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Effect of overweight and obesity on clinical course and prognosis in patients with acute coronary syndromes

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Abstract

Introduction and Objective. Acute coronary syndromes (ACS) are life-threatening conditions, characterized by limited or absent blood flow in the coronary arteries. Diagnosis of ACS depends on clinical symptoms, characteristic electrocardiogram (ECG) changes, and increased biochemical markers of myocardial necrosis above reference values. The aim of the study was to assess the effect of overweight and obesity on the clinical course and prognosis in patients with acute coronary syndromes.

Materials and Method. The study was conducted in the 2nd Cardiology Clinic in Kielce, south-east Poland. The study included 256 patients diagnosed with ACS, unstable angina (UA), non-ST-elevation myocardial infarction (NSTEMI), and ST-elevation myocardial infarction (STEMI). Males constituted 58.6% of the total number of patients, and persons aged 65 and older – 51.2%. The study was of an observational, case-control character. The procedure covered anthropometric measurements, collection of fasting venous blood samples, and analysis of patients' medical records.

Results. The mean BMI in the examined population was 28.86(±4.85) kg/m^2; mean body weight – 80.08(±16.03) kg; 41.8% of patients were diagnosed with overweight, 35.9% with obesity. The mean total cholesterol level in the examined population was 191.11(±51.28) mg/dL, and mean LVEF – 51.35 (±8.86)%. Coronary angiography was performed on 95.7% of patients. The most common risk factors for CVD were: arterial hypertension (65.6%), and hypercholesterolaemia (50.0%).

Conclusions. Overweight or obesity increases the risk of occurrence of classical cardiovascular risk factors, such as arterial hypertension, hypercholesterolaemia, and type 2 diabetes. In patients with ACS, obesity was related with renal failure. In overweight and obese persons coronary angiography was most often performed.

Key words

risk factors, overweight and obesity, ACS

INTRODUCTION AND OBJECTIVE

Acute coronary syndromes (ACS) are classified into life-threatening conditions, characterized by limited or lack of blood flow in the coronary arteries, most often caused by a blood clot resulting from damage or rupture of the atherosclerotic plaque, which is composed of a superficial layer, i.e. collagen fibres, muscularis and the core which includes fatty deposits. An inflammatory condition plays a crucial role in the development of instability in the atherosclerotic plaque. However, the mechanisms triggering a stimulus which causes acute inflammation are not fully known. The composition of the atherosclerotic plaque, extent of rupture, intensity of inflammation, vascularization of the site of rupture, and homeostasis between elements of the coagulation system – prothrombotic and antithrombotic factors – exert an effect on the development of ACS. In intravascular ultrasound (IVUS) multiple lesions of atherosclerotic plaques are observed at the sites other than the change causing ACS. Coronary artery stenosis by growing atherosclerotic plaque up to 50.0% of its diameter is called a haemodynamically insignificant change, myocardial oxygen demand is sufficient, and the patient usually does not experience pain complaints. Narrowing of the vessel lumen by 50.0% or more – haemodynamically significant –

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causes restriction of blood flow through the coronary artery, resulting in myocardial ischaemia. Patients experience pain complaints during increased myocardial oxygen demand: during physical effort, in a stressful situation, or during suddenly changes in ambient temperature. Narrowing of the vessel lumen by 80.0% or more, considered critical, causes the symptoms of angina at small effort made by the patient, or at rest. Atherosclerotic plaque progression, its lesion or rupture, leads to the complete closure of the vessel lumen resulting in necrosis of heart muscle cells. Rupture of the atherosclerotic plaque occurs in 75.0% of patients with ACS [1–4].

The classification and diagnosis of ACS depends on clinical symptoms, typical changes in the electrocardiogram (ECG) recording, and an increase in biochemical markers of myocardial necrosis above reference values. The basic symptom initiating diagnostics, and subsequently the treatment of patients with suspicion of ACS, is a characteristic pain in the chest, usually defined as a strong burning and choking pain, crushing, but rarely stabbing sensations in the chest. The pain is experienced by a patient on a large area of the chest with possible radiation to the mandible, shoulder and left arm, and to the interscapular area. The development of highly sensitive immunological tests to assess cardiac troponin levels (cTn) in blood serum contributed to the systematization of the classification of ACS [4, 5].

