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Keywords:	white-collar workers, manual workers, occupational status, cardiovascular risk factors, metabolic syndrome, pre-elderly

Physical activity-related behaviours are more important for cardiometabolic risk than overall energy expenditure or professional status in 60-65 year-old subjects

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Abstract:

Objectives: The aim of the study was to determine whether cardiovascular risk factors may differ according to workload, and whether physical activity related to total energy expenditure (PA-EE) and related to health related behaviours (PA-HRB) is associated with common cardiovascular risk factors or metabolic syndrome in pre-elderly subjects.

Methods: Three hundred subjects aged 60-65, were recruited and divided into three equal groups of intellectual, manual workers and unemployed subjects; 50% were women. The subjects were tested for major cardiovascular risk factors such as smoking, anthropometric indices, blood pressure, lipid levels, glucose, uric acid and homocysteine. PA-EE and PA-HRB were assessed with PA questionnaires.

Results: Manual workers displayed higher anthropometric indices, blood pressure and higher PA-EE in comparison with other two group. PA-HRB had a positive impact on body mass indices, lipids, glucose, uric acid and the prevalence of metabolic syndrome, with no such relationship observed for PA-EE.

Conclusions: The greatest cardiovascular risk was observed in the manual workers group. Only PA-HRB had a positive association with cardiometabolic risk. No relationship was observed for PA-EE. Thus, promoting everyday life and leisure time PA behaviours is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in manual workers with high work-related energy expenditure.

Article Summary

Manual workload seems to be related to higher cardiovascular risk. The results indicate positive impact of physical activity (PA) associated to health related behaviours on cardiovascular risk factors. PA calculated as total energy expenditure may be connected to adverse effect, probably due to its association to professional status and other social and health awareness behaviours. Presented data suggest that promoting everyday life and leisure time PA behaviours is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in manual workers with high work-related energy expenditure.

Strengths and limitations of the study:

- Three equinumerous groups of subjects with different workload;
- sex and age-matching of subjects;
- PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be biased;
- The findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Key words: white-collar workers, manual workers, occupational status, cardiovascular risk factors, metabolic syndrome, pre-elderly.

Introduction:

Cardiometabolic diseases are a major cause of death and important reason of disability in developed countries. The occurrence of cardiovascular disease is related to the presence of risk factors. Smoking increases morbidity and mortality associated with cardiovascular diseases[1-2]. Abdominal distribution of fat has a negative impact on blood pressure (BP), lipid metabolism, glucose tolerance or insulin resistance[3]. Obesity correlates with left ventricular hypertrophy, and weight reduction is a factor restoring normal heart muscle mass [4]. Cardiovascular risk is related to high blood pressure, especially to isolated systolic hypertension as a cause of coronary heart disease and stroke[5-6]. Hyperglycaemia is associated with increased risk of coronary heart disease. Diabetes worsens the long term prognosis for life expectancy[7], as 2/3 of diabetic deaths are related to cardiovascular disease[8]. Atherosclerosis is positively correlated with low density lipoprotein cholesterol (LDL-C) but negatively with high density lipoprotein cholesterol (HDL-C) concentration [9]. Homocysteine(Hcy) accelerates the development of atherosclerosis by enhancing the proliferation of vascular myocytes, endothelial dysfunction, oxidative stress and collagen synthesis, resulting in a deterioration of the elasticity of blood vessels.

The elongation of the working period reinforces the need for research into how workload influences the risk factors among seniors. The nature of work seem to have a direct impact on cardiovascular risk. Available data indicates that of various working groups, manual workers demonstrate the greatest cardiovascular risk [10] and that their workload may increase the risk of coronary heart disease[11]. The prolonged working time of middle-aged men, especially those with current cardiovascular disease, can cause the progression of carotid atherosclerosis[12]. There is some evidence that manual work may be related to greater occurrence of increased blood pressure than white collar work [13-14], even after adjustment for age, obesity or self-reported alcohol consumption[15]. Furthermore, studies on some areas of work highlight the impact of job strain on arterial hypertension[16]. Psychosocial factors (low economic status, social isolation, chronic stress or depression) have a negative impact on cardiovascular risk, and significantly worsen the effects of treatment and prognosis of patients who already have developed the disease [17].

Manual workers have often been found to demonstrate a higher prevalence of daily smoking than white collar co-workers[18-19]. Some data indicates also that the unemployed are heavier tobacco users than professional workers[20]. Subjects with occupations requiring lower qualifications may be more likely to demonstrate cardiovascular risk factors, such as obesity or lack of adequate physical activity (PA)[21]. Prevention in psychological factors or restoring a healthy lifestyle can reduce the risk or moderate the progression of cardiovascular disease[22]. Insufficient PA associated with a sedentary lifestyle increases cardiovascular risk, and an adequate level of activity can prolong the lifespan[23]: Moderate or strong PA inhibits the development of atherosclerosis and reduces total mortality by 20-25% [24], which has been attributed to a range of effects such as reducing body weight or improving glucose tolerance[25] or lipid profile. Manual workers usually report high PA as a consequence of work conditions[26]. The relationship observed between unemployment and low PA may be connected with higher susceptibility for cardiovascular diseases[27].

It has recently been shown that sub-populations of older people differ with regard to their level of PA and its association with sociodemographic data and concomitant diseases[35]. Furthermore, the relationship between PA and health profile may vary depending on the PA assessment methodology (PA related energy expenditure – PA-EE and PA-related health-related behaviors – PA-HRB). One of the most important questions in contemporary geriatric and occupational medicine is how socioeconomic status, workload and PA co-determine cardiovascular risk with regard to prolonged working time. Therefore, the aim of this work was to identify the occurrence of cardiovascular risk factors and diseases, and determine their relationships with different aspects of PA in three groups of pre-elderly: white-collar workers, manual workers and unemployed seniors.

Methods

Subjects

The study was conducted in three age- and sex-matched groups of inhabitants of the Lodz region aged 60 to 65 years. Participants were divided into three groups depending on the character of their professions: white-collar workers, manual workers and unemployed subjects. Each group included 100 volunteers (50 men and 50 women). The median of age was 62.5 (61-64) years for white-collar workers, 62 (61-64) years for physical workers and 63 (63-64) years for the unemployed (percentiles in brackets). The procedure for defining the type of profession has been described previously in a work concerning differences in the quality of work and life among the three senior groups[28].

