Obesity dilemma in the global burden of cardiovascular diseases

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Editor's Choice

Obesity dilemma in the global burden of cardiovascular diseases

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SUMMARY

Aim: Obesity is a well-known risk factor in the cardiovascular disease continuum. However, its clinical effects are multimodal, perplexed and non-unanimously understood. Our aim was to assess the prevalence and effects of obesity on the cardiometabolic risk factors and systolic function of left ventricle ejection fraction (LVEF) in patients scheduled for cardiovascular rehabilitation. **Methods:** A cohort of 302 consecutive patients recently treated for ischaemic or valvular heart disease was matched according to the existence of obesity, defined with body mass index (BMI $\geq$ 30 kg/m^2; n = 90 vs. 212), and the advanced grade of obesity (BMI $\geq$ 35 kg/m^2; n = 19 vs. 283). Nutritional risk screening was performed using the standardised NRS-2002 tool. **Results:** The mean age of patients was 62.4 $\pm$ 11.2 (range 23–86) years; there were more men than women 244 (80.8%) : 58 (19.2%). Group of obese conveyed higher prevalence of ischaemic heart disease than non-obese (OR = 2.69; 95% CI: 1.01–7.20; p = 0.048); while the difference was insignificant for the advanced grade of obesity (n = 17; 89.5%) vs. controls (n = 233; 82.3%; p > 0.05). There was no significant difference in prevalence of other comorbidities (diabetes, glucose intolerance, hypercholesterolaemia, chronic renal and chronic obstructive pulmonary disease) between studied groups (p > 0.05). Utilisation of lipid-lowering drugs was of similar range between the studied groups (p > 0.05), respectively. LVEF (%) was 50.5 $\pm$ 8.2 vs. 50.7 $\pm$ 7.7 (p > 0.05) and 50.6 $\pm$ 7.8 vs. 49.6 $\pm$ 10.9 (p > 0.05; Rho = 0.001; p > 0.05), respectively. **Conclusion:** In studied set of patients, BMI positively correlated with left ventricle dimension and thickness. No significant connection of obesity was found with the prevalence of chronic comorbidities, increased nutritional risk, laboratory diagnostics or systolic function of left ventricle. Existence of obesity paradox in clinical practice was in part reaffirmed with our study.

What's known

- Obesity is a well-established risk factor and an important chronic comorbidity in cardiovascular diseases continuum.
- However, obese individuals time and again have more fortunate prognosis than normal weighted individuals, known as the obesity paradox.
- Obesity paradox is repeatedly found in reports from observational trials.
- Modifications in lifestyle, healthy diet and treatment of obesity represent beneficial evidence-based medical interventions.
- Treatment of obesity improves course of diseases and conditions within the cardiovascular disease continuum.

What's new

- Studied patients were burdened with numerous cardiovascular risk factors; however, there was no clear discriminative difference on bases of body types i.e. existence of obesity.
- The increased nutritional risk (NRS-2002 > 3), incurred by invasive treatments prior to cardiovascular rehabilitation was of similar prevalence in the obese and non-obese.
- There was no significant difference in cardiometabolic profile, drug utilisation or prognostic parameters in terms of obesity existence, as well as regarding different grades of obesity.

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Disclosure
None declared.

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Introduction

Prevalence of obesity is of constantly growing trends, reaching the levels of global epidemic (1). Over half of the population in the North America or Europe is either overweight or obese (1). Global health burden of obesity is tremendous, particularly because of chronicity and increased prevalence of metabolic syndrome, glucose intolerance, diabetes, hypertension and chronic renal disease (2). Moreover, advanced grades of obesity, defined with substantially increased body mass index (BMI) over 35 or 40 kg/m^2, were found to be in causative relationship with multiple health hazards (3). Course of arterial hypertension, coronary artery disease, heart failure and several other chronic disorders is found to be negatively influenced by existence of obesity (4). This important comorbidity is considered as a poor prognostic parameter in terms of lifetime expectancy, increased morbidity and mortality (5).

