Acta Clin Croat 2022; 61:427-435
doi: 10.20471/acc.2022.61.03.08

Original Scientific Paper

CHANGES IN PHYSICAL ACTIVITY LEVELS IN PATIENTS WITH ACUTE CORONARY SYNDROME BETWEEN THE FIRST AND THIRD DECADES OF THE 21st CENTURY

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SUMMARY – Sedentary lifestyle and obesity increase the risk of coronary disease (CAD). The aims of this prospective study were to estimate the trends in physical activity (PA) level, accuracy of the Baecke's/LRC-PA questionnaires, and trends in obesity parameters (body mass index-BMI/waist-to-hip ratio-WHR) in patients with acute coronary syndrome (ACS) in the last two decades. We grouped 209 patients with ACS (UAP-unstable angina, STEMI-ST-elevation myocardial infarction, NSTEMI-non STEMI) by year of admission (Group 2002-05/Group 2017) and compared them by the levels of PA (Baecke's/LRC-PA questionnaires) and obesity parameters (BMI, WHR). Group 2017 had higher WHR (1.02 vs. 0.97) and leisure PA index (LI) (3.00 vs. 2.50), as well as less high and very low activity patients (P<0.05). Patients with UAP/STEMI had higher WHR in 2017 (1.02 vs. 0.96, 1.02 vs. 0.99, respectively) (P<0.05) and had lower LI in 2002-05 (2.50 vs. 3.25, 2.75 vs. 3.50, respectively) (P<0.05). In conclusion, leisure PA and WHR was increased in the study period both in patients with ACS and in the general population. We emphasize the usage of more precise methods for evaluation of PA and obesity (Baecke's/Four-point LRC-PA questionnaires, WHR), and that only increased PA with dietary changes leads to reduction of central obesity and risk of ACS.

Key words: *physical activity; acute coronary syndrome; anthropometric parameters, obesity; sedentary lifestyle*

Introduction

Sedentary lifestyle and physical inactivity are independent risk factors for the development of obesity, dyslipidemia, hypertension, hyperglycemia, diabetes and metabolic syndrome, which can lead to manifest cardiovascular disease (CVD), various other chronic diseases and all-cause mortality[1-4].

Current guidelines recommend the optimal level, type, quantity and intensity of physical activity for achievement of health benefits[5,6]. Regular physical activity and exercise training positively influences several cardiovascular risk factors at the same time. The prescription for physical activity and training should be lifelong and include fitness as well as strength and endurance training[5,6].

Baecke's questionnaire is an example of a standardized questionnaire uniformly applied in a

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Received September 22, 2021, accepted March 22, 2022

large population, which carefully analyses the most frequent types of light physical activity. It determines the total results of a physical activity, occupational activity, sports activity during leisure time and leisure-time activity excluding sport[7]. Baecke's questionnaire showed a high correlation with energy expenditure as measured by the double-labeled water method. Because of its simplicity, it is highly recommended in large-scale studies[7].

The Lipid Research Clinics Physical Activity (LRC-PA) questionnaire is a simple global assessment tool devised for differentiating trained versus untrained individuals[8]. While the two-point method classified participants as inactive or active, the four-point method divided participants into very low, low, moderate and high activity groups. The LRC-PA questionnaire is a relatively valid and reliable indicator of heavy physical activity in adults. The four-point method has increased capacity to show graded associations between measures of cardiorespiratory fitness, body fatness and leisure time physical activity compared with the two-point scoring method[8].

The main objectives of this study were:

1. To estimate the level of physical activity at patients with acute coronary syndrome (ACS) and to compare the values in years 2002-05 and 2017.
2. To assess the accuracy of the Baecke's and LRC-PA questionnaires in this estimation.
3. To investigate the trends in two obesity parameters (body mass index – BMI, waist-to-hip ratio – WHR) in the two study periods and their accuracy.

