory tract reduces expiratory reserve volume (ERV) and functional residual capacity (FRC), vital capacity (VC) and total lung capacity (TLC). These changes can lead to hypoxia and hypercapnia [21-24]. In obese people functional residual capacity

(FRC) is reduced, which tends to decrease arterial oxygen saturation.

Szreter and Gaszyński [2] reported that pre-oxygenate is one of the essential elements of induction of general anesthesia, affecting safety of the patient. There are specific recommendations for the proper and effective conduct of pre-oxygenation [22,25]. This procedure is performed according to the recommendations quoted – i.e. 3 min of passive oxygenation - provides in the majority of patients an obtainment of an appropriate concentration of oxygen in lungs ( $ETO_2 > 90\%$ ).

Altermatt et al. [23] describe a standard pre-oxygenate in patients with severe obesity as ineffective due to a number of serious changes in the respiratory and circulatory systems. In these patients it is observed, among others, the reduction of FRC, which is considered as the main reservoir of oxygen. In addition, the position of the patient on the operating table affects the further reduction in FRC. Disorders in pulmonary circulation and the relations of perfusion to ventilation affect the development of significant leakage unoxygenated blood in the lungs, up to 10-20%.

It was noted that after the standard pre-oxygenation lasting 3 min, obese patients have safe apnea time (SAP - Safe Apnea Period) almost 2.5 times shorter than compared to non-obese people. A series of studies was conducted on various methods of pre-oxygenation in order to improve its efficiency and to extend the SAP. Passive oxygenation for 5 minutes was compared to 4 min of deep breathing within 30 seconds obtaining similar SAP. It has been shown that obese patient position during passive oxygenation in the HELP position (Head-Elevated Laryngoscopy Position) extends SAP compared with oxygen therapy in the recumbent. It is a medical position in which the patient lies on the back and the head, upper chest and torso are above the level of the lower limbs. This facilitates the introduction of the laryngoscope by reducing the angle between the level of the chest and face. This position also slightly improves mechanical ventilation. The impact of sitting position on the effectiveness of pre-oxygenation in obese patients was also examined [7,23,25].

During the research no statistically significant differences regarding the value of saturation were found. The analysis shows only that it is lower than in those patients with normal weight, but is within the norm.

Our study showed that in obese patients who underwent surgery, comorbidities which develop because of obesity were more frequent.

The research clearly shows that the higher the BMI, the higher the ASA, which means a greater body burden, and thus the risk associated with anesthesia and surgery is higher.

## CONCLUSIONS

The following conclusions based on the study have been formulated:

1. Overweight and obesity significantly affect the increase in systolic, diastolic, and MAP. The increase in BMI significantly affects the risk of developing hypertension.
2. The study did not confirm the significant impact of obesity on the deterioration of oxygenation, which may indicate the effectiveness of the treatment of pre-oxygenation and effectiveness of the procedures of intubating patients in the anti-Trendelenburg position.
3. Examined men had significantly higher preoperative absolute risk compared to women. There is close relationship between increasing BMI and an increased risk associated with anesthesia expressed in ASA scoring.

## Conflicts of interest

The authors declare that they have no conflicts of interest.

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