Subjects were asked about the presence of arterial hypertension (HA), diabetes mellitus type 2 (DM2), dyslipidaemia and smoking habit. Blood pressure was measured twice with an auscultation sphygmomanometer in accordance with the current guidelines[29]. Fasting blood samples were drawn from the antecubital vein into test tubes. The blood serum was assayed spectrophotometrically for fasting glucose concentration, total cholesterol (TC), LDL-C, HDL-C, triglycerides (TG), uric acid (UA) (DIRUI CS 400, Changchun, China). Hcy was estimated in blood serum by immunochemiluminescence (Immulite 2000XPi analyser, Siemens, Germany). Blood morphology was evaluated with 5-Diff Sysmex XS-1000i haematological analyser (Sysmex, Kobe, Japan). Weight and height were measured in participants while barefoot, and waist and hip circumference were measured at a level midway between the lowest rib margin and the iliac crest[30]; Body mass index (BMI) and waist-hip ratio (WHR) were then calculated based on the results. Metabolic syndrome was assessed according to International Diabetes Federation[31].

Physical activity assessment

Physical activity was assessed by two popular PA questionnaires: the Seven-Day Recall PA Questionnaire[32] and the Stanford Usual Activity Questionnaire[33]. Both have demonstrated high validity in older individuals and have been assessed in accordance to standardized protocols[34,35]. For the Seven-Day Recall PA Questionnaire, a list of examples of different level of activities was included. Additionally, if in doubt, participants were allowed to ask questions to the interviewer. All participants were informed that the questionnaire was anonymous and that only the researchers will have access to the results.

The Seven-Day Recall PA Questionnaire determines the hours spent sleeping for the week, sums up the time spent in light (activities with energy expenditure of 1.5 $kcal \cdot min^{-1}$), moderate (activities with energy expenditure of 4 kcal·min^{-1}), hard (activities with energy expenditure of 6 kcal·min^{-1}), and very hard (activities with energy expenditure of 10 kcal·min^{-1}) activities and estimates overall weekly energy expenditure through analysis of PA during the previous seven days. The Seven-Day Recall Total score (total energy expenditure over past week – kcal·kg^{-1}·day^{-1}) was then calculated and used for further comparisons as PA-energy expenditure (PA-EE).

The Stanford moderate index allows an assessment of health-related PA behaviors of light and moderate intensity. The respondents indicate the type of behavior typical of their exercise habits: climbing the stairs instead of using the elevator, walking instead of driving for a short distance, parking the car further away from the destination in order to approach on foot, walking before or after lunch or dinner, exiting the bus or tram a stop earlier in order to walk the remaining distance, or performing other activities of a similar nature. In the Stanford Hard (vigorous) index, the respondent indicates the following activities performed regularly for at least the last three months: jogging or running at least 10 miles per week, play strenuous racquet sports at least five hours per week, play other strenuous sports at least five hours per week, ride a bicycle at least 50 miles per week, swim at least two miles per week. The Stanford Moderate (six habitual moderate activities) and Hard (five habitual intensive activities) indices were calculated and used for further comparisons. These two PA indices are expressed as PA-health-related behaviors I (PA-HRB I) and PA-health-related behaviors II (PA-HRB II), respectively.

Statistical analysis

Data was verified for normality of distribution and equality of variances. The Kruskal-Wallis test, Mann-Whitney test and chi-square test (3x2 and 2x2 with Yates' correction) were used to compare the groups. The correlations were assessed with Spearman's correlation coefficients. The results of the quantitative variables are presented as mean ± (standard deviation). Multivariate analyses were performed to identify factors independently predicting cardiometabolic risk, general linear models were constructed for the main cardiovascular risk factor and logistic regression was employed for dichotomized variables. Non-normally distributed variables were log-transformed for the purpose of multivariate analyses; however, the results are presented in standard values. PA-HRB II was dichotomized for multivariate analyses as no PA-HRB II vs. at least one PA-HRB II. The limit of significance was regarded as p≤0.05 for all analyses. Statistical analysis were performed using Statistica 12 software.

Ethical considerations

The study was approved by the Ethics Committee of the Medical University of Lodz.

Data sharing statement

No additional data available.

Patient and public involvement statement

The study design was based on the fact that Łódź region is one with the fastest ageing population in Europe. Conduction of the study was crucial for searching new approach to cardiovascular risk among pre-elderly seniors. The respondents obtained information on individual test results. In addition, they are informed about the results obtained on the basis of the collected data.

Except above-mentioned there was no involvement of patient in this study.

Results

Table 1 presents differences between the three working group. The mean age of the unemployed subjects group was higher than those of both the working groups. White-collar workers were better educated than manual labourers and the unemployed subjects. Manual workers presented higher WHR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and PA-EE than the other two groups. Manual workers also presented a significantly higher platelet count in comparison with intellectual workers.

Table 1. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three working groups.

Variable	Intellectual workers Mean ±SD	Manual workers Mean ±SD	Unemployed Mean ±SD
Age [years]	62.5 (61-64)	62 (61-64)	63 (63-64)*^{U} #^{U}
Education [years]	15.5 (12.5-17)	12 (11-13)*^{U}	12 (11-14.5)*^{U}
BMI [kg/m²]	27.72 ±3.95	28.21 (25.48-31.47)	27.45 (23.9-30.8)
WHR	0.92 (0.84-0.98)	0.95 ±0.09*^{U}	0.92 (0.82-0.99)#^{U}
TC [mg/dl]	207.4 (178.6-233.5)	203.5 (172.5-235.0)	203.1 (167.1-239.3)
LDL [mg/dl]	126.5 (103.3-152.1)	130.93 ±38.60	127.36 ±38.77
HDL [mg/dl]	50.0 (42.5-57.6)	46.9 (40.7-56.2)	47.9 (39.9-59.6)
TG [mg/dl]	107.7 (74.9-148.9)	109.2 (74.5-158.7)	116.5 (82.2-173.9)
Glucose [mg/dl]	97.2 (90.1-110.3)	101.9 (93.7-113.2)	98.8 (90.8-111.5)
Uric acid [mg/dl]	4.87 ±1.18	4.8 (4.0-5.7)	4.81 ±1.39
Homocysteine [µmol/l]	14.0 (12.5-17.0)	14.45 (12.2-16.8)	14.8 (12.9-17.1)
Blood platelets [10^3/mm^3]	207.04 ±48.08	223.60 ±50.11*^{t}	214.5 (173.0-250.5)
SBP [mmHg]	133.48 ±17.00	143.39 ±16.99*^{t}	134.54 ±15.97#^{t}
DBP [mmHg]	80.0 (72.0-88.0)	87.04±11.69*^{U}	81.86 ±12.42#^{t}
Metabolic syndrome	63%	69%	63%
PA-EE [kcal/kg^{-1} day^{-1}]	41.3 (37.3-48.6)	49.59 ±7.64*^{U}	41.0 (37.5-44.7)#^{U}
Stanford moderate PA-HRB I	23.0 (1.0-4.0)	3.0 (1.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0(0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	17%	12%	18%
Diseases and drugs	**n and %**	**n and %**	**n and %**
HA	50	53	54
Hypercholesterolemia	60	67	71
Smoking	20	26	23
DM 2	10	13	12
MI	5	4	6
IHD	11	13	19
Stroke	4	4	4
Obesity	30	33	32
Anticoagulants	16	15	23
B-blocker	26	28	31
Ca-blocker	13	13	7
Angiotensin conv. enzyme inhibitor	21	27	22
Angiotensin II receptor blocker	12	6	9
Diuretics	24	23	10
Statins and fibrates	21	26	30
Antidiabetics	9	14	11

* statistically different from intellectual p<0.05. # statistically different from manual p<0.05. ^{t} T -Student test ; ^{U} Man-Whitney test.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease.