Materials and Methods

Study population

In this prospective study, we examined 209 patients admitted to the Intensive Cardiac Care Unit Sestre Milosrdnice University Hospital Centre, Zagreb, Croatia (ICCU), due to ACS. They were classified into two groups, Group 2002-05 (106 patients admitted between 2002 and 2005) and Group 2017 (103 patients admitted during 2017) according the time of hospitalization.

ACS diagnosis included patients with unstable angina pectoris (UAP) and acute myocardial infarction with (STEMI) and without ST-segment elevation (NSTEMI)[9,10]. STEMI and NSTEMI were diagnosed by the presence of 2 out of 3 criteria: 1) prolonged chest/retrostrenal pain; 2) ECG presence of ST-segment elevation, ST-segment depression > 1 mm in two consecutive leads at rest, T-wave inversion at rest or de novo/transient LBBB; 3) increased cardiac troponin I (hsTnI), serum creatin kinase (CK) and isoenzyme MB (CK-MB) levels.

UAP was diagnosed based on the presence of prolonged chest pain at rest, de novo angina (CCS degree III), or recent destabilization of stable angina (CCS degree III) associated with transient ischemic ST-segment changes on ECG and normal serum levels of hsTnI, CK and CK-MB[9-12].

Exclusion criteria were pre-existing coronary incident, presence of malignancy, renal failure, lack of informed consent.

Data collection

A 12-lead ECG was recorded on admission, shortly after arrival to the ICCU, every 6 hours for the first two days and once a day during hospitalization. Blood samples for assessing CK and hsTnI levels were collected on admission and every 6 hours until verifying the decrease of CK and hsTnI levels. During hospitalization, echocardiography was provided for all patients at least once (2D, M-mode, doppler and color-doppler mode). Urgent or elective coronary angiography (transradial, transfemoral) was provided for all investigated patients based on the present clinical symptoms. Percutaneous coronary intervention of culprit lesion was performed according to indications[9-12].

Demographic data, the presence of risk factors of CAD, and comorbidity data were collected. The measurements of anthropometric parameters were performed (BMI, WHR) using an appropriate medical scale and meter.

Baecke's questionnaire was composed of 16 items, examining the physical workload, load during sport activity, and load during leisure time[7]. Three basic indices were calculated from the results of this questionnaire: work index (WI), sport index (SI), and leisure-time index (LI). The lowest possible value of the indices was 1.0, representing the lowest physical activity, whereas 5.0 was the highest possible value, signifying the highest physical activity. The total index (TI) was calculated as an average of three indices.

In the LRC-PA questionnaire, the first two questions ask subjects to rate their level of physical activity relative to peers at work and leisure[8]. The third question asks subjects if they regularly engage in strenuous exercise or hard physical labor. If the

answer is yes to the third question, subjects are asked if they engage in such activities at least three times a week. In the two-point scoring system, investigated patients who reported strenuous activity were called active, all other were classified as inactive. In the four-point scoring system, among those reporting strenuous exercise (active in two-point scoring system), those who indicated that they were more active than their peers were classified as highly active, those who though they were as active as their peers were classified as moderately active. Among those reporting no strenuous exercise (inactive in two-point scoring system), those who indicated that they were as active as their peers were classified as low active, those who though they were less active than their peers were classified as very low active.

Statistical analysis

The data were processed by means of descriptive statistics. Statistical significance of differences in analyzed demographic, anthropometric and physical activity level indices among patient subgroups as well as physical activity level indices among patients subgroups were tested by means of the Mann-Whitney U Test and Pearson Chi-Square Test. The statistical analysis was carried out in the STATISTICA for Windows program.

Ethical standards and study limitations

The investigation was performed in accordance with the ethical standards in the Declaration of Helsinki and was approved by the appropriate institutional review committee. The results of this study should be considered in light of several limitations. This study represents a single-center experience in a relatively small sample of patients. Due to this limitations, validation of our findings in larger clinical randomized trials will be needed.