Epidemiological studies clearly indicate that morbidity due to cardiovascular diseases (CVD), including ACS, is closely related with the presence of risk factors which, in patients diagnosed with ACS, may be divided into two groups: modifiable and non-modifiable risk factors. Change of life style, treatment undertaken, and application of prophylactic measures, may limit or totally eliminate modifiable risk factors. Non-modifiable risk factors are not subject to changes, and include: age, gender, genetic load, and concomitant diseases. Limitation of the occurrence of modifiable risk factors for CVD through change of life style decreases the possibility of development of each type of ACS [6, 7].

Overweight and obesity may exert a negative effect on the metabolism of cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL), and high-density lipoprotein cholesterol (HDL). In addition, the effect of abnormal body weight on arterial blood pressure, insulin resistance, and the development of type 2 diabetes, is important. According to the majority of reports, the risk of CVD increases with an increase in BMI. Moreover, obesity causes changes in body composition, which may affect the haemodynamics of cardiac function, and may also alter the structural composition of the heart muscle. Adipose tissue produces pro-inflammatory cytokines, which may contribute to the development of heart rhythm disturbances and promote the formation of atherosclerotic plaques. An elevated level of BMI also increases the risk of development of cancerous diseases involving the large intestine, breasts, prostate gland, endometrium, kidneys, and bladder. Therefore, it is considered that an optimum BMI value should be 18.5–24.9 kg/m^2 [8].

Overweight and obesity are also related with an increased risk of death due to CVD, as well as general mortality. In persons aged under 60 general mortality is the lowest for the BMI value of 20–25 kg/m^2, further reduction of body weight below 20 kg/m^2 is not recommended as a factor protecting against the development of CVD. It has been documented that the maintenance of normal body weight exerts a beneficial effect on the metabolic factors of CVD, such as arterial hypertension, dyslipidaemia, and glucose concentration in venous blood serum.

Change of life style in terms of diet and physical activity and behavioural modifications should be the basis in the treatment of overweight and obesity. In patients with considerable obesity, and unsatisfactory results of the change in life mode, pharmacological treatment should be considered or the use of bariatric surgery procedures [9, 10].

The aim of the study was assessment of the effect of overweight and obesity on the clinical course and prognosis in patients with acute coronary syndromes.

MATERIALS AND METHOD

The study was carried out on 256 patients in the 2nd Cardiology Clinic (ŚCK) in in Kielce, south-east Poland. Patients with the diagnosis of ACS, including unstable angina pectoris (UA), non-ST-elevation myocardial infarction (NSTEMI), and ST-elevation myocardial infarction (STEMI), were enrolled into the study. Written consent was obtained from the patients, as well as consent from the Bioethical Committee at the Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce (Decision No. 33/2017). Anthropometric measurements were performed from 06:00–07:00. Subsequently, the nursing staff at the clinic collected blood for biochemical tests in fasting patients from 07:00–08:00. The subsequent stage was analysis of medical records (medical history, nursing interview, nursing process documentation, and data contained in the IT system Asseco Medical Management Solutions (AMMS) concerning hospitalization in the clinic ŚCK. After 6 months, the recurrence of a CVD episode was control in the ŚCK database, using the software AMMS and the Electronic Verification of Entitlement of Beneficiaries (eWUŚ), and by telephone contact with the patients.

Venous blood samples were collected in a sitting position, using a vacuum system. Measurements of body height were taken in a standing position with an accuracy of 1 cm, while body weight was measured in a standing position with an accuracy of 0.1 kg using a certified electronic medical scale with stadiometer. BMI was calculated on this basis.

The criteria of selection were: diagnosis of ACS (UA, NSTEMI, STEMI), first event of ACS, age under 86, voluntary participation in the study, and hospitalization at the Kielce Province Cardiology Centre. The criteria of exclusion were a subsequent event of ACS, age over 85, lack of a written consent to participate in the study, patients currently undergoing anti-cancer therapy, mental dysfunction, a disease significantly affecting the state of awareness, and low physical fitness making anthropometric measurements impossible.

Numerical variables were analyzed using the mean ($\bar{x}$), standard deviation (SD), median, interquartile range (IQR), minimum and maximum values (range). Categorical variables were presented by means numbers and percentages. Detail research problems were verified using tables with descriptive statistics, Mann–Whitney U test or Kruskal-Wallis test, as well as numbers and percentages with chi-square or Fisher's test. The p values $p<0.05$ were considered statistically significant.