The prevalence of cardiovascular diseases and risk factors throughout the whole studied population was as follows: hypercholesterolemia - 66%, HA - 52.33%, DM2 - 11.67%, previous myocardial infarction (MI) - 5%, ischaemic heart disease (IHD) - 14.33%, previous stroke - 4%, obesity (counted as a BMI equal or greater than 30kg*m^{-2}) - 31.67%, and metabolic syndrome - 65% of subjects. No differences were seen between the three groups regarding the incidence of diseases or drug intake.

Regarding the female respondents, the unemployed subjects were significantly older than working subjects, and those in white-collar work were better educated than the other two groups. Manual workers were significantly more obese (WHR), with higher SBP and PA-EE values, than the white-collar and unemployed groups. The women in manual work had higher platelet count and DBP in than those in white collar positions, and displayed significantly higher UA concentration than unemployed respondents. Table 2a displays differences between groups of women in more detail.

Table 2a. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three working groups of women.

Variable	**Intellectually working females Mean ±SD**	**Manually working females Mean ±SD**	**Unemployed females Mean ±SD**
Age [years]	62 (61-64)	62 (61-63)	63 (63-64)*^{U} #^{U}
Education [years]	14.5 (12-17)	13 (11-14)*^{U}	13 (12-16)*^{U}
BMI [kg/m²]	27.61 ±4.42	28.24 (25.3-31.3)	27.0 (23.4-31.6)
WHR	0.85 ±0.06	0.89 ±0.08*^{U}	0.83 ±0.07#^{U}
TC [mg/dl]	214.5 (185.0-249.0)	221.29 ±51.47	216.44 ±44.33
LDL [mg/dl]	140.4 (104.9-156.3)	143.69 ±41.06	134.5 ±41.95
HDL [mg/dl]	52.9 (45.4-69.0)	51.2 (45.2-51.9)	57.03 ±14.63
TG [mg/dl]	107.9 (78.6-159.8)	114.7 (74.0-158.7)	113.0 (76.8-159.4)
Glucose [mg/dl]	95.8 (89.0-105.6)	101.6 (92.6-108.9)	94.7 (88.7-106.9)
Uric acid [mg/dl]	4.44 ±1.21	4.3 (3.9-5.1)	3.8 (3.2-4.9)#^{U}
Homocysteine [µmol/l]	13.3 (11.9-16.2)	14.25 (12.1-15.9)	14.3 (12.7-16.0)
Blood platelets [10^3/mm^3]	220.09 ±45.92	246.18 ±46.69*^{t}	224.5 (196-256)
SBP [mmHg]	130.48 ±15.48	140.5 ±15.12*^{t}	133.14 ±13.25#^{t}
DBP [mmHg]	78.18 ±11.61	84.64 ±9.91*^{t}	80.5 ±11.98
Metabolic syndrome	27 (54%)	30 (60%)	22 (44%)
PA-EE [kcal/kg^{-1} day^{-1}]	44.1 (38.7-48.7)	50.52 ±7.33*^{U}	41.0 (38.1-43.8)#^{U}
Stanford moderate- PA-HRB I	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	8 (16%)	5 (10%)	10 (20%)
Diseases and drugs	**n and %**	**n and %**	**n and %**
HA	24 (48%)	23 (46%)	21 (42%)
Hypercholesterolemia	34 (68%)	35 (70%)	36 (72%)
Smoking	13 (26%)	12 (24%)	6 (12%)
DM 2	4 (8%)	7 (14%)	5 (10%)
MI	1 (2%)	0 (0%)	1 (2%)
IHD	6 (12%)	5 (10%)	6 (12%)
Stroke	3 (6%)	2 (4%)	1 (2%)
Obesity	17 (34%)	16 (32%)	14 (28%)
Anticoagulants	6 (12%)	9 (18%)	13 (26%)
B-blocker	15 (30%)	14 (28%)	15 (30%)
Ca-blocker	5 (10%)	5 (10%)	2 (4%)
Angiotensin conv. enzyme inhibitor	10 (20%)	13 (26%)	10 (20%)
Angiotensin II receptor blocker	10 (20%)	3 (6%)	4 (8%)
Diuretics	12 (24%)	12 (24%)	5 (10%)
Statins+ fibrates	9 (18%)	12 (24%)	13 (26%)
Antidiabetics	3 (6%)	7 (14%)	5 (10%)

* statistically different from intellectual $p<0.05$. # statistically different from manual $p<0.05$. ^{t} T -Student test ; ^{U} Man-Whitney test.

Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Regarding the men, white-collar workers were better educated than manual workers and unemployed men. Manual workers had significantly higher SBP, DBP and PA-EE than the other two groups. Unemployed men had higher TG and lower HDL-C than the white-collar workers. No differences were found between the three groups concerning PA-HRB, either with or without division by gender. These differences are highlighted in Table 2b.

Table 2b. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three working groups of men.