Results

Patients with ACS in Group 2017 (103 subjects, 29.4% women and 70.6% men) were significantly older (median age 60.0 vs. 56.5 years) ($P<0.05$) than in Group 2002-05 (106 subjects, 20.8% women and 79.2% men). Additionally, Group 2017 had higher values of WHR (1.02 vs. 0.97) and Baecke's leisure PA index (LI) (3.00 vs. 2.50) (for all $P<0.05$), but without significant differences in gender, BMI, and other activity indices (WI, SI and TI) (Table 1).

Using the two-point LRC-PA questionnaire, we found no statistically significant difference in percentage of active/inactive patients between Group 2017 and Group 2002-05 (68.0/32.0% vs. 63.2/36.8%). In comparison with year 2002-05, both active and inactive patients in 2017 had higher values of WHR and LI of PA. Additionally, active patients had higher values of TI (Tables 2 and 3). The four-point method of same questionnaire revealed a decreasing percentage of highly and very low active respondents, as well as increasing percentage of moderately and low active patients in Group 2017 in comparison with Group 2002-05 (Fig. 1).

When examining UAP, NSTEMI, and STEMI between the two groups, we observed the following:

Table 1. Results of the baseline demographic and PA parameters for patients with ACS (N=209)

PARAMETERS	2002-05 (N = 106)	2017 (N = 103)	*P*
	Median (range)	Median (range)	
Age (years)	56.5 (32 – 66)	60.0 (38 – 66)	**0.009**
BMI	28.1 (20.3 – 38.0)	28.7 (20.3 – 37.9)	0.328
WHR	0.97 (0.85 – 1.11)	1.02 (0.74 – 1.18)	**0.001**
WI	2.5 (1.38 – 4.38)	2.75 (1.25 – 4.75)	0.172
SI	2.0 (1.25 – 4.95)	2.25 (1.00 – 4.75)	0.182
LI	2.50 (1.25 – 5.00)	3.0 (1.50 – 4.75)	**0.001**
TI	2.58 (1.58 – 3.93)	2.63 (1.54 – 4.08)	0.966

ACS – acute coronary syndrome; BMI – body mass index; LI – Leisure index; PA – Physical activity; SI – Sport index; TI – Total index; WHR – Waist-hip ratio; WI – working index.

Table 2. Results of the baseline demographic and PA data for active patients with ACS (N=72)

PARAMETERS	2002-05 (N = 39)	2017 (N = 33)	*P*
	Median (range)	Median (range)	
BMI (kg/m^2)	27.2 (21.6-38.0)	29.6 (20.3-35.2)	0.184
WHR	0.98 (0.85-1.11)	1.02 (0.74-1.18)	**0.047**
WI	3.38 (1.75-4.75)	3.25 (1.88-4.75)	0.959
SI	2.75 (1.00-4.75)	2.50 (1.50-4.95)	0.955
LI	2.75 (1.50-5.00)	3.50 (1.75-4.25)	**0.000**
TI	2.88 (2.17-4.08)	3.25 (2.17-4.14)	**0.016**

ACS – acute coronary syndrome; BMI – body mass index; LI – Leisure index; PA – Physical activity; SI – Sport index; TI – Total index; WHR – Waist-hip ratio; WI – working index.

Table 3. Results of the baseline demographic and PA data for inactive patients with ACS (N=137)

PARAMETERS	2002-05 (N = 67)	2017 (N = 70)	*P*
	Median (range)	Median (range)	
BMI (kg/m^2)	28.1 (20.3-36.8)	27.7 (20.5-42.6)	0.795
WHR	0.97 (0.86-1.07)	1.02 (0.80-1.17)	**0.000**
WI	2.50 (1.25-4.25)	2.43 (1.38-4.00)	0.692
SI	2.00 (1.25-4.00)	2.00 (1.25-3.48)	0.050
LI	2.50 (1.25-4.00)	3.00 (1.50-4.25)	**0.010**
TI	2.50 (1.54-3.46)	2.50 (1.58-3.33)	0.878

ACS – acute coronary syndrome; BMI – body mass index; LI – Leisure index; PA – Physical activity; SI – Sport index; TI – Total index; WHR – Waist-hip ratio; WI – working index.