Obesity is a chronic multisystem disorder, affecting function and performance of several organ systems, as well as the cardiovascular (6). It causes, to some degree, reversible increase in the cardiac steatosis or mass of the myocardium, instigating a combination of eccentric and concentric hypertrophy of the left ventricle (7). Long-term effects include changes in intermediary metabolism within heart

muscle, diastolic and systolic-on-diastolic dysfunction (8). Hyperdynamic circulatory profile increased volume of extracellular compartment and blood perpetuate complex pathophysiological processes that may lead to the development of obesity-related heart failure (9). Right-sided heart failure is associated with advanced classes of obesity, which cause chronic alveolar hypoventilation, persistently enlarged cardiac output and obstructive sleep apnea syndrome. In addition, obesity is connected with increased prevalence of coronary artery disease and several other cardiovascular risk factors (10). Renal function becomes decreased because of obesity-related glomerulonephritis, apart from combined effects of diabetes, glucose intolerance and hypertension (11). Prevalence of atrial fibrillation is more common in obese, along with cumulative rise in share of therapy resistant cases (12).

Regardless the numerous expected deleterious effects, overall cardiovascular morbidity and mortality is inconsistently related with obesity (10). Recounted prevalence of obesity is of similar range in general population and the subsection of population with coronary artery disease (13). Contrary to expectations, studies that analysed long-term follow up of patients surviving the acute coronary syndrome reported on better outcomes for individuals that were of 'non-ideal' body type (10). Even more, prognosis of decompensated heart failure was also found to be inversely related to the BMI (14). This unforeseen and contradictory improvement in clinical course of disease or recovery connected with existence of overweightness is commonly known as the *obesity paradox* (15).

There is a limited knowledge on relationship existing between obesity and temporal stages of cardiovascular illnesses caused by acute exacerbation, deterioration or to ones incurred by invasive treatments. First, our aim was to analyse prevalence and clinical impact of obesity in patients scheduled for cardiovascular rehabilitation. Second, systematic appraisal of established cardiometabolic risk factors and systolic function of the left ventricle ejection fraction (LVEF) was evaluated in connection with different types of obesity. Study addressed short-term course of stationary rehabilitation subsequent to acute treatment for ischaemic or valvular heart disease.

Patients and methods

The study included consecutive sample of patients scheduled for rehabilitation during the period 1–6 months after acute treatment for ischaemic, valvular or combined (valvular and ischaemic) heart disease. Comprehensive clinical reassessment was done by team of experienced specialists. Diagnostics protocol included anthropometrics, routine biochemistry and transthoracic echocardiography. Review of medical history with evaluation of cardiovascular risk factors and comorbidities or other relevant conditions was performed for every patient. Medical records from acute treatment were available for the entire set of studied population. Cognitive functions, emotional profile and social functioning were assessed by psychologist. Population was divided twofold on bases of presence of obesity, with BMI cut-off point set at 30 kg/m^2 and the advanced obesity, defined by BMI $<$ or $>$ 35 kg/m^2. Patients were subanalysed on treatments to percutaneous coronary interventions (PCI), conservatively treated myocardial infarction, as well as surgical treatments comprising of coronary artery bypass operations (CABG) and valvular surgeries.

Laboratory samples were taken for analyses in early morning hours 07:30–08:30, after an overnight fast. Laboratory included serum glucose, urea, creatinine and lipid profile. Echocardiographic assessments were performed on Toshiba 'Artida' with PST30BT 3 MHz cardiology transducer, by two experienced high throughput cardiologists. LVEF was appraised using the Simpson biplane method. Preserved systolic function was defined by LVEF $\geq$ 50%.

Anthropometrics: Body weight was expressed in kilograms, height in metres and BMI calculated (kg/m^2). Waist and hip circumferences (WC, HC) were articulated in centimetres, with calculation of the waist-hip ratio (WHR). Nutritional risk was assessed using the standardised NRS-2002 screening tool endorsed by the *European society for clinical nutrition and metabolism* (16). Increased nutritional risk is customary considered with NRS-2002 $\geq$ 3.

Patients with general contraindications for cardiovascular rehabilitation were not included. Former particularly were made of pronounced acute illness or unregulated chronic disorder as severe heart failure, thyroid disorders, metastatic cancer, decompensated diabetes, end stage renal and respiratory disease, haemodynamic instability or malignant disorders of heart rhythms. Patients operated for period longer than 6 months prior to rehabilitation, ones treated with PCI or conservative for ischaemic heart disease were not included.