RESULTS

The mean age of patients in the study group was 63.6 (±9.57), males constituted 58.6% (n=150) of the examined population. The mean BMI value in the study group was 28.86(±4.85) kg/m^2, and the men's body weight – 80.08(±16.03) kg. In 86.8% (n=92) of females, the hip circumference was ≥80 cm, in 76.0% (n=114) of males – ≥94 cm. Normal BMI values were observed in 21.1% (n=54) of the study participants. In 41.8% (n=107) of patients, overweight was observed, and in 35.9% (n=92) – obesity (Tab. 1).

Table 1. Characteristics of the study group – demographic data, anthropometric measurements

Variable	Parameter		Total (N=256)
Age [years]	N		256
	$\bar{x}$ (SD)		63.6 (9.57)
	Me (IQR)		65 (59–70)
	Range		37–84
Gender	Female		41.4% (n=106)
	Male		58.6% (n=150)
BMI [kg/m^2]	N		256
	$\bar{x}$ (SD)		28.86 (4.85)
	Me (IQR)		28.22 (25.36-31.74)
	Range		16.31-47.13
BMI (division)	Emaciation		0.4% (n=1)
	Underweight		0.8% (n=2)
	Normal		21.1% (n=54)
	Overweight		41.8% (n=107)
	Obesity Grade 1		26.6% (n=68)
	Obesity Grade 2		7.8% (n=20)
	Obesity Grade 3		1.6% (n=4)
	Obesity Grades 1,2,3		35.9% (n=92)
Body weight [kg]	N		256
	$\bar{x}$ (SD)		80.08 (16.03)
	Me (IQR)		79.15 (68.8–87.91)
	Range		41.75–139.6
Height [cm]	N		256
	$\bar{x}$ (SD)		166.38 (9.66)
	Me (IQR)		167 (158–173.25)
	Range		143–191
Hip circumference [cm]	N		256
	$\bar{x}$ (SD)		101.96 (8.76)
	Me (IQR)		101 (96–107)
	Range		81–137
Waist circumference [cm]	N		256
	$\bar{x}$ (SD)		97.79 (12.45)
	Me (IQR)		98 (90–105)
	Range		62–140
Waist circumference [cm]	Female	<80	13.2% (n=14)
		≥80	86.8% (n=92)
	Male	<94	24.0% (n=36)
		≥94	76.0% (n=114)

N – total number; n – subgroup size; $\bar{x}$ mean; SD – standard deviation; Me – median; IQR – interquartile range; kg – kilogram; m^2 – meter square; cm – centimetre; BMI – body mass index

The mean level of total cholesterol in the examined population was 191.11(±51.28) mg/dL. In 31.2% (n=80) of the examined patients the level of LDL exceeded 135 mg/dL, and in 32.0% (n=82) the level of triglycerides was ≥150 mg/dL. The level of HDL ≤45 mg/dL occurred in 45.3% (n=48) of females, HDL≤40 mg/dL was observed in 46.0% (n=69) of males. Elevated fasting glucose levels >100 mg/dL occurred in 42.6% (n=109) of patients, the concentration of HbA1C≥7% was observed in 12.9% (n=33). The mean BNP value in the examined population was 180.61(±200.8) pg/mL, more than a half of patients (54.3%, n=139) had BNP exceeding reference values. In the case of the remaining variables concerning laboratory analyses, the majority of the study participants obtained results within reference values (Tab. 2).

The mean LVEF in the examined population was 51.35 (±8.86) %, and was higher in females (54.51±7.65%), compared to males (49.11±9.01%). LVEF<50% was observed in 51.2% (n=131) of patients (43.3% of males and 17.0% of females). The left ventricular end-diastolic diameter was 51.79(±5,53) mm and remained within the range of reference values in 94.3% (n=100) of females and in 72.7% (n=109) of males. Left ventricular end-systolic diameter was 38.09(±6.13)mm and exceeded the reference values in 61.3% (n=65) of females and 87.3% (n=131) of males (Tab. 3).

Coronary angiography was performed in 95.7% (n=245) of patients. Single-vessel disease was diagnosed in 33.1% (n=81) of patients, multivessel disease in 39.6% (n=97) of the study participants. The majority of patients were treated using PCI – 54.5% (n=139), CABG was performed in 10.6% (n=27), combined therapy – PCI and CABG in 3.1% (n=8), and in 31.8% (n=81) of patients conservative treatment was applied (Tab. 4).