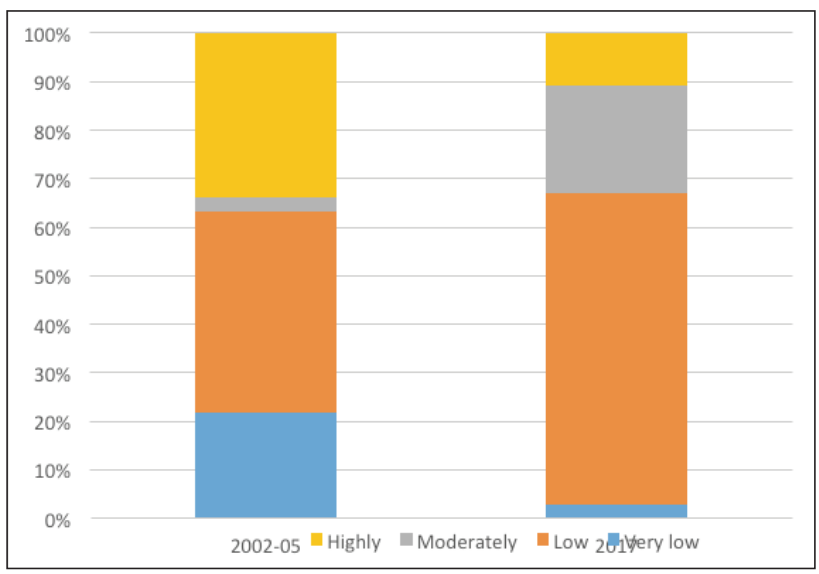

Fig. 1. Differences in the level of PA using the four-point LRC-PA questionnaire. LRC-PA – The Lipid Research Clinics Physical Activity questionnaire; PA – Physical activity.

Table 4. Results of the baseline and PA data for patients with ACS (UAP, NSTEMI, STEMI) (N=209)

ACS subtype	PARAMETERS	2002-05 (N = 106)	2017 (N = 103)	*P*
		Median (range)	Median (range)	
UAP	BMI (kg/m^2)	27.1 (23.0-33.1)	27.8 (20.3-42.1)	0.228
	WHR	0.96 (0.86-1.04)	1.02 (0.74-1.09)	**0.000**
	WI	2.79 (1.63-4.63)	2.50 (1.50-4.25)	0.175
	SI	2.25 (1.00-3.50)	2.25 (1.25-4.95)	0.769
	LI	2.50 (1.50-4.00)	3.25 (1.75-4.25)	**0.000**
	TI	2.60 (1.86-3.38)	2.60 (2.00-4.14)	0.344
NSTEMI	BMI (kg/m^2)	26.9 (21.6-35.49)	31.0 (20.5-35.2)	0.292
	WHR	0.99 (0.85-1.08)	1.03 (0.89-1.10)	0.083
	WI	2.50 (1.25-4.75)	2.50 (1.38-4.38)	0.675
	SI	2.25 (1.25-4.58)	2.00 (1.25-4.50)	0.424
	LI	2.75 (1.50-4.00)	3.50 (2.75-4.25)	**0.003**
	TI	2.63 (1.75-3.49)	2.62 (2.04-3.46)	0.453
STEMI	BMI (kg/m^2)	29.1 (20.3-38.0)	28.6 (22.0-42.6)	0.875
	WHR	0.99 (0.86-1.11)	1.02 (0.80-1.18)	**0.007**
	WI	2.88 (1.36-4.50)	3.12 (1.50-4.75)	0.619
	SI	2.25 (1.25-4.75)	2.25 (1.25-4.36)	0.081
	LI	2.50 (1.25-5.00)	2.75 (1.50-3.75)	0.116
	TI	2.63 (1.54-4.08)	2.67 (1.58-3.47)	0.822

ACS – acute coronary syndrome; BMI – body mass index; LI – Leisure index; NSTEMI – non ST-elevation myocardial infarction; PA – Physical activity; SI – Sport index; STEMI – ST-elevation myocardial infarction; TI – Total index; UAP – unstable angina pectoris; WHR – Waist-hip ratio; WI – working indeks.

