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Comparison of Body Quality Composition, Including Phase Angle, in Post-Myocardial Infarction Patients Qualified for Rehabilitation under the MC-AMI Program and Patients with Angina Pectoris

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Abstract

Background: *In some diseases, such as heart failure, there is talk of an obesity paradox, as lower mortality is observed in patients with higher BMI. Both obesity and frailty syndrome are risk factors for adverse prognosis and treatment, including high mortality. Body composition analysis with electrical bioimpedance (BIA) appears to be a good method for assessing changes in patients after various cardiovascular incidents, as well as for primary prevention of cardiovascular disease.*

Aim of the study: *The aim of this study is to evaluate the qualitative composition of the body (including but not limited to phase angle (PhA), visceral fat, and lean body mass) using BIA in post-MI patients qualified for rehabilitation under the Managed Care after Acute Myocardial Infarction (MC-AMI) program. The control group consisted of patients with suspected ischemic heart disease with symptoms of angina but without myocardial infarction.*

Methods: *The project was conducted as a retrospective analysis of prospectively collected data from 148 patients. The final study included 94 patients after revascularization for myocardial infarction and 54 patients with stable angina admitted electively to the Cardiology Department for coronary angiography.*

Results: *The group of patients after myocardial infarction had statistically significantly higher values of total cholesterol, LDL, and triglycerides. The group of women after myocardial infarction had lower values for fat-free tissue mass and muscle mass in the trunk and limbs. No significant differences in PhA values were observed between the two groups.*

Conclusions: *Learning more about the role of electrical bioimpedance brings much hope as a non-invasive method that can be used as a predictive marker of health change in cardiology.*

Keywords: Phase Angle, Myocardial Infarction, Cardiac Rehabilitation, Electrical Impedance, MC-AMI

1. Introduction

The main causative and modifiable risk factors for cardiovascular disease are lipoprotein B-containing lipoproteins (of which low-density lipoprotein-LDL is the most abundant), in addition to hypertension, smoking, and diabetes. Another important risk factor is obesity, particularly abdominal obesity [1]. In some diseases, such as heart failure, there is talk of an obesity paradox, as lower mortality rates are observed in patients with higher BMI [1]. Both obesity and frailty syndrome are risk factors for an unfavorable prognosis. Frailty syndrome is a multidimensional condition, independent of age and comorbidities, that makes a given patient more susceptible to the effects of stressors. Therefore, it seems important to actively seek out patients who have incorrect nutrition. In addition to the standard ways (clinical examination, biochemical blood tests, including glucose, lipidogram, and anthropometric tests), a method that gives an idea of many body composition parameters is the body composition analysis by electrical bioimpedance analysis (BIA). Singling out these patients is important both in the context of primary prevention of cardiovascular disease (mobilization for regular physical activity, dietary education) and secondary prevention (for patients after myocardial infarction to prevent another myocardial ischemia or ischemic stroke) [1-3].

Ischemic myocardial damage is the most common cause of heart failure in patients. Until now, one of the recommendations in the outpatient care of patients with chronic heart failure was to weigh themselves regularly. However, it is known that in this group of patients, weight gain occurs with some delay concerning the changes in fluid distribution in the body that occur earlier [4]. On the other hand, the persistence of constant body weight in this group of patients may misleadingly reassure patients who, due to nutrient malabsorption in the intestines, may experience nutritional disorders and unfavorable distribution of muscle mass relative to visceral fat and body water. Studies show that changes in the body's hemodynamics and gradual fluid accumulation appear as early as 3 weeks before an episode of decompensation, weight gain is seen one week before decompensation, while clinical symptoms (shortness of breath, peripheral edema) are found only a few days before hospitalization. Thus, researchers point to the important role of popularizing access to cardiac scales that consider other biomarkers in addition to assessing BIA parameters [4,5].