Variable	Intellectually working males Mean ±SD	Manually working males Mean ±SD	Unemployed males Mean ±SD
Age [years]	63 (61-64)	63 (61-65)	63 (63-65)
Education [years]	16 (13-17)	12.0 (11.0-13.0)*^{U}	12.0 (11.0-13.0)* ^{U}
BMI [kg/m²]	27.83 ±3.47	28.0 (25.5-32.1)	27.73±4.34
WHR	0.98 ±0.59	1.01 ±0.06	0.99 ±0.06
TC [mg/dl]	197.77±35.84	190.26 ±37.40	192.54 ±40.10
LDL [mg/dl]	124.93 ±30.82	117.91 ±31.29	120.07 ±34.12
HDL [mg/dl]	48.2 (39.3-54.0)	44.7 (39.2-52.5)	41.5 (36.6-48.4)* ^{U}
TG [mg/dl]	104.4 (70.9-139.3)	106.0 (74.9-158.6)	123.1 (88.3-188.5)* ^{U}
Glucose [mg/dl]	99.2 (92.2-112.4)	102.3 (96.1-114.7)	1022.3 (93.9-114.1)
Uric acid [mg/dl]	5.31 ±0.99	5.35 ±1.15	5.50 ±1.06
Homocysteine [µmol/l]	16.02 ±3.68	14.7 (12.7-17.5)	15.9 ±3.94
Blood platelets [10^3/mm^3]	193.73 ±47.00	201.48 ±43.33	187.5 (165.0-237.0)
SBP [mmHg]	135 (125-145)	146.28 ±18.37* ^{U}	135.94 ±18.32# ^{t}
DBP [mmHg]	82 (75-93)	89.44 ±12.89* ^{U}	83.22 ±12.81# ^{t}
Metabolic syndrome	36 (72%)	39 (78%)	41 (82%)
PA-EE [kcal/kg^{-1} day^{-1}]	40.0 (36.6-48.1)	48.66 ±7.90* ^{U}	40.9 (37.3-45.0)# ^{U}
Stanford moderate- PA-HRB I	3.0 (1.0-4.0)	2.5 (1.0-4.0)	2.5 (1.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	9 (18%)	7 (14%)	8 (16%)
Diseases and drugs	**n and %**	**n and %**	**n and %**
HA	26 (52%)	30 (60%)	33 (66%)
Hypercholesterolemia	26 (52%)	32 (62%)	35 (70%)
Smoking	7 (14%)	14 (28%)	17 (34%)
DM 2	6 (12%)	6 (12%)	7 (14%)
MI	4 (8%)	4 (8%)	5 (10%)
IHD	5 (10%)	8 (16%)	13 (26%)
Stroke	1 (2%)	2 (4%)	3 (6%)
Obesity	13 (26%)	17 (34%)	18 (36%)
Anticoagulants	10 (20%)	6 (12%)	10 (20%)
B-blocker	11 (22%)	14 (28%)	16 (32%)
Ca-blocker	8 (16%)	8 (16%)	5 (10%)
Angiotensin conv. enzyme inhibitor	11 (22%)	14 (28%)	12 (24%)
Angiotensin II receptor blocker	2 (4%)	3 (6%)	5 (10%)
Diuretics	12 (24%)	11 (22%)	5 (1%)
Statins+ fibrates	12 (24%)	14 (28%)	17 (34%)
Antidiabetics	6 (12%)	7 (14%)	6 (12%)

* statistically different from intellectual p<0.05. # statistically different from manual p<0.05. ^{t} T -Student test ; ^{U} Man-Whitney test.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Table 3 describes correlations between PA-EE, PA-HRB and major cardiovascular risk factors. In the whole studied group, PA-EE was inversely related to education level, and directly related to SBP. Subjects with higher PA-HRB I presented with lower body mass indices, lower TG, glucose and UA concentration. Higher PA-HRB II was related to lower body mass indices, lower TG, glucose and higher HDL-C. In women, PA-EE was negatively related education level. Women with higher PA-EE had higher WHR, while those with higher PA-HRB (both moderate and hard) had lower body mass indices (BMI and BMI/WHR respectively). Higher PA-HRB I correlated with lower TG, glucose and UA; higher PA-HRB II was associated with higher HDL-C and lower glucose and UA concentration. In men, higher PA-EE was related to a lower education level, lower concentration of Hcy, higher SBP. Both

PA-HRB I and PA-HRB II correlated negatively with WHR, and PA-HRB II also correlated negatively with BMI. Higher PA-HRB II also correlated with lower TG and higher HDL-C (Table 3).

Tab. 3 Correlations between PA and major cardiovascular risk factor in tested groups.

	PA	Education [years]	BMI [kg/m^2]	WHR	TC [mg/dl]	TG [mg/dl]	HDL-C [mg/dl]	LDL-C [mg/dl]	Glucose [mg/dl]	UA [mg/dl]	Hcy [µmol/l]	SBP [mmHg]	DBP [mmHg]
All participants N=300	PA-EE	-0.17	0.02	0.02	0.03	-0.003	0.006	0.03	-0.02	-0.002	-0.06	0.14	0.06
		(p=0.003)	(p=0.72)	(p=0.72)	(p=0.57)	(p=0.95)	(p=0.91)	(p=0.55)	(p=0.75)	(p=0.97)	(p=0.29)	(p=0.01)	(p=0.24)
	PA-HRBI	0.03	-0.18	-0.19	-0.003	-0.13	0.06	0.02	-0.19	-0.18	0.02	-0.03	0.04
		(p=0.57)	(p=0.002)	(p=0.001)	(p=0.95)	(p=0.02)	(p=0.26)	(p=0.73)	(p=0.001)	(p=0.001)	(p=0.72)	(p=0.56)	(p=0.44)
	PA-HRBII	-0.02	-0.19	-0.17	0.05	-0.15	0.18	0.05	-0.12	-0.10	0.01	0.01	(-0.05
		(p=0,73	(p=0.001)	(p=0.003)	(p=0,35)	(p=0.008)	(p=0.001)	(p=0.38)	(p=0.03)	(p=0.07)	(p=0.77)	(p=0.86	(p=0.35)
Women N=150	PA-EE	-0.16	-0.02	0.17	0.02	0.02	-0.11	0.053	-0.08	-0.06	0.09	0.13	0.07
		(p=0.05)	(p=0.78)	p=0.03)	(p=0.77)	(p=0.81)	(p=0.19	(p=0.52)	(p=0.31)	(p=0.48)	(p=0.25)	(p=0.10)	(p=0.37)
	PA-HRBI	-0.14	-0.23	-0.14	0.01	-0.16	0.08	0.04	-0.22	-0.28	0.02	-0.08	0.03
		(p=0.08)	(p=0.004)	(p=0.09)	(p=0.85)	(p=0.05)	(p=0.28)	(p=0.57)	(p=0.007)	(p=0.000)	(p=0.81)	(p=0.32)	(p=0.67)
	PA-HRBII	0.12	-0.21	-0.22	0.05	-0.14	0.20	0.03	-0.17	-0.19	0.15	-0.03	-0.01
		(p=0.16)	(p=0.01)	(p=0.006)	(p=0.51)	(p=0.92)	(p=0.01)	(p=0.67)	(p=0.03)	(p=0.01)	(p=0.07)	(p=0.69)	(p=0.95
Men N=150	PA-EE	-0.20	0.07	-0.03	0.01	-0.01	0.09	-0.01	0.56	0.10	-0.19	0.16	0.08
		(p=0.01)	(p=0.42)	(p=0.71)	(p=0.89	(p=0.85)	(p=0.25)	(p=0.84)	(p=0.49)	(p=0.19)	(p=0.01)	(p=0.05)	(p=0.31)
	PA-HRBI	-0.03	-0.12	-0.29	-0.07	-0.10	0.001	-0.05	-0.15	-0.61	0.04	0.02	0.07
		(p=0.73)	(p=0.15)	(p=0.000)	(p=0.38)	(p=0.21)	(p=0.99)	(p=0.57)	(p=0.07)	(p=0.46)	(p=0.62)	(p=0.80)	(p=0.37
	PA-HRBII	-0.06	-0.17	-0.29	0.07	-0.16	0.20	0.09	-0.07	-0.04	-0.12	0.04	-0.10
		(p=0.43)	(p=0.04)	(p=0.000)	(p=0.37)	(p=0.04)	(p=0.01)	(p=0.28)	(p=0.38)	(p=0.66)	(p=0.13	(p=0.61)	(p=0.20)

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy-homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PLT- blood platelets, PA-EE-physical activity related to energy expenditure, PA-HRB I - physical activity moderate health related behaviours, PA-HRB II physical activity hard health related behaviours. No correlation for PLT count was found. *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001

Subjects with metabolic syndrome demonstrated lower PA-HRB I and PA-HRB II (relation presented also among men, as assessed separately) compared to the subjects without metabolic syndrome; however, the two groups displayed virtually identical PA-EE (not shown in the table).