Ethical issues

This study was approved by the ethical committee of University Hospital in line with the good clinical practice guidelines. Patients were included upon signing of written informed consent.

Statistical analyses

Population and studied groups were analysed with descriptive statistic and presented as an average combined with standard deviations. Characteristics of treatments, aetiology of heart disease and established cardiovascular risk factors were tested for differences by χ^2-tests accordingly. Numeric data including anthropometrics, laboratory and echocardiography were tested for differences using Mann–Whitney *U*-test. Correlation with clinical diagnostics and outcomes was done by Spearman Rho. Predisposition of studied patients for ischaemic heart disease or type of acute treatment in connection with obesity was calculated as odds through binomial logistic regression. p-value less than 0.05 was considered significant. Statistical analyses were done by professional statistician using Statistica 10 for Windows (StatSoft, Tulsa, OK, USA) and IBM-SPSS12 v20 (IBM corporation, Armonk, NY, USA).

Results

Patients

The study population included 302 consecutive patients scheduled for rehabilitation in the timeline 1–6 months after acute cardiovascular treatment. Nineteen patients (6.3%) were treated for myocardial infarction conservatively; there were 144 (47.7%) PCI and 139 (46.0%) surgical treatments; 106 (35.15) CABG procedures and 52 (17.2%) of valvular (including combined operations).

The mean age of patients was 62.4 ± 11.2 years (range 23–86), with 160 (53.0%) in group 45–64 years and 124 patients (40.2%) were older than 65 years. There were more male patients than female patients; 244 (80.8%) : 56 (19.2%), respectively. Left ventricle ejection fraction was 50.5 ± 8.1% in range 23–66. Preserved systolic function of the left ventricle (LVEF ≥ 50%) was found in 207 (68.5%) of studied patients. Median BMI was 28.4 ± 3.8 kg/m^2 (18.2–45.9), with most of the patients 160 (52.3%) being overweight (BMI range 25–30 kg/m^2), waist circumference was 101.6 ± 9.7 cm (71.0–132.0) and hip circumference was 102.4 ± 9.3 cm (83.0–136.0). The 'ideal body type' with BMI < 25 kg/m^2 was found in 52 (17.2%) patients.

Average patient had 6.2 ± 1.5 (0–9) cardiovascular risk factors; of which chronic renal disease was found in 101 (33.4%), chronic obstructive pulmonary disease in 66 (21.9%), glucose intolerance in 75 (24.8%) and diabetes mellitus (treated) in 88 (33.1%). One hundred and twenty (39.7%) of studied patients had never smoked, whilst 91 (30.1%) were active cigarette abusers. Coronary artery disease was existing in 269 (89.1%), while 235 (77.8%) survived myocardial infarction, atherothrombotic disorder (including history of peripheral artery disease, carotid disease, cerebrovascular stroke or thromboembolism) was found in 62 (20.5%) and 44 (14.6%) had permanent atrial fibrillation. Any form of deviation within psychological testing was detected in 134 (44.4%) of patients. Most of the laboratory outputs were within referral values or in line with chronic comorbidities of steady phase: serum glucose 6.8 ± 1.7 mmol/l, triglycerides 1.5 ± 0.8 mmol/l, total cholesterol 4.4 ± 2.2 mmol/l; LDL-cholesterol 2.4 ± 1.1 mmol/l, HDL-cholesterol 0.9 ± 0.4 mmol/l, urea 7.2 ± 2.7 mmol/l and creatinine 112.4 ± 45.1 μmol/l; with estimated glomerular filtration rate (eGFR; Cockcroft-Gault formula) 77.2 ± 33.1 ml/min. Ischaemic heart disease was the reason for acute treatment in 250 (82.8%); valvular in 33 (10.9%) and combined (valvular + ischaemic) in 19 (6.3%).

Prevalence and clinical effects of obesity

Ninety patients (29.8%) were obese (BMI ≥ 30 kg/m^2) vs. 212 (71.2%) of non-obese; while the advanced obesity (BMI ≥ 35 kg/m^2) was found in 19 (6.3%) vs. 283 (93.7%) of controls.