Over the past few years, interest in the use of BIA as an easy, accessible, safe method of body composition analysis has grown significantly in various medical fields, including cardiology. BIA is used primarily for muscle mass, hydration, and phase angle (PhA) assessment. With the PhA, we can express the state of hydration and assess the quality of cell membranes. A pulse of low-intensity current passes through the body. It assesses the resistance (R) of individual tissues providing data on water volume and hydration and the reactance parameter (Xc) evaluating the integrity of cell membranes [6]. A systematic review by Scicchitano et al., assessing the role of PhA in heart failure and its impact on the clinical management and risk stratification of patients with heart failure, recognized PhA measured by BIA as a parameter to holistically assess the patient. The use of PhA in the clinical evaluation of patients with acute and chronic heart failure may be a good alternative for clinicians. It is suggested that the assessment of electrical bioimpedance be incorporated into a validated multiparametric model (NT-proBNP or BNP, echocardiography with EF assessment) for clinical and prognostic evaluation of patients with heart failure [7].

We also studied the correlation between PhA and physical function, nutritional indices, and sarcopenia in patients with cardiovascular disease, including chronic heart failure. Handshake strength, gait speed, anterior mid-thigh muscle thickness, biochemical tests, and BIA were evaluated. PhA is a good marker of muscle atrophy and malnutrition in patients with cardiovascular disease, and thus its value has implications for the response to patient treatment [8]. Improved PhA in this group of patients may be influenced by increased muscle strength in the extremities [9]. Among the reviewed studies, we were unable to find any that compared body composition parameters measured by BIA in patients after myocardial infarction or patients with angina symptoms who have not yet had a myocardial infarction.

1.1. Aims

The main aim of the study was to compare qualitative body composition (including, but not limited to PhA, visceral fat, and lean body mass) using BIA in patients after myocardial infarction (up to 14 days after myocardial infarction) with a group of patients with suspected ischemic heart disease with symptoms of stable angina but without a history of myocardial infarction, who were admitted electively to the Department of Cardiology for invasive diagnosis (coronary angiography). In addition, the goal was to look for correlations between the parameters considered with serum biochemical results (lipidogram components) and left ventricular ejection fraction (EF) assessed by echocardiography.

2. Materials and Methods

The study was approved by the Bioethics Committee of the Silesian Piast Medical University in Wroclaw (approval number KB 275/2021) and conducted following the Good Clinical Practice Guidelines and the Declaration of Helsinki. All project participants were informed of what purpose and how the study would be conducted and gave written consent to participate and process personal data.

2.1. Study Participants and Study Site

The project was conducted as a retrospective analysis of prospectively collected data from 148 patients. The final study included 94 post-revascularization patients who were discharged from cardiology departments with recommendations for outpatient cardiac rehabilitation under the MC-AMI program (Managed Care for Patients After Myocardial Infarction) and 54 patients with stable angina admitted to the Department of Cardiology on an elective basis for coronary angiography (control group). All patients were Caucasian. The selection of patients to participate in the study was purposive. Eligibility criteria to which all participants were subjected included age≥18 years, status post myocardial infarction (up to 14 days after the end of hospitalization) or symptoms of angina without a history of myocardial infarction, adherence to rules such as no eating and drinking within 3 hours before measurement, no intense exercise within 12 hours before measurement, no drinking alcohol within 12 hours before measurement, if possible-no urination before measurement, no large amounts of food and drink on the day before measurement, in the case of women, no measurements during menstruation, and signing an informed consent to participate in the study.