Interestingly, in the whole group, PA-HRB I and PA-HRB II levels correlated with PA-EE (rho=0.17; p=0.003 and rho=0.18; p=0.002, respectively) but not each other. PA-EE was related to PA-HRB I and PA-HRB II in men but only PA-HRB II in women.

General linear model and logistic regression were further used to select variables that independently predict major cardiovascular risk factors.

SBP and DBP were related to work type and gender:

SBP [mmHg]= 137.1+6.25 (if manual worker) -3.65 (if intellectual worker)-2.60 (if unemployed)-2.43 (if women)+2.43 (if men).

DBP [mmHg]= 83.32+3.72 (if manual worker)- 2.26 (if intellectual worker)- 1.46 (if unemployed)-2.21 (if woman) +2.21 (if man).

BMI and TG were related to PA- HRB I and PA- HRB II:

BMI [kg/m^2] = 28.62-0.478*PA-HRB I+1.34 (if no PA-HRB II) -1.34 (if at least one PA-HRB II).

TG [mg/dl] = 135.2-6.77*PA-HRB I +17.68 (if no PA-HRB II) -17.68 (if at least one PA-HRB II).

WHR was related to PA-HRB I, PA-HRB II, work type and gender.

WHR = 0.939-0.00857*PA-HRB I+0.0216 (if no PA-HRB II) -0.0216 (if at least one PA-HRB II)-0.0096 (if intellectual worker) +0.0213 (if manual worker)-0.0117 (if unemployed)-0.065 (if woman)+0.065 (if man).

Glucose was related to PA-HRB I, PA-HRB II and gender:

Glucose [mg/dl] = 108.6-2.37*PA-HRB I+5.03 (if no PA-HRB II) -5.03 (if at least one PA-HRB II)-3.35 (if woman)+3.35 (if man)

HDL-C was related to PA-HRB II and gender:

HDL-C [mg/dl] = 53.2-3.66 (if no PA-HRB II) +3.66 (if at least one PA-HRB II)+4.80 (if woman) -4.80 (if man)

UA was related to PA-HRB I and gender:

UA [mg/dl] = 5.23-0.122*PA-HRB I-0.488 (if woman)+0.488 (if man)

TC and homocysteine were predicted only by gender:

TC[mg/dl] = 206.9+13.32 (if woman)-13.32 (if man)

Hcy[µmol/l] = 15.2-0.604 (if woman) +0.604 (if man)

Sex, PA-HRB I and PA-HRB II appeared as significant independent predictors of metabolic syndrome in the whole group (Table 4): PA-HRB II significantly predicted the probability of metabolic syndrome in men, but only with borderline significance in women (p=0.061).

Table 4. Independent predictors of metabolic syndrome of whole studied population and in groups separated by gender and work type.

Odds ratios and 95%confidence intervals	PA-HRBI	PA-HRBII (if no PA-HRB II)	Sex (if women)
N=300	0.83*(0.71-0.96)	2.76** (1.41-5.40)	0.31*** (0.19-0.53)
Women N=150	NS	NS	-
Men N=150	NS	3.04* (1.19-7.72)	-

*p<0.05, **p<0.01, ***p<0.001,

Discussion

The major finding of the present study is that in 60-65 year-old subjects, physical activity (PA)-related behaviours have a greater influence on cardiometabolic risk than overall energy expenditure or professional status. The prevalence of cardiometabolic diseases is similar across this group of pre-elderly subjects, independent of workload, with no apparent relationship being found between PA and health status. However, the prevalence of cardiometabolic risk factors was found to vary depending on workload, with the group of manual workers displaying the worst profile.

Manual workers presented higher indices for body mass than white-collar workers and unemployed subjects, with WHR being significantly greater. Nevertheless, all three groups demonstrated similar levels of obesity, defined as BMI equal or greater than 30kg/m^2. Some indications exist that occupational PA may have a protective impact against obesity[30,36]; however, our data indicates that higher body mass indices in 60- to 65-year-old subjects are associated with the higher PA-EE scores observed in the manual labour group, which is coherent with some literature data[27].

As the highest values of blood pressure were observed in the manual labour group, hypertension may be associated with physical workload[37]. Despite demonstrating a similar ratio of hypertensive treatment and diagnosed HA to the other groups, manual workers presented higher BP. Engaging in physical work each working day for several hours may result in elevated blood pressure and increased cardiovascular risk[1,38]. Furthermore, some studies characterise manual labourers with the highest rate of obesity, another important risk factor for hypertension[39]. Importantly, despite the fact that over 50% of subjects were diagnosed with HA, BP measures indicate that manual workers may be still underdiagnosed and undertreated. Furthermore, manual work may be associated with other sex-related cardiovascular risk factors, i.e. higher glucose and UA concentration among women and greater lipid imbalance among men. Overall, these results indicate that of the three tested professional groups, the highest global cardiovascular risk is found among manual workers.

One of the most important findings is that in contrast to leisure-time PA, higher work-related PA (PA-EE) demonstrated no positive association with cardiovascular risk factors. PA-EE demonstrates no association with BMI, WHR, lipid fractions or glucose. This may indicate that PA related to work or occupational activity has no positive impact on basic cardiovascular risk factors, or that this impact is counterbalanced by other risk factors. Furthermore, it is possible that work-related PA may have a negative impact on some cardiovascular risk factors, i.e. to increased blood pressure. Among the whole group, PA-EE was connected with higher SBP. This correlation may be explained by the fact that manual workers, those with highest PA-EE, presented increased blood pressure values. Within the sample, the men with the greatest energy expenditure tended to present not only the lowest education level (manual workers) but interestingly, also the lowest Hcy concentration. Some literature data indicates that PA may decrease Hcy level[36]. Therefore, among the tested older subjects, the overall worse cardiometabolic risk profile displayed by manual workers is counterbalanced by higher PA-EE, as compared to white-collar workers and unemployed subjects. However, PA-HRB appears to have a closer relationship with cardiometabolic risk profile than PA-EE, which may be related to the relationship between PA-EE profile and socioeconomic status.

Both moderate and hard PA-HRBs were found to exert beneficial impact on body mass indices and improve metabolic markers such as TG (both PA-HRB I and II), HDL-C (PA-HRBII) glucose (both PA-HRBI and II) or UA (PA-HRBI). All these correlations are consistent with previous findings [40-42].