UAP was more frequently present in Group 2017 (48 vs. 34%, P<0.05), NSTEMI had higher frequency in Group 2002-05 (27 vs. 13%, P<0.05), and STEMI was almost equally present in both groups (45 in 2002-05 vs. 42% in 2017; P=NS). Patients with UAP and STEMI had significantly higher values of WHR in 2017 than during 2002-05; patients with UAP and NSTEMI in 2002-05 had significantly lower values of LI than in year 2017 (Tables 4-6).

Discussion

This investigation revealed these two main findings: during the study period of more than one decade, there was an increase of leisure time physical activity level but unfortunately also an increase in central obesity in patients with ACS.

Measurement of BMI and WHR (less often waist circumference (WC), waist-to-height ratio (WHtR), and others) is the primary method for diagnosing obesity in everyday clinical practice[2-4,13,14]. While BMI only determines the overall obesity, other obesity indices determine central obesity. Central obesity correlates with excessive visceral fat, which is directly associated with insulin resistance and compensatory hyperinsulinemia, dyslipidemia, and inflammatory states that synergistically lead to smooth muscle cell proliferation, calcium and cholesterol ester deposition in the artery, and finally to atherosclerotic vascular disease. This is why the latter parameters are stronger predictors of cardiovascular risk than BMI[15-18]. In subjects with acute myocardial infarction, there is a positive association increased abdominal obesity and higher mortality, but an inverse or no association

between BMI and mortality (the "obesity paradox"). A possible explanation could be that BMI does not adequately discriminate between the difference in body fat (especially abdominal) and lean muscle mass, unlike WHR[19-21]. WHR may be a better indicator of the distribution of body fat, as increased WHR is associated with more severe CAD and with more frequent heart failure and mortality rate in acute STEMI [2-4,13,14,22-24]. These facts could explain why we found no significant differences in BMI during the study period, but observed significantly higher WHR values in patients with STEMI in 2017 compared with 2002-2005.

As in this investigation, the prevalence of overweight and obesity has increased significantly in all societies around the world over the last three decades, and everything indicates that this trend is likely to continue, with far-reaching negative public health effects. It should be noted that the effects of public health actions on reducing the rate of obesity over the past 30 years in most countries have been very limited due to the failure to long-term limiting of energy intake or maintaining high levels of energy consumption[25,26]. In the WHO European Region, more than 50% of men and women are overweight, and more of 20% are obese[27]. This is particularly evident in patients with CAD, and a study by 2013 Babić and al.[28] reported that patients with ACS, compared with the general population, had statistically significantly larger WC and WHR but without statistically significantly higher BMI.

In the same study[28], patients with ACS had lower leisure time PA indices as well as lower indices of total PA compared with the general population of Croatia. That finding was expected, because physical activity has a graded inverse association with the risk of coronary events[25,29-34] and prevents weight gains and the development of hypertension, hypercholesterolemia, metabolic syndrome, and diabetes, all of which are important cardiovascular risk factors[25,29,35-37].

Many studies have also demonstrated that physical activity reduces blood concentrations of several inflammatory biomarkers such as C-reactive protein, lipoprotein-associated phospholipase A2, and cytokines interleukin (IL)-1β, IL-6, and tumor necrosis factor-α, many of which have been recognized as having important roles in the initiation and development of atherosclerosis[29,38,39]. Finally, both physical activity and physical fitness are independent protective elements for cardiovascular events[25,40-42]. Rapid urbanization, mechanization, and motorized transport have continuously reduced energy consumption over the past half century[43,44] in economically developed and low-income countries, especially in urban areas[45,46].