Unstable angina pectoris was most often diagnosed in the study group: UA – 38.3% (n=98), followed by ST elevation myocardial infarction: STEMI – 32.8% (n=84), and non-ST-elevation myocardial infarction: NSTEMI – 28.9% (n=74). The presence of ACS complications was observed in 2.9% (n=33) of patients. Atrioventricular block was most often diagnosed – 3.5% (n=9), followed by atrial fibrillation – 2.7% (n=7), ventricular fibrillation – 2.7% (n=7), and pulmonary oedema – 2.3% (n=6). Mean hospitalization time – 6.97(±3.7) days, repeated hospitalization concerned 38.7% (n=99) of patients. During the post-hospital observation period lasting for 6 months, 3.9% (n=10) of the study participants died (Tab. 5).

The most common risk factors for CVD in the examined population were: arterial hypertension (65.6%; n=168), hypercholesterolaemia (50.0%; n=128), and obesity – 35.9% (n=92). Nicotinism was also a frequent risk factor which concerned 31.2% (n=80) of patients, and type 2 diabetes diagnosed in 21.1% (n=54) of study participants (Tab. 6).

Analysis of cardiovascular risk factors in individual age groups indicated that arterial hypertension and hypercholesterolaemia were observed significantly more often in patients with overweight and obesity (p=0.002). A tendency was also noted towards a frequent occurrence of type 2 diabetes in overweight and obese patients (p=0.058) (Tab. 7).

No significant effect of overweight on the course and prognosis was observed in patients with acute coronary syndrome. Diagnostic procedures, examinations results, method of treatment, duration of hospitalization and survival of overweight patients were comparable to those in patients

Table 2. Results of laboratory tests

Variable	Parameter	Total (N=256)	Ref. value	Total (N=256)
Total cholesterol [mg/dL]	N	256		
	$\bar{x}$ (SD)	191.11 (51.28)	<130	9.8% (n=25)
	Me (IQR)	186.5 (156.5–126.25)	130–200	53.1% (n=136)
	Range	72–337	>200	37.1% (n=95)
LDL cholesterol [mg/dL]	N	256		
	$\bar{x}$ (SD)	118.95 (42.54)	<70	13.3% (n=34)
	Me (IQR)	116.5 (86–144)	70–135	55.5% (n=142)
	Range	29–249	>135	31.2% (n=80)
Triglycerides [mg/dL]	N	256	<150	68.0% (n=174)
	$\bar{x}$ (SD)	142.25 (88.31)		
	Me (IQR)	122 (93–165.5)	≥150	32.0% (n=82)
	Range	39–834		
HDL cholesterol l[mg/dL]	N	256	K ≤45	45.3% (n=48)
	$\bar{x}$ (SD)	45.17 (12.5)	>45	54.7% (n=58)
	Me (IQR)	44 (37–51.25)	M ≤40	46.0% (n=69)
	Range	13–101	>40	54.0% (n=81)
Fasting glucose [mg/dL]	N	256		
	$\bar{x}$ (SD)	110.68 (40.13)	<65	0.4% (n=1)
	Me (IQR)	98 (91–118)	65–100	57.0% (n=146)
	Range	62–395	>100	42.6% (n=109)
Haemoglobin HbA1C [%]	N	256	<7	87.1% (n=223)
	$\bar{x}$ (SD)	6.23 (1.29)		
	Me (IQR)	5.89 (5.55–6.4)	≥7	12.9% (n=33)
	Range	4.72–17.06		
Haemoglobin [g/dL]	N	256		
	$\bar{x}$ (SD)	13.93 (1.51)	<12	10.2% (n=26)
	Me (IQR)	14 (13.07–15)	12.0–15.6	76.6% (n=196)
	Range	8.6–17.2	>15.6	13.3% (n=34)
Erythrocytes [1012/L]	N	256		
	$\bar{x}$ (SD)	4.61 (0.49)	<3.6	2.3% (n=6)
	Me (IQR)	4.65 (4.3–4.95)	3.6–5.2	87.9% (n=225)
	Range	2.8–6.16	>5.2	9.8% (n=25)
Leukocytes [109/L]	N	256		
	$\bar{x}$ (SD)	9.01 (3.23)	<4.1	0.8% (n=2)
	Me (IQR)	8.41 (7–10.17)	4.1–10.9	79.3% (n=203)
	Range	3.88–32.6	>10.9	19.9% (n=51)
Platelets [109/L]	N	256		
	$\bar{x}$ (SD)	234.75 (65.45)	<140	1.6% (n=4)
	Me (IQR)	223 (188.75–269.25)	140–440	97.7% (n=250)
	Range	116–494	>440	0.8% (n=2)
BNP[pg/mL]	N	256		
	$\bar{x}$ (SD)	180.61 (200.8)	0–100	45.7% (n=117)
	Me (IQR)	111.5 (54–247.25)		
	Range	5–1386	>100	54.3% (n=139)
MDRD [mL/min/1.73 m2]	N	256		
	$\bar{x}$ (SD)	72.01 (17.03)	<60	23.0% (n=59)
	Me (IQR)	72.25 (61.15–82)	60–89	65.6% (n=168)
	Range	28.8–188.2	>89	11.3% (n=29)