When analysed according to gender, these observations were found to apply particularly closely to the group of women. In the case of men, PA-HRB may decrease body mass indices (BMI, WHR) and improve the concentrations of lipids like TG or HDL-C; although, in case of lipids, this relationship was only observed for PA-HRBII. It should be emphasized that the Stanford Usual Activity questionnaire assesses different dimensions of not work-related PA. PA-HRB I and PA-HRB II were not found to be interrelated; however, each was associated with PA-EE.

To the best of our knowledge this is the first work to compare cardiovascular risk factors and different dimensions of PA in three groups of seniors according to type of the workload. Its key strength is its sex and age-matching of subjects. However, the present cross-sectional study has some limitations. PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be incorrect. Finally, our findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Practical implications

All presented data suggest that promoting everyday life and leisure time PA behaviour is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in manual workers with high work-related energy expenditure. Whether that beneficial effect results only from PA *per se* or also from social and health awareness behaviours requires further prospective studies.

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Competing interest statement

The authors declare no competing financial interest.

Contributorship statement

Hereby we present contribution of work in the presented publication:

Bartłomiej K. Sołtysik

- recruitment of subjects, medical history, physical examination, anthropometric examination, database preparation, basic statistical calculations, manuscript writing;

Joanna Kostka

- conducting questionnaire surveys on physical activity, performing statistical calculations on cardiovascular risk factors and physical activity, substantive supervision, manuscript drafting and revising;

Kamil Karolczak

- laboratory tests conduction, substantive supervision, manuscript revising;

Cezary Watała

- laboratory tests conduction, substantive supervision, manuscript revising;

Tomasz Kostka

- Preparing of the study design, performing statistical calculations, substantive supervision, manuscript drafting and revising.

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What is the most important determinant of cardiometabolic risk in 60-65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland.

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What is the most important determinant of cardiometabolic risk in 60-65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland.

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Abstract:

Objectives: The aim of the study was to determine whether cardiovascular risk factors may differ according to occupational status and whether physical activity related to total energy expenditure (PA-EE) and related to health related behaviours (PA-HRB) is associated with common cardiovascular risk factors or metabolic syndrome in pre-elderly subjects.

Methods: Three hundred subjects aged 60-65, were recruited and divided into three equal groups of white-collar, manual workers and unemployed subjects; 50% were women. The subjects were tested for major cardiovascular risk factors such as smoking, anthropometric indices, blood pressure, lipid levels, glucose, uric acid and homocysteine. PA-EE and PA-HRB were assessed with PA questionnaires.

Results: Manual workers displayed higher anthropometric indices, blood pressure and higher PA-EE in comparison with other two group. PA-HRB had a positive impact on body mass indices, lipids, glucose, uric acid and the prevalence of metabolic syndrome, with no such relationship observed for PA-EE.

Conclusions: The greatest cardiovascular risk was observed in the manual workers group. Only PA-HRB had a positive association with cardiometabolic risk. No relationship was observed for PA-EE. Thus, promoting everyday life and leisure time PA behaviours is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in manual workers with high work-related energy expenditure.

Article Summary

Strengths and limitations of the study:

- Three equinumerous sex- and age-matched groups of subjects with different occupational status were recruited in the study.
- The paper promotes the idea that everyday life and leisure time PA behaviours are crucial for preventing cardiometabolic risk in pre-elderly subjects, even in manual workers with high work-related energy expenditure.
- PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be biased.
- The findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Key words: white-collar workers, manual workers, occupational status, cardiovascular risk factors, metabolic syndrome, pre-elderly.

Introduction:

Cardiometabolic diseases are a major cause of death and important reason of disability in developed countries. The occurrence of cardiovascular disease is related to the presence of risk factors. Smoking increases morbidity and mortality associated with cardiovascular diseases[1-2]. Abdominal distribution of fat has a negative impact on blood pressure (BP), lipid metabolism, glucose tolerance or insulin resistance[3]. Obesity correlates with left ventricular hypertrophy, and weight reduction is a factor restoring normal heart muscle mass [4]. Cardiovascular risk is related to high blood pressure, especially to isolated systolic hypertension as a cause of coronary heart disease and stroke[5-6]. Hyperglycaemia is associated with increased risk of coronary heart disease. Diabetes worsens the long term prognosis for life expectancy[7], as 2/3 of diabetic deaths are related to cardiovascular disease[8]. Atherosclerosis is positively correlated with low density lipoprotein cholesterol (LDL-C) but negatively with high density lipoprotein cholesterol (HDL-C) concentration [9]. Homocysteine(Hcy) accelerates the development of atherosclerosis by enhancing the proliferation of vascular myocytes, endothelial dysfunction, oxidative stress and collagen synthesis, resulting in a deterioration of the elasticity of blood vessels.

The elongation of the working period reinforces the need for research into how employment status influences the risk factors among seniors. The nature of work seems to have a direct impact on cardiovascular risk. Available data indicates that of various working groups, manual workers demonstrate the greatest cardiovascular risk [10] and that their workload may increase the risk of coronary heart disease[11]. The prolonged working time of middle-aged men, especially those with current cardiovascular disease, can cause the progression of carotid atherosclerosis[12]. There is some evidence that manual work may be related to greater occurrence of increased blood pressure than white-collar work [13-14], even after adjustment for age, obesity or self-reported alcohol consumption[15]. Furthermore, studies on some areas of work highlight the impact of job strain on arterial hypertension[16]. Psychosocial factors (low economic status, social isolation, chronic stress or depression) have a negative impact on cardiovascular risk, and significantly worsen the effects of treatment and prognosis of patients who already have developed the disease [17].

Manual workers have often been found to demonstrate a higher prevalence of daily smoking than white-collar co-workers[18-19]. Some data indicates also that the unemployed are heavier tobacco users than professional workers[20]. Subjects with occupations requiring lower qualifications may be more likely to demonstrate cardiovascular risk factors, such as obesity or lack of adequate physical activity (PA)[21]. Prevention in psychological factors or restoring a healthy lifestyle can reduce the risk or moderate the progression of cardiovascular disease[22].

Insufficient PA associated with a sedentary lifestyle increases cardiovascular risk, and an adequate level of activity can prolong the lifespan[23]. Moderate or strong PA inhibits the development of atherosclerosis and reduces total mortality by 20-25% [24], which has been attributed to a range of effects such as reducing body weight or improving glucose tolerance[25] or lipid profile. Manual workers usually report high PA as a consequence of work conditions[26]. The relationship observed between unemployment and low PA may be connected with higher susceptibility for cardiovascular diseases[27].