Exclusion criteria included patients who did not consent to participate in the study or had electronic implants such as pacemakers, cardioverter defibrillators, or cardiac resynchronization systems, and pregnant women. The premise of the MC-AMI program was that physicians who discharged a patient from the Cardiology Department after a heart attack would qualify the patient for inpatient rehabilitation (e.g., patients with LVEF < or =35% on NYHA III scale, insulin-dependent diabetes mellitus, COPD with high severity of symptoms or high risk of exacerbations, cancer, having difficulty with daily commute to rehabilitation due to musculoskeletal dysfunction - Rankin scale grade 3) or outpatient [10]. Any patient who went to outpatient rehabilitation at the Pro Corde center and met the inclusion criteria was offered participation in the study. Patients who were qualified for hospital rehabilitation were not included in the study. The difference in the number of patients subjected to statistical analysis is dictated by the fact that biochemical parameters (lipidogram fractions) in people after myocardial infarction, were collected from hospital discharge cards after completing a 5-week rehabilitation with repeated bioimpedance testing. A total of 39 patients were not examined twice by body composition analyzer, of whom 2 died, 1 person was qualified for ICD implantation, 3 patients underwent repeated coronary angioplasty (rehabilitation was suspended), and 7 people did not return for another examination due to family reasons (8 people—follow-up examination coincided with the holiday season; 18 people—they did not fit into assumed 7 days due to the need for periodic body composition analyser validation).

Measurements were made using a high-end Tanita MC-780 body composition analyzer, which measured the resistance of tissues to a low-intensity electrical pulse sent (not perceptible to the test subject). The parameters were measured once. Anthropometric measurements (height), date of birth, gender, and race were entered before analysis. The patient was examined in a standing position, with bare feet on the scale, taking the electrodes in both hands while keeping the upper limbs straight at the elbows, at a 45-degree angle away from the torso. Echocardiography with assessment of left ventricular ejection fraction was performed before hospital discharge for hospitalizations related to myocardial infarction, while it was performed on the day of admission for patients in the control group.

2.2. Statistical Analysis

Statistical analysis was performed using Statistica 13.1 (TIBCO, Inc., USA). For measurable variables, arithmetic means, medians, standard deviations, range of variation (extreme values), lower quartile, and upper quartile were calculated. For qualitative variables, their frequencies (percentages) were calculated. To determine the type of distribution, a Shapiro-Wilk test was performed for all quantitative-type variables. Determination of differences between variables was made using the non-parametric Mann-Whitney U test or the Kruskal-Wallis test, depending on whether the assumptions were met. A comparison of the results of qualitative variables was made using the chi-square test. All comparisons were made at a significance level of $\alpha=0.05$.

3. Results

148 people participated in the study, including 72% (n=106) men and 28% (n=42) women. Table 1 shows the characteristics of the group. Mean age was 63.8 years (min-max: 29.0-88.0 years; SD=12.1 years), mean body height was 170.6 centimeters (min-max: 148.0-194.0 centimeters; SD=9.6 centimeters), mean body weight was 83.7 kilograms (min-max: 36.9-151.8 kg; SD=18.4 kg), and mean BMI was 28.6 (min-max: 14.8-46.9; SD=5.2).

Variable		**$\bar{x}$**	**Me**	**Min**	**Max**	**Q1**	**Q3**	**SD**
Age [years] (n=148)		63.8	65.0	29.0	88.0	55.5	73.0	12.1
Body height [cm] (n=148)		170.6	171.0	148.0	194.0	164.0	176.5	9.6
Body weight [kg] (n=148)		83.7	83.1	36.9	151.8	70.2	94.7	18.4
BMI (n=148)		28.6	28.8	14.8	46.9	24.9	32.5	5.2
Variable	**Variable category**	**n**			**%**			
Gender (n=148)	Women	42			28.4			
	Men	106			71.6			
$\bar{x}$ – mean; Me – median; Q1 – first quartile; Q3 – third quartile; Min – minimum value; Max – maximum value; SD – standard deviation; n – number of people; % – percentage of people.								

Table 1: Group Characteristics

Table 2 shows a comparison of the characteristics of the post-MI group and the non-MI group. The mean age in the post-MI group was 61.4 years (min-max: 29.0-88.0 years; SD=11.7 years) and was lower than the mean age of non-MI subjects, which was 67.9 years (min-max: 30.0-88.0 years; SD=11.8 years). The results are statistically significantly different ($p<0.05$). The rest of the cases showed no statistically significant differences ($p>0.05$).