Patients' characteristics including comorbidities, heart disease aetiologies and acute treatments were analysed between studied groups of obesity and advanced obesity; and presented in the Table 1.

Obese patients expressed significantly higher prevalence of ischaemic heart disease ($p = 0.044$); which was also seen in group of advanced obesity, however without significance ($p > 0.05$). Cumulative odds for predilection to ischaemic heart disease with BMI ≥ 30 kg/m^2 were significant in binary logistic regression model; OR = 2.69 (95% CI: 1.01–7.20, Wald 3.902; $p = 0.048$); and group of advanced obesity was not significantly related to ischaemic heart disease through used model ($p > 0.05$).

Surgical treatments predominated in the group of non-obese; whilst obese had greater prevalence of PCI-procedures ($p = 0.019$). The advanced obesity showed no significant differences within acute treatments ($p > 0.05$). Cumulative odds for having a predilection to PCI in studied sample of patients with BMI ≥ 30 kg/m^2 were significant in binary logistic regression model; that estimated OR of 1.99 (95% CI: 1.21–3.29, Wald 7.272; $p = 0.007$); while group of advanced obesity showed 3.25 (95% CI: 1.14–9.26, Wald 4.861; $p = 0.027$). In this manner, obesity decreased the chances for surgical treatments OR = 0.51 (95% CI: 0.30–0.84, Wald 6.818; $p = 0.009$), which was even more accentuated for advanced obesity OR = 0.29 (95% CI: 0.09–0.90, Wald 4.572; $p = 0.033$).

There were no significant differences in laboratory diagnostics for established cardiovascular risk factors (glucose, creatinine, triglycerides, total cholesterol,

Table 1 Characteristics of patients (n = 302) and studied groups of obesity

	Obesity			Advanced obesity		
	BMI < 30 n (%)	BMI ≥ 30 n (%)	χ^2	BMI < 35 n (%)	BMI > 35 n (%)	χ^2
Treatments						
Conservative	14 (6.6)	5 (5.6)	**0.019**	18 (6.4)	1 (5.3)	0.059
PCI	90 (42.5)	54 (60.0)		130 (45.9)	14 (73.7)	
Surgery	108 (50.9)	31 (34.4)		135 (47.7)	4 (21.1)	
Disease						
Ischaemic	168 (79.2)	82 (91.1)	**0.044**	233 (82.3)	17 (89.5)	0.691
Valvular	28 (13.2)	5 (5.6)		32 (11.3)	1 (5.3)	
Combined	16 (7.5)	3 (3.3)		18 (6.4)	1 (5.3)	
Nicotine history						
Non-smoker	69 (32.5)	22 (24.4)	0.200	87 (30.7)	4 (21.1)	0.087
Active smoker	58 (27.4)	33 (36.7)		81 (28.6)	10 (52.6)	
Former smoker	85 (40.1)	35 (38.9)		115 (40.6)	5 (26.3)	
Arterial hypertension	193 (91.0)	88 (97.8)	**0.035**	262 (92.6)	19 (100.0)	0.218
Hyperlipoproteinaemia	199 (93.9)	87 (96.7)	0.321	268 (94.7)	18 (94.7)	0.994
Chronic renal disease	75 (35.4)	26 (28.9)	0.274	95 (33.6)	6 (31.6)	0.895
Diabetes mellitus	57 (26.9)	31 (34.4)	0.186	79 (27.9)	9 (47.4)	0.071
Glucose intolerance	52 (24.5)	23 (25.6)	0.850	71 (25.1)	4 (21.1)	0.693
Chronic obstructive pulmonary disease	41 (19.3)	25 (27.8)	0.105	61 (21.6)	5 (26.3)	0.627
Any psychological disturbance	94 (44.3)	40 (44.4)	0.987	124 (43.8)	10 (52.6)	0.454
Known coronary artery disease	184 (86.8)	85 (94.4)	0.051	251 (88.7)	18 (94.7)	0.414
Post myocardial infarction	160 (75.5)	75 (83.3)	0.133	220 (77.7)	15 (78.9)	0.902
Atherothrombotic disease	43 (20.3)	19 (21.1)	0.871	56 (19.8)	6 (31.6)	0.218
Atrial fibrillation	34 (16.0)	10 (11.1)	0.267	43 (15.2)	1 (5.3)	0.235
Preserved systolic function of left ventricle (LVEF > 50%)	140 (67.6)	67 (75.3)	0.188	194 (70.0)	13 (68.4)	0.882