On the other hand, the trend observed among ACS patients was that participation in leisure physical activity progressively increased during the 20th century in highly developed countries. However, this does not seem to have been sufficient globally to compensate for the increase in the sedentary lifestyle of the population[47,48].

Instead, a sedentary lifestyle is considered to be a separate and independent risk factor for cardiovascular and overall mortality independent of the level of intense physical activity in leisure time and should be viewed and influenced as such[49,50].

Despite other direct and indirect methods of determining the level of physical activity, including recently popular mechanical and electronic devices (pedometers, mobile applications, etc.) for research on the impact of physical activity on chronic diseases, quality and life expectancy questionnaire remains a first choice, especially if they can be standardized and uniformly applied in a large population according to epidemiological principles[28,51]. Baecke's and LRC PA questionnaires are example of a such well-constructed questionnaires for investigations of cardiovascular diseases and risks in different groups of patients[7,8]. In this, as well as in previous studies[28,51], the less complicated LRC PA questionnaire (especially the two-point method) seemed to provide less precise data and failed to provide all the data on the impact of physical activity levels. The four-point method of the LRC PA questionnaire and Baecke's questionnaire confirmed an increase in moderate-intensity leisure time activity the patients with ACS in the present study. Such trends correspond to trends in the general population and are a consequence of recommendations in the scientific and professional literature[5,6].

Conclusion

In conclusion, as in global population of developed countries, there was an increase both in leisure time PA levels and in central obesity among patients with ACS. It is very important to use more precise methods of evaluating the level of physical activity and central obesity (e.g. Baecke's questionnaire, Four-point LRC-

PA questionnaire, WHR) in everyday clinical work. Only increasing physical activity levels associated with dietary changes leads to reduction of dangerous central obesity and prevention of development and exacerbation of CAD.

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Sažetak

PROMJENE U RAZINI TJELESNE AKTIVNOSTI U BOLESNIKA S AKUTNIM KORONARNIM SINDROMOM IZMEĐU PRVOG I TREĆEG DESETLJEĆA 21. STOLJEĆA

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Sedentni način života i debljina povećavaju rizik koronarne bolest (CAD). Ova prospektivna studija istražuje trendove razine tjelesne aktivnosti (PA), preciznost Baeckeovog/LRC-PA upitnika i trendove parametara debljine (indeks tjelesne mase-BMI/omjer struk-bokovi-WHR) u kod pacijenata s akutnim koronarnim sindromom (AKS) u posljednja dva desetljeća. U istraživanju je sudjelovalo 209 pacijenata s AKS (UAP-nestabilna angina, STEMI-infarkt miokarda s ST-elevacijom, NSTEMI-infarkt miokarda bez ST-elevacije), grupiranih prema godini hospitalizacije (Group 2002-05/Group 2017) i kompariranih prema razini PA (Baecke's/LRC-PA upitnici) i parametrima debljine (BMI, WHR). Groupa 2017 imala je veće WHR (1.02 vs. 0.97) i Beckeov indeks PA u slobodno vrijeme (LI) (3.00 vs. 2.50), manji broj visoko i vrlo nisko aktivnih ($P<0.05$). Pacijenti s UAP/STEMI imali su veći WHR u 2017 (1.02 vs. 0.96, 1.02 vs. 0.99) ($P<0.05$), a u 2002-05 niži LI (2.50 vs. 3.25, 2.75 vs. 3.50) ($P<0.05$). Zaključno, kao u općoj populaciji i u pacijenata s AKS porasla je aktivnost u slobodno vrijeme i WHR u periodu od 2002-05 do 2017. Naglašavamo važnost korištenja preciznijih metoda u procjeni PA i debljine (Baecke's/Four-point LRC-PA upitnici, WHR), te važnost da povišenje razine PA samo uz promjene prehrane vode smanjenju centralne debljine i rizika od AKS.

Ključne riječi: *tjelesna aktivnost; akutni koronarni sindrom; anthropometrijski parametri; debljina; sedentni način života.*