Ref. Value – reference value; N – total number; n – subgroup size; $\bar{x}$ – mean; SD – standard deviation; Me – median; IQR – interquartile range; mg – milligram; dL – decilitre; LDL – low density lipoprotein; HDL – high density lipoprotein; $HbA1_c$ – glycated haemoglobin; g – gram; L – litre; BNP – natriuretic peptide; pg – picogram; mL – millilitre; MDRD – glomerular filtration; min – minute; m^2 – meter square; % – percentage

Table 3. Echocardiography results

Variable	Parameter	Total (N=256)	Females (n=106)	Males (n=150)
LVEF [%]	<50	51.2% (n=131)	17.0% (n=18)	43.3% (n=96)
	≥50	48.8% (n=125)	83.0% (n=88)	56.7% (n=85)
	N	256	106	150
	Mean (SD)	51.35 (8.86)	54.51 (7.65)	49.11 (9.01)
	Median (IQR)	50.00 (45.00–60.00)	55.00 (50.00–60.00)	50.00 (45.00–55.00)
	Range	20.00–68.00	30.00–65.00	20.00–68.00
LV diastolic dimension [mm]	N	256	106	150
	Mean (SD)	51.79 (5.53)	48.98 (4.31)	53.77 (5.45)
	Median (IQR)	51 (48–55)	49 (46–51.75)	53 (50.25–57)
	Range	40–74	40–62	41–74
LV systolic dimension [mm]	N	256	106	150
	Mean (SD)	38.09 (6.13)	35.29 (5.34)	40.07 (5.9)
	Median (IQR)	38 (35–41)	36 (31–38)	40 (37–42)
	Range	21–64	21–58	24–64
LV diastolic dimension [mm]	<34	0% (n=0)	0% (n=0)	0% (n=0)
	34–56	81.6% (n=209)	94.3% (n=100)	72.7% (n=109)
	>56	18.4% (n=47)	5.7% (n=6)	27.3% (n=41)
LV systolic dimension [mm]	<26	1.2% (n=3)	1.9% (n=2)	0.7% (n=1)
	26–34	22.3% (n=57)	36.8% (n=39)	12.0% (n=18)
	>34	76.6% (n=196)	61.3% (n=65)	87.3% (n=131)

N – total number; n – subgroup size; $\bar{x}$ – mean; SD – standard deviation; Me – median; IQR – interquartile range; LVEF – left ventricular ejection fraction; % – percentage; LV – left ventricle

Table 4. Coronary angiography and treatment applied

Variable	Parameter	Total (N=256)
Coronary angiography	Yes	95.7% (n=245)
	No	4.3% (n=11)
Result of coronary angiography	Single-vessel disease	33.1% (n=81)
	Multi-vessel disease	39.6% (n=97)
	No significant changes in coronary arteries	27.3% (n=67)
Treatment	PCI	54.5% (n=139)
	CABG	10.6% (n=27)
	PCI and CABG	3.1% (n=8)
	Conservative treatment	31.8% (n=81)

N – total number; n – subgroup size; PCI – percutaneous myocardial revascularization; CABG – coronary artery bypass grafting; % – percentage

with normal body weight. Comparison of the results of diagnostic tests and therapy in patients with acute coronary syndrome with various grades of obesity, did not show significant differences. Marginally more frequent occurrence of single-vessel coronary artery disease was observed and no atherosclerotic changes in the examined patients with Grade 2 and 3 obesity, and more frequent multi-vascular changes in patients with Grade 1 obesity (p=0.051). Survival rate at 6 months post-hospital follow-up was comparable among patients with various grades of obesity. No correlation was confirmed in the study between normal body weight, overweight or obesity, and the occurrence of a specific type of acute coronary syndrome.