Data labels: BMI, body mass index (kg/m^2); n, number of patients;%, percentage; SD, standard deviation; eGFR, estimated glomerular filtration (Cockcroft and Gault equation); LVEDd, left ventricle end-diastolic dimension; LVEDs, left ventricle end-systolic dimension; IVS, interventricular septum thickness; LPW, left ventricle posterior wall thickness; LVEF, left ventricle ejection fraction. Statistically significant values bolded.

LDL-cholesterol and HDL-cholesterol), $p > 0.05$ respectively. Estimated glomerular filtration was significantly different between studied groups; 70.9 ± 25.9 vs. 91.9 ± 33.8, $p < 0.001$ and 75.0 ± 27.8 vs. 109.7 ± 42.9, $p \ll 0.001$, respectively. Outcome was in part expected because of the formulation of Cockcroft–Gault equation (weight, age).

Echocardiographic exams revealed significant differences in left ventricle dimensions (end-systolic, end-diastolic, interventricular septum diastolic thickness and posterior wall thickness) through studied groups of obesity. No differences were found for LVEF and grades of obesity.

Differences in age, anthropometrics, nutritional risk and diagnostics (laboratory, echocardiography) for studied groups are presented in the Table 2.

Non-parametric correlation of ranks was used to verify connections of echocardiographic parameters with BMI, prevalence of obesity and advanced obesity; the correlation is presented in the Table 3.

Discussion

Our study addressed clinical implications of different types of obesity in patients scheduled for rehabilitation after acute treatment for ischaemic or valvular heart disease. Prevalence of obesity in our study was of similar range to North American or European Union general community level, the National population prevalence (in Croatia), the National prevalence in patients from secondary cardiovascular prevention, as well as the prevalence in EUROASPIRE III (13,17–19). Data on prevalence all together indirectly put a shed of uncertainty on obesity as a distinctive risk factor; and since this lack of discrimination indirectly is more close to concept of the obesity paradox (15). Studied anthropometrics revealed increase in weight circumference and WHRs corresponding with the extent of obesity pointing to overall increase in cardiovascular risk (20). However, differences found in our study were not of signifi-