	Group														**p* value**
	After myocardial infarction (n=94)							**No infarction (n=54)**							
Variable	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	$\bar{x}$	Me	Min	Max	Q1	Q3	SD	
Age [years]	61.4	61.5	29.0	88.0	52.0	71.0	11.7	67.9	70.5	30.0	88.0	61.0	76.0	11.8	<0.001
Body height [cm]	171.5	172.0	149.0	194.0	168.0	177.0	9.7	169.1	170.0	148.0	188.0	162.0	176.0	9.4	0.143
Body weight [kg]	83.3	81.4	36.9	151.8	69.3	94.3	19.7	84.5	84.7	49.2	116.0	75.1	95.4	16.0	0.536
BMI	28.1	28.1	14.8	46.9	24.2	31.6	5.3	29.5	29.1	20.7	41.3	25.4	33.1	5.0	0.157

Variable	Variable category	n	%	n	%	p** value
Gender	Women	23	24.5	19	35.2	0.164
	Men	71	75.5	35	64.8	
x̅ – mean; Me – median; Q1 – first quartile; Q3 – third quartile; Min – minimum value; Max – maximum value; SD - standard deviation; n – number of people; % – percentage of people; * Mann-Whitney U test; ** chi-square test.						

Table 2: Characteristics of the Post-MI Group and the Non-MI Group

Table 3 shows the intergroup comparison of cholesterol, triglyceride, and cardiac ejection fraction results. The mean total cholesterol score of post-infarction subjects was 195.7 mg/dl (min-max: 112.0-268.0 mg/dl; SD=43.5 mg/dl), which was higher than that of subjects without known infarction, whose mean was 155.5 mg/dl (min-max: 91.0-311.0 mg/dl; SD=41.6 mg/dl). Also, the post-infarction group had higher results for LDL cholesterol values, and the mean was 122.7 mg/dl (min-max: 44.0-198.0 mg/dl; SD=35.4 mg/dl), while those who did not suffer an MI had a mean of 87.7 mg/dl (min-max: 29.0-277.0 mg/dl; SD=37.0 mg/dl). Similarly, for triglyceride results, the post-infarction group had higher results, with the mean 145.3 mg/dl (min-max: 39.0-353.0 mg/dl; SD=72.6 mg/dl), than those without a history of MI, with a mean of 101.7 mg/dl (min-max: 33.0-189.0 mg/dl; SD=34.4 mg/dl). The aforementioned results were statistically significantly different ($p<0.05$), while the remaining cases showed no such differences ($p>0.05$).

	Group	x̅	Me	Min	Max	Q1	Q3	SD	The p* value
Total Cholesterol [mg/dl].	After myocardial infarction (n=55)	195.7	191.0	112.0	268.0	160.0	242.0	43.5	<0.001
	No infarction (n=50)	155.5	149.5	91.0	311.0	120.0	179.0	41.6	
LDL cholesterol [mg/dl]	After myocardial infarction (n=57)	122.7	121.0	44.0	198.0	95.0	158.0	35.4	<0.001
	No infarction (n=50)	87.7	79.5	29.0	227.0	61.0	103.0	37.0	
HDL cholesterol [mg/dl]	After myocardial infarction (n=55)	44.6	43.0	23.0	75.0	37.0	52.0	11.4	0.304
	No infarction (n=49)	47.7	46.0	25.0	92.0	39.0	53.0	13.7	
Triglycerides [mg/dl]	After myocardial infarction (n=52)	145.3	123.5	39.0	353.0	96.0	197.5	72.6	0.001
	No infarction (n=50)	101.7	96.0	33.0	189.0	79.0	124.0	34.4	
EF% [%]	After myocardial infarction (n=55)	52.7	55.0	25.0	65.0	45.0	60.0	8.8	0.835
	No infarction (n=50)	52.0	58.0	26.0	65.0	40.0	60.0	10.9	
x̅ – mean; Me – median; Q1 – first quartile; Q3 – third quartile; Min – minimum value; Max – maximum value; SD – standard deviation; *Mann-Whitney U-test;									

Table 3: Intergroup Comparison of Cholesterol, Triglyceride, and Cardiac Ejection Fraction Results

Table 4 shows the intergroup comparison of PhA results. There were no statistically significant differences between the groups ($p>0.05$).