Table 5. Course and prognosis in ACS

Variable	Parameter	Total (N=256)
Acute coronary syndrome	UA	38.3% (n=98)
	NSTEMI	28.9% (n=74)
	STEMI	32.8% (n=84)
Complications	No	87.1% (n=223)
	Atrioventricular block	3.1% (n=8)
	Atrial fibrillation	2.3% (n=6)
	Pulmonary oedema	1.6% (n=4)
	Pericarditis	0.4% (n=1)
	Aneurysm at the site of arterial puncture (coronary angiography, PCI)	1.6% (n=4)
	Ventricular fibrillation	2.3% (n=6)
	Ventricular tachycardia	0.4% (n=1)
	Atrioventricular block, ventricular fibrillation	0.4% (n=1)
	Atrial fibrillation, ventricular tachycardia, pulmonary oedema	0.4% (n=1)
	Ventricular tachycardia, pulmonary oedema	0.4% (n=1)
Days of hospitalization	N	256
	$\bar{x}$ (SD)	6.97 (3.7)
	Me (IQR)	6.5 (5-8)
	Range	2-36
Repeated hospitalization	Yes	38.7% (n=99)
	No	61.3% (n=157)
Death during 6-month post-hospital follow-up	Yes	3.9% (n=10)
	No	96.1% (n=246)

N – total number; n – subgroup size; UA – unstable angina; NSTEMI – non-ST-elevation acute coronary syndrome; STEMI – ST-elevation myocardial infarction, $\bar{x}$ – mean; SD – standard deviation; Me – median; IQR – interquartile range; % – percentage, PCI – percutaneous myocardial revascularization

Table 6. Occurrence of risk factors for CVD

Variable	Parameter	Total (N=256)
Arterial hypertension	Yes	65.6% (n=168)
	No	34.4% (n=88)
Nicotinism	Yes	31.2% (n=80)
	No	68.8% (n=176)
Hypercholesterolaemia	Yes	50.0% (n=128)
	No	50.0% (n=128)
Impaired fasting glucose	Yes	20.7% (n=53)
	No	79.3% (n=203)
Glucose intolerance	Yes	4.7% (n=12)
	No	95.3% (n=244)
Type 2 diabetes	Yes	21.1% (n=54)
	No	78.9% (n=202)
Alcohol Dependence Syndrome	Yes	2.0% (n=5)
	No	98.0% (n=251)
Obesity	Yes	35.9% (n=92)
	No	64.1% (n=164)

N – total number; n – subgroup size; % – percentage

DISCUSSION

In recent years, the problem of the effect of overweight and obesity on the risk of development of cardiovascular diseases has been frequently analyzed due to the controversial results of observational studies. According to some scientific reports, obesity is a significant risk factor exerting an effect on the deterioration of survival in patients with CVD, while other reports suggest a protective effect. This means a better prognosis for survival called the obesity paradox [11, 12, 13].

At present, overweight and obesity are a growing social problem. The study LIPIDOGRAM 2004, 2006 and 2015, clearly shows that overweight and obesity exert a considerable effect on the risk of CVD, and are also an important problem in the Polish population. The results of the presented study are comparable to the most up-to-date study LIPIDOGRAM 2015, where overweight was observed in 39.5% of the study

Table 7. Occurrence of risk factors for CVD with consideration of BMI

Variable	Parameter	Normal body weight (n=54)	Overweight (n=107)	Obesity (n=92)	Test	p
Arterial hypertension	Yes	50.0% (n=27)	62.6% (n=67)	78.3% (n=72)	χ2	**0.002**
	No	50.0% (n=27)	37.4% (n=40)	21.7% (n=20)		
Nicotinism	Yes	40.7% (n=22)	30.8% (n=33)	25.0% (n=23)	χ2	0.138
	No	59.3% (n=32)	69.2% (n=74)	75.0% (n=69)		
Hypercholesterolaemia	Yes	38.9% (n=21)	43.0% (n=46)	64.1% (n=59)	χ2	**0.002**
	No	61.1% (n=33)	57.0% (n=61)	35.9% (n=33)		
Impaired fasting glucose	Yes	20.4% (n=11)	19.6% (n=21)	22.8% (n=21)	χ2	0.852
	No	79.6% (n=43)	80.4% (n=86)	77.2% (n=71)		
Glucose intolerance	Yes	3.7% (n=2)	6.5% (n=7)	3.3% (n=3)	χ2	0.600
	No	96.3% (n=52)	93.5% (n=100)	96.7% (n=89)		
Type 2 diabetes	Yes	14.8% (n=8)	17.8% (n=19)	29.3% (n=27)	χ2	0.058
	No	85.2% (n=46)	82.2% (n=88)	70.7% (n=65)		
Alcohol Dependence Syndrome	Yes	5.6% (n=3)	0.9% (n=1)	1.1% (n=1)	F	0.125
	No	94.4% (n=51)	99.1% (n=106)	98.9% (n=91)		

n - subgroup size; % - percentage; p - level of significance; F - Fisher's test; χ2 - chi-square test participants, whereas obesity concerned 34.9% persons [14].