It has recently been shown that sub-populations of older people differ with regard to their level of PA and its association with sociodemographic data and concomitant diseases[28]. Furthermore, the relationship between PA and health profile may vary depending on the PA assessment methodology (PA related energy expenditure – PA-EE and PA-related health-related behaviors – PA-HRB). One of the most important questions in contemporary geriatric and occupational medicine is how socioeconomic status, workload and PA co-determine cardiovascular risk with regard to prolonged working time. Therefore, the aim of this work was to identify the occurrence of cardiovascular risk factors and diseases, and determine their relationships with different aspects of PA in three groups of pre-elderly: white-collar workers, manual workers and unemployed seniors.

Methods

Subjects

The study was conducted in three age- and sex-matched groups of inhabitants of the Lodz region aged 60 to 65 years. Participants were divided into three groups depending on the character of their professions: white-collar workers, manual workers and unemployed subjects. The subjects were recruited through local media (TV, radio and newspapers). All the volunteers were initially checked for the basic recruitment criteria and classified according to the occupational status. As manual workers were the least common group in this age range, they were qualified first for the study. An age- and sex-matched consecutive peer was assigned for each recruited worker from the white-collar and unemployed groups. Each group included 100 volunteers (50 men and 50 women). The procedure for defining the type of profession has been described previously in a work concerning differences in the quality of work and life among the three senior groups[29].

Subjects were asked about the presence of arterial hypertension (HA), diabetes mellitus type 2 (DM2), dyslipidaemia and smoking habit. Blood pressure was measured twice with an auscultation sphygmomanometer in accordance with the current guidelines[30]. Fasting blood samples were drawn from the antecubital vein into test tubes. The blood serum was assayed spectrophotometrically for fasting glucose concentration, total cholesterol (TC), LDL-C, HDL-C, triglycerides (TG), uric acid (UA) (DIRUI CS 400, Changchun, China). Hcy was estimated in blood serum by immunochemiluminescence (Immulite 2000XPi analyser, Siemens, Germany). Blood morphology was evaluated with 5-Diff Sysmex XS-1000i haematological analyser (Sysmex, Kobe, Japan). Weight and height were measured in participants while barefoot, and waist and hip circumference were measured at a level midway between the lowest rib margin and the iliac crest[31]; Body mass index (BMI) and waist-hip ratio (WHR) were then calculated based on the results. Metabolic syndrome was assessed according to International Diabetes Federation[32].

Physical activity assessment

Physical activity was assessed by two popular PA questionnaires: the Seven-Day Recall PA Questionnaire[33] and the Stanford Usual Activity Questionnaire[34]. Both questionnaires used in the present study have been previously described in detail[35]. Both have demonstrated high validity in older individuals against doubly labeled water and have been assessed in the present study in accordance with standardized protocols[28,36].

For the Seven-Day Recall PA Questionnaire, a list of examples of different level of activities was included. Additionally, if in doubt, participants were allowed to ask questions to the interviewer. All participants were informed that the questionnaire was anonymous and that only the researchers will have access to the results.

The Seven-Day Recall PA Questionnaire determines the hours spent sleeping for the week, sums up the time spent in light (activities with energy expenditure of 1.5 $kcal\cdot min^{-1}$), moderate (activities with energy expenditure of 4 $kcal\cdot min^{-1}$), hard (activities with energy expenditure of 6 $kcal\cdot min^{-1}$), and very hard (activities with energy expenditure of 10 $kcal\cdot min^{-1}$) activities and estimates overall weekly energy expenditure through analysis of PA during the previous seven days. The Seven-Day Recall Total score (total energy expenditure over past week – $kcal\cdot kg^{-1}\cdot day^{-1}$) was then calculated and used for further comparisons as PA-energy expenditure (PA-EE).

The Stanford moderate index allows an assessment of health-related PA behaviors of light and moderate intensity. The respondents indicate the type of behavior typical of their exercise habits: climbing the stairs instead of using the elevator, walking instead of driving for a short distance, parking the car further away from the destination in order to approach on foot, walking before or after lunch or dinner, exiting the bus or tram a stop earlier in order to walk the remaining distance, or performing other activities of a similar nature. In the Stanford Hard (vigorous) index, the respondent indicates the following activities performed regularly for at least the last three months: jogging or running at least 10 miles per week, play strenuous racquet sports at least five hours per week, play other strenuous sports at least five hours per week, ride a bicycle at least 50 miles per week, swim at least two miles per week. The Stanford Moderate (six habitual moderate activities; scoring points 0-6) and Hard (five habitual intensive activities; scoring points 0-5) indices were calculated as a numerical sum of points for each activity and used for further comparisons. These two PA indices are expressed as PA-health-related behaviors I (PA-HRB I) and PA-health-related behaviors II (PA-HRB II), respectively.

Statistical analysis

Data was verified for normality of distribution and equality of variances. The one-way analysis of variance (ANOVA) with Tukey post hoc testing, Kruskal-Wallis test, and 3x2 chi-square test were used to compare the three groups. The Student's t-test, Mann-Whitney test and chi-square test (2x2 with Yates' correction) were used to make comparisons between the two groups with applied Bonferroni correction. The correlations were assessed with Spearman's correlation coefficients. The results of the quantitative variables are presented as mean ± (standard deviation) or median (interquartile ranges). Multivariate analyses were performed to identify factors independently predicting cardiometabolic risk, general linear models were constructed for the main cardiovascular risk factors and logistic regression was employed for dichotomized variables. All the variables statistically significant in bivariate relationships were entered into the multivariate analyses. Age, sex, occupational status, physical activity variables, smoking and drugs were taken into consideration as

potential independent variables. Non-normally distributed variables were log-transformed for the purpose of multivariate analyses; however, the results are presented in standard values. PA-HRB II was dichotomized for multivariate analyses as no PA-HRB II versus at least one PA-HRB II. The limit of significance was regarded as p≤0.05 for all analyses. Statistical analysis were performed using Statistica 12 software.

Ethical considerations

The study was approved by the Ethics Committee of the Medical University of Łódź (No RNN/648/14/KB). All subjects signed an informed consent form prior to participation in the study.

Data sharing statement

No additional data available.

Patient and public involvement statement

The study design was based on the fact that Łódź region is one with the fastest ageing population in Europe. The study was important for the understanding of the impact of occupational status on cardiovascular risk among pre-elderly seniors. The respondents obtained information on individual test results. In addition, they are informed about the results obtained on the basis of the collected data.
No additional involvement of patients has been stated.

Results

Table 1 presents differences between the three working group. The median age of the unemployed subjects was slightly higher than those of both working groups. White-collar workers were better educated than manual labourers and the unemployed subjects. Manual workers presented higher WHR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and PA-EE than the other two groups. Manual workers also presented a significantly higher platelet count in comparison with white-collar workers.

Table 1. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups.