	Group	x̅	Me	Min	Max	Q1	Q3	SD	Thep* value
PHASE ANGLE	After myocardial infarction (n=94)	5.45	5.48	3.29	7.60	4.86	6.14	0.89	0.761
	No infarction (n=54)	5.43	5.58	3.23	8.10	4.69	6.05	0.87	
x̅ – mean; Me – median; Q1 – first quartile; Q3 – third quartile; Min – minimum value; Max – maximum value; SD – standard deviation; *Mann-Whitney U-test;									

Table 4: Intergroup Comparison of PhA Results

In an intergroup comparison of PhA scores in women, there were no statistically significant differences between groups ($p>0.05$). Similarly, in the intergroup comparison of PhA in men ($p>0.05$).

Intergroup comparisons of intracellular and extracellular water results and the ratio of extracellular to total water are presented in Table 5. There were no statistically significant differences in the results obtained ($p>0.05$).

	Group	x̄	Me	Min	Max	Q1	Q3	SD	The p* value
ECW	After myocardial infarction (n=94)	18.4	18.4	9.8	27.5	16.6	20.5	3.3	0.453
	No infarction (n=54)	18.8	18.9	11.5	24.9	17.0	20.5	3.0	
ICW	After myocardial infarction (n=94)	23.6	23.8	11.4	35.4	20.0	27.7	5.8	0.453
	No infarction (n=54)	24.1	23.7	11.9	38.5	19.6	27.3	5.8	
ECW/TBW	After myocardial infarction (n=94)	18.4	18.4	9.8	27.5	16.6	20.5	3.3	0.948
	No infarction (n=54)	18.8	18.9	11.5	24.9	17.0	20.5	3.0	
x̄ – mean; Me – median; Q1 – first quartile; Q3 – third quartile; Min – minimum value; Max – maximum value; SD – standard deviation; *Mann-Whitney U-test;									

Table 5: Intergroup Comparison of Intracellular and Extracellular Water Results and Extracellular to Total Water Ratio

An intergroup comparison of metabolic age scores showed no statistically significant differences in the results obtained (p>0.05). The same was true in the intergroup comparison of visceral fat and upper and lower extremity fat scores (p>0.05). Table 6 shows the intergroup comparison of fat-free tissue mass scores in the lower extremities (RLFFM+LLFFM) and upper extremities (RAFFM+LAFFM) in women. In the post-MI group, the mean RLFFM+LLFFM score was 14.1 (min-max: 9.9-18.0; SD=2.1), which was 1.4 lower than in women who had not undergone MI, with a mean of 15.5 (min-max: 10.4-20.7; SD=2.6). Statistically significant differences were found (p<0.05). In the post-MI group, the mean RAFFM+LAFFM score was 4.4 (min-max: 3.1-5.9; SD=0.8), which was 0.9 lower than in women who had not undergone MI, with a mean of 5.3 (min-max: 3.8-6.6; SD=0.9). The results were statistically significantly different (p<0.05).

	Group	x̄	Me	Min	Max	Q1	Q3	SD	The p* value
RLFFM+LLFFM	After myocardial infarction (n=23)	14.1	14.2	9.9	18.0	13.2	14.8	2.1	0.046
	No infarction (n=19)	15.5	15.4	10.4	20.7	14.4	17.1	2.6	
RAFFM+LAFFM	After myocardial infarction (n=23)	4.4	4.3	3.1	5.9	3.6	5.0	0.8	0.003
	No infarction (n=19)	5.3	5.0	3.8	6.6	4.8	5.9	0.9	
x̄ – mean; Me – median; Q1 – first quartile; Q3 – third quartile; Min – minimum value; Max – maximum value; SD – standard deviation; *Mann-Whitney U-test;									