Table 2 Anthropometrics and diagnostics of patients (n = 302) and studied groups

	Obese			Advanced obesity		
	BMI < 30 Mean ± SD	BMI ≥ 30 Mean ± SD	Mann–Whitney	BMI < 35 Mean ± SD	BMI ≥ 35 Mean ± SD	Mann–Whitney
Age (years)	63.4 ± 11.0	60.2 ± 11.4	**0.021**	62.8 ± 11.1	56.4 ± 10.8	**0.008**
Height (m)	1.73 ± 0.09	1.72 ± 0.10	0.601	1.72 ± 0.09	1.73 ± 0.11	0.689
Weight (kg)	79.1 ± 10.4	97.8 ± 14.4	**< 0.001**	82.8 ± 12.6	112.2 ± 13.4	**< 0.001**
BMI (kg/m^2)	26.45 ± 2.21	32.95 ± 2.77	**< 0.001**	27.79 ± 3.07	37.28 ± 2.46	**< 0.001**
Waist circumference (cm)	97.8 ± 7.6	110.6 ± 8.2	**< 0.001**	100.4 ± 8.8	118.5 ± 5.7	**< 0.001**
Hip circumference (cm)	100.1 ± 8.6	108.1 ± 8.4	**< 0.001**	101.6 ± 8.7	114.9 ± 9.1	**< 0.001**
WHR (n/n)	0.97 ± 0.08	1.03 ± 0.08	**< 0.001**	0.99 ± 0.08	1.04 ± 0.09	**0.012**
NRS-2002	3.7 ± 1.6	3.4 ± 1.5	0.222	3.61 ± 1.57	3.21 ± 1.23	0.275
Glucose (mmol/l)	6.7 ± 1.7	7.0 ± 1.8	0.056	6.8 ± 1.7	7.0 ± 1.6	0.236
Creatinine (μmol/l)	113.0 ± 47.6	111.0 ± 39.0	0.862	111.9 ± 43.6	120.4 ± 64.8	0.730
eGFR (ml/min)	70.9 ± 25.9	91.9 ± 33.8	**< 0.001**	75.0 ± 27.8	109.7 ± 42.9	**< 0.001**
Triglycerides (mmol/l)	1.46 ± 0.69	1.74 ± 1.06	0.094	1.54 ± 0.84	1.55 ± 0.58	0.627
Cholesterol (mmol/l)	4.33 ± 1.25	4.63 ± 3.56	0.932	4.43 ± 2.26	4.28 ± 1.15	0.822
HDL-cholesterol (mmol/l)	0.95 ± 0.44	0.94 ± 0.38	0.884	0.95 ± 0.43	0.85 ± 0.34	0.125
LDL-cholesterol (mmol/l)	2.36 ± 1.07	2.32 ± 0.99	0.891	2.34 ± 1.04	2.51 ± 1.21	0.655
LVEDd (mm)	52.7 ± 5.7	54.5 ± 5.6	**0.019**	52.9 ± 5.4	58.5 ± 7.8	**0.001**
LVEDs (mm)	35.4 ± 7.3	37.2 ± 8.4	0.112	35.5 ± 7.3	41.3 ± 10.6	**0.018**
IVS (mm)	11.5 ± 1.8	11.7 ± 2.2	**0.008**	11.5 ± 1.9	12.1 ± 1.5	0.148
LPW (mm)	10.5 ± 6.9	10.5 ± 0.9	**0.007**	10.4 ± 6.0	10.8 ± 1.0	**0.021**
LVEF (%)	50.5 ± 8.2	50.7 ± 7.7	0.986	50.6 ± 7.8	49.6 ± 10.9	0.948
Drug utilisation	BMI < 30 n (%)	BMI ≥ 30 n (%)	χ^2	BMI < 35 n (%)	BMI ≥ 35 n (%)	χ^2
Angiontensinogen-convertase inhibitor/sartan	157 (74.1)	76 (84.4)	**0.049**	216 (76.3)	17 (89.5)	0.186
Beta blocker	191 (90.1)	81 (90.0)	0.980	255 (90.1)	17 (89.5)	0.929
Calcium antagonist	51 (24.1)	34 (37.8)	**0.015**	82 (29.0)	3 (15.8)	0.216
Statin	152 (71.7)	71 (78.9)	0.193	206 (72.8)	17 (89.5)	0.109
Fibrate	83 (39.2)	44 (48.9)	0.117	117 (41.3)	10 (52.6)	0.335
Proton pump inhibitor	109 (51.4)	29 (32.2)	**0.002**	134 (47.3)	4 (21.1)	**0.026**
Oral antidiabetic	37 (17.5)	19 (21.1)	0.454	51 (18.0)	5 (26.3)	0.368
Insulin	10 (4.7)	6 (6.7)	0.489	15 (5.3)	1 (5.3)	0.994

Data labels: n, number of patients;%, percentage; SD, standard deviation; eGFR, estimated glomerular filtration (Cockcroft and Gault equation); LVEDd, left ventricle end-diastolic dimension; LVEDs, left ventricle end-systolic dimension; IVS, interventricular septum thickness; LPW, left ventricle posterior wall thickness; LVEF, left ventricle ejection fraction. Statistically significant values bolded.