The lack of all-Polish population studies such as LIPIDOGRAM after 2015, limits the possibility to trace trends in the post-pandemic context. However, according to a report by the World Health Organization (WHO) Europe 2024, Poland is located in the group of Central and East European countries where the rate of increase in the incidence of obesity is among the highest in the region, especially among adults and children [15].

Data published by the NCD Risk Factor Collaboration in 2023 show that the percentage of adults with BMI ≥ 30 in Poland exceeded 25%, and even up to 65–70% of the adult population may be overweight (BMI ≥ 25) [16]. Data by the Eurostat from 2024 indicate an alarming upward trend in abdominal obesity and decline in physical activity, especially among persons at productivity age [17]. Therefore, it should be emphasized that the problem of obesity and overweight in Poland requires re-analysis as part of the updated population studies, because in recent years changes in life style and eating habits could have significantly affected the dynamics of this phenomenon.

In the current study, no significant differences were found in the survival of patients with normal body weight, overweight, and obesity in the course of acute coronary syndromes; however, only short-term mortality was assessed – up to 6 months after ACS. In addition, a tendency was observed which deserves attention (p=0.051) concerning the occurrence of single-vessel coronary artery disease and the lack of significant atherosclerotic changes in the coronary arteries in patients with Grade 2 and 3 obesity, compared to those with Grade 1 obesity. This type of phenomenon, together with better left ventricular ejection fraction in overweight and obese patients, as well as better renal parameters occurring in overweight persons, seems to confirm the presence of the obesity paradox, the causes of which have not yet been unequivocally decided. In a review article, Chrysant et al. evaluated studies concerning the obesity paradox and noticed that there were reports which do not confirm the protective effect of obesity in patients with ACS. Obesity is an important risk factor for CVD and the reason for the discrepancy in results concerning obesity paradox is probably due to the methods of assessment of obesity. In studies indicating the presence of the obesity paradox is a measure of obesity by which exclusively BMI is determined, whereas in contradictory studies, the distribution of adipose tissue is additionally assessed using the measurement of waist circumference, or determination of waist hip ratio (WHR). Therefore, it is not possible to clearly determine whether or not there is an obesity paradox, while it is considered that evidence for the presence of this phenomenon may be misleading to the public.

There is no scientific basis for the presumption that obesity is not the primary factor exerting a negative effect on health [18]. Abdulla et al. came to similar a conclusion while analyzing data in Danish registers concerning more than 21,000 patients who had undergone myocardial infarction, or with circulatory failure. In this group of patients an overall mortality was calculated and it was found that in patients with past myocardial infarction it is U-shaped, with the highest mortality in patients with underweight, or those severely obese. In addition, the researchers analyzed the occurrence of risk factors for CVD, the occurrence of COPD, glomerular filtration rate, and LVEF. While summing-up their analyses, they did not find evidence for the presence of any protective effect of obesity, and emphasized that obesity should be considered as an important risk factor for both myocardial infarction and circulatory failure [19].

In the context of obesity paradox, an increasing number of studies indicate that traditional measures of obesity, such as BMI, may be insufficient for assessment of the actual cardiovascular risk. The use of more advanced indicators, such as WHR, visceral fat volume and abdominal subcutaneous fat volume, allows a more precise differentiation of metabolic phenotypes and their relation with cardiovascular diseases [20–22].

The study by Hou et al. assessed the reliability of tools for automatic measurement of visceral and subcutaneous fat tissue, based on computed tomography (CT). The result showed that the differences in the distribution of fat may be of a greater prognostic importance than body weight itself [20]. Similarly, Mueller et al. demonstrated that the distribution of fat tissue, and not its volume, more strongly correlates with the risk of cardiovascular diseases. Their model based on graph neural networks effectively predicted the volume of visceral and subcutaneous fat on the grounds of the 3-dimensional shape of the body, irrespective of BMI [21].