Table 6: Intergroup Comparison of Lower and Upper Extremity Fat-Free Tissue Mass Scores in Women

In an intergroup comparison of fat-free tissue mass scores in the lower extremities (RLFFM+LLFFM) and upper extremities (RAFFM+LAFFM) in men, there were no statistically significant differences between groups (p>0.05). In an intergroup comparison of muscle mass scores in the lower extremities (RLPMM+LLPMM) and upper extremities (RAPMM+LAPMM) in women, statistically significant differences (p<0.05) were found. In the post-MI group, the mean RLPMM+LLPMM score was 13.3 (min-max: 9.3-17.0; SD=2.0), which was 1.4 lower than in women who had not undergone MI, with a mean of 14.7 (min-max: 9.8-19.5; SD=2.4). In the post-MI group, the mean RAPMM+LAPMM score was 4.2 (min-max: 2.9-5.6; SD=0.8), which was 0.8 lower than in women who had not undergone MI, with a mean of 5.0 (min-max: 3.6-6.2; SD=0.8).

In an intergroup comparison of muscle mass scores in the lower extremities (RLPMM+LLPMM) and upper extremities (RAPMM+LAPMM) in men, there were no statistically significant differences between groups (p>0.05). In an intergroup comparison of the results of trunk fat-free mass (TRFFM) in women, statistically significant differences were found (p<0.05). In the post-MI group, the mean TRFFM score was 25.1 (min-max: 17.7-33.4; SD=4.2), which was 3.9 lower than in women who had not undergone MI, with a mean of 29.0 (min-max: 19.7-35.6; SD=4.7). In an intergroup comparison of the results of torso fat-free tissue mass in men, there were no statistically significant differences between groups (p>0.05). In an intergroup comparison of trunk muscle mass scores (TRPMM) in women, statistically significant differences were found (p<0.05). In the post-MI group, the mean TRPMM score was 23.9 (min-max: 16.9-31.8; SD=4.0), which was 3.7 lower than in women who had not undergone MI, with a mean of 27.6 (min-max: 18.8-34.0; SD=4.5). In an intergroup comparison of muscle mass scores in the trunk in men, there were no statistically significant differences between groups (p>0.05). Table 7 shows the intergroup comparison of the PhA. There were no statistically significant differences between the groups (p>0.05).

Variable	Variable category	Group				The p* value
		After a heart attack		No heart attack		
		n	%	n	%	
Phase angle	Low	30	31.9	19	35.8	0.800
	Medium	37	39.4	18	34.0	
	High	27	28.7	16	30.2	
n – number of people; % – percentage of people; *chi-square test Phase angle values: low < 5.0, medium 5.0-6.0, high >6.0						

Table 7: Comparison of PhA Results Due to Groups

4. Discussion

According to the literature and epidemiological findings, our study was dominated by men after myocardial infarction. Statistically, more men develop cardiovascular disease, including heart attack at a younger age [1]. In addition, Anderson et al., and Wilkosz et al., highlight the fact that fewer women than men opt for outpatient rehabilitation after myocardial infarction (family, social reasons) [11,12]. In our study, more than 30% of patients in each group had a low PhA (31.9% after MI vs. 35.8% without MI). Langer et al., found a statistically significant association between a 6-year decline in PhA and the risk of total mortality and cardiovascular incidents, with the highest risk observed for PhA below 2.6 [13]. Similarly, a study by Saad et al., showed an independent association of PhA values with estimated global cardiovascular risk in the elderly population [14]. PhA can be used as a marker for predicting morbidity and mortality in various clinical situations. In their publication, Campa et al., demonstrated the positive effect of resistance training on the improvement (growth) of PhA in older men and women [15]. Considering our study group, it can be assumed that more than 30% of them (PhA <5.0) should get a special benefit from participation in rehabilitation programs (including MC-AMI), and therefore body quality composition analysis in these patients can be a valuable addition to the overall evaluation of patients.