Table 3 Correlation of echocardiography with BMI, prevalence of obesity and advanced obesity

Spearman's rho	LVEDd (mm)	LVEDs (mm)	IVS (mm)	PW (mm)	LVEF (%)
BMI (kg/m^2)					
Rho	0.274	0.176	0.176	0.201	−0.023
Sig. (two-tailed)	**< 0.001**	**0.014**	**0.003**	**0.001**	0.689
Obesity (BMI ≥ 30 kg/m^2)					
Rho	0.138	0.114	0.163	0.171	0.001
Sig. (two-tailed)	**0.018**	0.111	**0.006**	**0.005**	0.985
Advanced obesity (BMI ≥ 30 kg/m^2)					
Rho	0.204	0.170	0.089	0.147	−0.004
Sig. (two-tailed)	**< 0.001**	**0.017**	0.140	**0.016**	0.946

Data labels: Rho, correlation coefficient; BMI, body mass index; Sig, significance; LVEDd, left ventricle end-diastolic dimension; LVEDs, left ventricle end-systolic dimension; IVS, interventricular septum thickness; LPW, left ventricle posterior wall thickness; LVEF, left ventricle ejection fraction. Statistically significant values bolded.

cantly discriminative values and not firmly connected with studied clinical outcomes. Both categories seemed underrated for prognostics, as well as for unanimous evaluation of the obesity-related cardiovascular risks.

There were no significant differences among the entire set of studied cardiovascular risk factors, with the exception of arterial hypertension (4). Last was more common in the group of obese (BMI ≥ 30 kg/m^2), and also verified by increased consumption of antihypertensive drugs (calcium antagonists, inhibitors of angiotensin-convertase or blockers of AT-2 receptors i.e. sartans). Studied laboratory cardiovascular risk factors (glucose, creatinine, cholesterol profile) was of similar range in the studied groups of obesity (2,13). Drug utilisation analyses also affirmed similar patterns of consumption for lipid-lowering therapies (statins, fibrate). In addition, no difference of nutritional risk screening was found on the bases of obesity prevalence (14). Hence, from the studied patient sample, obesity was not found to be of greater influence on the cardiometabolic risk profile, even when the contemporary effects of pharmacotherapy or nutritional risk were excluded (21).

Prevalence of obesity within the study sample made patients to be more prone for earlier development of a heart disease, one that would have to be treated in acute settings. An age-related difference was significant on bases of obesity, and of greater age difference if the patient had advanced grade of obesity. Obese patients displayed increased odds (OR = 2.69; 95% CI = 1.01–7.20; p = 0.048) for developing the ischaemic heart disease. Interestingly, no predisposing relations for ischaemic heart disease were found with advanced grade of obesity. Nevertheless, in line with the obesity paradox, no repercussions were found in terms of left ventricle systolic function i.e. ejection fraction, which is considered as well-established predictor of long-term cardiovascular outcome and mortality (22,23). Echocardiographic characteristics clearly showed influence of obesity on left ventricle morphology, and the extent of changes was in correlation with BMI i.e. extent of obesity (9,24).

The non-obese were significantly more prone to surgical treatments, while the odds for PCI depended on the extent of obesity; with advanced grade of obesity had greater predisposition to PCI treatment (OR = 3.25; 95% CI: 1.14–9.26; p = 0.027). Differences between prevalence of surgical and PCI treatments might be responsible for the increased consumption of proton pump inhibitors found in the non-obese and non-advance obese.

Despite numerous observed landmarks on clinical existence of the obesity paradox, one must not disregard that lifestyle modifications and obesity treatment must be the mainstay of therapeutic measures in order to improve outcomes from the cardiovascular disease continuum (25–28). Treatment of obesity is connected with multiple health benefits, particularly the common risk factors as diabetes, chronic renal disease, hypertension and related to the decrease in total or cardiovascular mortality (17,29,30).

Conclusion

Although almost one-third of studied patients were obese, no significant connections were found to the prevalence of chronic comorbidities, laboratory risk factors or systolic function of left ventricle. Existence of the obesity paradox in clinical practice was in part reaffirmed with our study. However, health initiatives that include obesity treatment, continuous control of modifiable risk factors, lifestyle modifications, cessation of cigarette smoking, healthy dieting and physical exercise are a must in order to attain more

successful amelioration of the cardiovascular disease continuum. Further investigations are needed in order to improve the knowledge on complex relations of cardiovascular diseases and obesity.

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Authors contributions

MB, AR, and ND carried out the studies and data analyses and drafted the manuscript. AB, BM and ZJ carried out the samples analyses. SM and GL participated in the design of the study and writing of the manuscript. LB performed the statistical analysis. MB and VP conceived of the study, and participated in its design and coordination and helped to draft the manuscript.

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