The most recent data analysis by the UK Biobank, carried out by Starck et al., confirms that persons with similar BMI may have completely different fat distribution, which is translated into varied risk of myocardial infarction or heart failure. The researchers developed atlases of population magnetic resonance images of the whole body, which highlight the differences in fat distribution between healthy individuals and those with cardiovascular diseases [22]. All these data collectively indicate that the alleged protective effect of obesity may be merely a methodological artifact resulting from limitations of the methods for the assessment of body weight used. Therefore, further studies should consider not only BMI, but also modern imaging techniques and precise measurements of fat distribution.

While analyzing the results of available epidemiological studies and meta-analyses it may be presumed that coronary angiography is more often performed on patients with ACS who are additionally obese. It has also been observed that PCI is more frequently performed in this group of patients. This is also confirmed by the results of a meta-analysis by Zhang et al., where more than 95,000 patients with ACS were assessed in prospective studies. The researchers demonstrated that obesity was related with a higher probability of making the decision on coronary angiography and performance of PCI, especially in patients under the age of 65 [23]. A greater number of procedures did not translate into better long-term outcomes, which additionally emphasizes the complexity of the phenomenon of obesity paradox. In turn, the analysis of German clinical registers covering more than 70 cardiology hospitals performed by Stelzer et al., demonstrated that patients with obesity were more often referred for invasive interventions within the first 48 hours of hospitalization, irrespective of clinical risk indicators [24].

The presented analysis showed a tendency towards the more frequent performance of PCI in the group of patients with overweight and obesity. Additionally, in persons with Grades 2 and 3 obesity, more frequent occurrence of single-vessel coronary artery disease or lack of atherosclerotic changes in the coronary arteries was noted, compared to Grade 1 obesity, in which multi-vessel changes were more often observed. The occurrence of complications during hospitalization in the course of ACS was comparable in individual BMI categories, similar to the duration of hospitalization, and repeated hospitalizations due to CVD. The survival of patients after ACS in a 6-month post-hospital follow-up did not significantly differ in groups with normal body weight, overweight, and obesity. Literature reports increasingly more often indicate the lack of the unequivocal effect of overweight and obesity on short-term outcomes of treatment of ACS. A study by Shaheen et al., covering more than 2,000 patients after ACS, did not confirm any differences in 6-month mortality between the BMI groups, despite the fact that PCI was more frequently performed in obese patients [25]. In turn, analysis by Guimarães et al., based on data from the Brazilian ACS registers, also did not confirm significant differences in the frequency of occurrence of hospital complications and the duration of hospitalization between patients with normal body weight, and those overweight or obese. The researchers emphasized that short-term outcomes may be deceptively advantageous in persons with overweight, partly due to earlier undertaking of invasive treatment and greater availability of clinical resources [26].

A more frequent occurrence of single-vessel disease, or even lack of atherosclerotic changes in persons with obesity grade 2 and 3 indicated in the presented analysis, may confirm the observations known from imaging tests that in a part of obese patients myocardial ischemia may be of a microcirculatory nature not associated with typical epicardial atherosclerosis [27].

Conformity between of the duration of hospitalization and the percentage of re-hospitalization in all BMI groups may evidence the fact that BMI as an independent indicator is insufficient for differentiation of clinical risk after ACS. Many researchers emphasize the necessity for using more precise indicators, such as fat distribution, muscle mass, or inflammatory markers, which may better predict the prognosis [28].

Limitations of the study. The limitation of the study is the relatively small population of patients with ACS. In addition, patients diagnosed with ACS who died prior to or soon after admission to hospital were not represented in the study. The measurement of BMI was performed only during hospitalization, which does not reflect possible fluctuations in body weight during 6-month observation. A small number of patients with BMI below 18.5 kg/m^2 could have resulted in a less accurate assessment of the occurrence of the obesity paradox.

CONCLUSIONS

1) Overweight and obesity increase the risk of occurrence of classical cardiovascular risk factors, such as arterial hypertension, hypercholesterolaemia, and type 2 diabetes.
2) Obesity is related with renal function disorders in patients with acute coronary syndrome, whereas overweight does not exert a negative effect on renal function in the examined population.
3) In overweight and obese patients, coronary angiography is more often performed, with a tendency towards more frequent percutaneous myocardial revascularization, with a similar frequency of occurrence of individual types of acute coronary syndrome in individual BMI categories.
4) Improved left ventricular systolic function in overweight and obese patients in the course of acute coronary syndrome, better kidney function in persons with overweight, and less intensified atheromatous changes in coronary arteries in patients with Grade 2 and 3 obesity, speak for the occurrence of the obesity paradox and requires further research.

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