In an updated Cochrane systematic review, Anderson et al., confirm that exercise-based cardiac rehabilitation reduces the risk of death from cardiovascular disease, and numerous publications evaluating the benefits of the nationwide MC-AMI program show a positive clinical effect at various stages of 12-month follow-up of patients [11,16-21]. Among our subjects, the mean BMI in both groups indicates that patients were significantly overweight, while underweight patients were also observed in the post-infarction group, which may suggest the need to actively look for frailty syndrome in these patients as an independent factor for a worse prognosis in cardiovascular disease [1]. In a systematic review, Norman et al., summarized the current evidence linking PhA to sarcopenia, malnutrition, and frailty syndrome [3]. Low PhA indicated an increased risk of these conditions, which was also confirmed by Yokomachi et al., specifying a cutoff point for PhA in sarcopenia of 4.65 degrees in men and 3.95 degrees in women [8].

In our current study, we found no statistically significant differences in body water distribution, which may be related to the selection of patients for the study (post-MI patients eligible for outpatient rehabilitation under the MC-AMI program were compensated in terms of the cardiovascular and respiratory function) [10]. In addition, in the current study, we observed no significant differences in PhA values in the post-MI and non-MI groups. Similar to the study by Lira et al., subjects with baseline good clinical status showed no significant differences in PhA values despite changes in lipidogram components [22]. In addition, we observed no difference in metabolic age in the two groups. Interestingly, a previous study by Slazak et al., evaluating body composition parameters by BIA twice in post-MI patients (before and after completion of a 5-week outpatient rehabilitation cycle under the MC-AMI program) observed a statistically significant increase in metabolic age [17].

In addition, in the current study, we also found no significant difference in visceral fat, limb fat, fat-free tissue mass, or muscle mass in the trunk and limbs in the two groups, while there was a statistically significant difference in the values of some parameters considering the gender division. We found statistically significantly lower levels of muscle mass and fat-free tissue mass in the trunk and extremities (upper and lower) in women after myocardial infarction. In contrast, these differences were not proven for men of both groups. Taking care to increase muscle mass and lower body fat in women reduces the risk of heart attack, while we can surmise that for men, taking care to improve these parameters may not be as important when it comes to the incidence of heart attack. Men should focus particularly on reducing other modifiable risk factors for heart attack [1]. This thesis would need to be confirmed by larger-scale studies with more women in the groups.

4.1. Limitations

The first limitation of our study was that the trial was not randomized. Secondly, this study was a single-center study. In the future, it is worth conducting a multicenter study for validation in other cohorts. Moreover, the study group was limited in size, differing significantly in age, with a significant numerical predominance of men. In the future, studies should be conducted on a larger group of patients, with a larger number of women and considering a group of more similar age.

5. Conclusions

The mean age in the post-MI group was significantly lower than the mean age of those who had not suffered a heart attack. Post-

MI patients had statistically significantly higher levels of total cholesterol, LDL cholesterol, and triglycerides than patients with angina without a history of myocardial infarction. There was no significant difference in left ventricular ejection fraction values or HDL cholesterol levels. There was no significant difference in PhA values, visceral fat, or body water distribution comparing post-MI and non-MI subjects. Both groups showed a similar percentage distribution of subjects with low, medium, and high PhA values. In contrast, the group of women who had suffered a myocardial infarction had significantly lower levels of fat-free tissue and muscle mass in the trunk, upper extremities, and lower limbs. Even though both groups (test and control) were in relatively good clinical condition, and compensated, it was still possible to highlight the differences. Although our study did not show statistically significant differences in the phase angle value in both groups, taking into account the limitations of the study and comparing it with the available literature, the phase angle values can be analyzed in a wider group of patients in the future, taking into account the change in its value over time under the influence of the applied invasive treatment, rehabilitation or no treatment in groups of people with ischemic heart disease with different clinical characteristics. Further research is needed to confirm these preliminary findings.

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