Variable	White-collar workers Mean ±SD or median (quartiles) n=100	Manual workers Mean ±SD or median (quartiles) n=100	Unemployed subjects Mean ±SD or median (quartiles) n=100
Age [years]	62.5 (61-64)	62 (61-64)	63 (63-64)*#
Education [years]	15.5 (12.5-17)	12 (11-13)*	12 (11-14.5)*
BMI [kg/m²]	27.7 ±3.9	28.2 (25.5-31.5)	27.5 (23.9-30.8)
Waist circumference (cm)	95 (87.5-102)	97 (90-107.7)*	96 (83-105)
WHR	0.9 (0.8-1.0)	0.9 ±0.1*	0.9 (0.8-1.0)#
TC [mg/dl]	207.4 (178.6-233.5)	203.5 (172.5-235.0)	203.1 (167.1-239.3)
LDL [mg/dl]	126.5 (103.3-152.1)	130.9 ±38.6	127.4 ±38.8
HDL [mg/dl]	50.0 (42.5-57.6)	46.9 (40.7-56.2)	47.9 (39.9-59.6)
TG [mg/dl]	107.7 (74.9-148.9)	109.2 (74.5-158.7)	116.5 (82.2-173.9)
Glucose [mg/dl]	97.2 (90.1-110.3)	101.9 (93.7-113.2)	98.8 (90.8-111.5)
Uric acid [mg/dl]	4.9 ±1.2	4.8 (4.0-5.7)	4.8 ±1.4
Homocysteine [µmol/l]	14.0 (12.5-17.0)	14.45 (12.2-16.8)	14.8 (12.9-17.1)
Blood platelets [10^3/mm^3]	207.0 ±48.1	223.6 ±50.1*	214.5 (173.0-250.5)
SBP [mmHg]	133.5 ±17.0	143.4 ±17.0*	134.5 ±16.0#
DBP [mmHg]	80.0 (72.0-88.0)	87.0±11.7*	81.9 ±12.4#
Metabolic syndrome	63%	69%	63%
PA-EE [kcal/kg^{-1} day^{-1}]	41.3 (37.3-48.6)	49.6 ±7.6*	41.0 (37.5-44.7)#
Stanford moderate PA-HRB I	3.0 (1.0-4.0)	3.0 (1.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0(0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	17%	12%	18%
Diseases and drugs	**n**	**n**	**n**
HA	50	53	54
Hypercholesterolemia	60	67	71
Smoking	20	26	23
DM 2	10	13	12
MI	5	4	6
IHD	11	13	19
Stroke	4	4	4
Obesity	30	33	32
Antiplatelet drugs	16	15	23
B-blocker	26	28	31
Ca-blocker	13	13	7
Angiotensin converting enzyme inhibitor	21	27	22
Angiotensin II receptor blocker	12	6	9
Diuretics	24	23	10
Hypolipemic drugs	21	26	30
Antidiabetics	9	14	11

* statistically different from white-collar; # statistically different from manual workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease.

The prevalence of cardiovascular diseases and risk factors throughout the whole studied population was as follows: hypercholesterolemia - 66%, HA - 52.33%, DM2 - 11.67%, previous myocardial infarction (MI) - 5%, ischaemic heart disease (IHD) - 14.33%, previous stroke - 4%, obesity (counted as a BMI equal or greater than 30kg*m^{-2}) - 31.67%, and metabolic syndrome - 65% of subjects. No differences were seen between the three groups regarding the incidence of diseases or drug intake.

Regarding the female respondents, the unemployed subjects were significantly older than working subjects, and those in white-collar work were better educated than the other two groups.

Manual workers were significantly more obese (WHR), with higher SBP and PA-EE values, than the white-collar and unemployed groups. The women in manual work had higher platelet count and DBP in than those in white-collar positions, and displayed significantly higher UA concentration than unemployed respondents. Table 2a displays differences between groups of women in more detail.

Table 2a. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups of women.

Variable	**White-collar female workers Mean ±SD or median (quartiles) n=50**	**Manual female workers Mean ±SD or median (quartiles) n=50**	**Unemployed females Mean ±SD or median (quartiles) n=50**
Age [years]	62 (61-64)	62 (61-63)	63 (63-64)* #
Education [years]	14.5 (12-17)	13 (11-14)*	13 (12-16)*
BMI [kg/m²]	27.6 ±4.4	28.24 (25.3-31.3)	27.0 (23.4-31.6)
Waist circumference (cm)	88.5 (81-97)	93 (86-100)	85.5 (77.5-100)
WHR	0.8 ±0.1	0.9 ±0.1*	0.8 ±0.1#
TC [mg/dl]	214.5 (185.0-249.0)	221.3 ±51.5	216.4 ±44.3
LDL [mg/dl]	140.4 (104.9-156.3)	143.7 ±41.1	134.5 ±41.9
HDL [mg/dl]	52.9 (45.4-69.0)	51.2 (45.2-51.9)	57.0 ±14.6
TG [mg/dl]	107.9 (78.6-159.8)	114.7 (74.0-158.7)	113.0 (76.8-159.4)
Glucose [mg/dl]	95.8 (89.0-105.6)	101.6 (92.6-108.9)	94.7 (88.7-106.9)
Uric acid [mg/dl]	4.4 ±1.2	4.3 (3.9-5.1)	3.8 (3.2-4.9)#
Homocysteine [µmol/l]	13.3 (11.9-16.2)	14.25 (12.1-15.9)	14.3 (12.7-16.0)
Blood platelets [10³/mm³]	220.1 ±45.9	246.2 ±46.7*	224.5 (196-256)
SBP [mmHg]	130.5 ±15.48	140.5 ±15.1*	133.1 ±13.2#
DBP [mmHg]	78.2 ±11.6	84.6 ±9.9*	80.5 ±11.9
Metabolic syndrome	27 (54%)	30 (60%)	22 (44%)
PA-EE [kcal/kg^{-1} day^{-1}]	44.1 (38.7-48.7)	50.52 ±7.33*	41.0 (38.1-43.8)#
Stanford moderate- PA-HRB I	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	8 (16%)	5 (10%)	10 (20%)
Diseases and drugs	**n**	**n**	**n**
HA	24	23	21
Hypercholesterolemia	34	35	36
Smoking	13	12	6
DM 2	4	7	5
MI	1	0	1
IHD	6	5	6
Stroke	3	2	1
Obesity	17	16	14
Antiplatelet drugs	6	9	13
B-blocker	15	14	15
Ca-blocker	5	5	2
Angiotensin converting enzyme inhibitor	10	13	10
Angiotensin II receptor blocker	10	3	4
Diuretics	12	12	5
Hypolipemic drugs	9	12	13
Antidiabetics	3	7	5

* statistically different from white-collar; # statistically different from manual workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Regarding the men, white-collar workers were better educated than manual workers and unemployed men. Manual workers had significantly higher SBP, DBP and PA-EE than the other two groups. Unemployed men had higher TG and lower HDL-C than the white-collar workers. No differences were found between the three groups concerning PA-HRB, either with or without division by sex. These differences are highlighted in Table 2b.

Table 2b. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups of men.

Variable	White-collar male workers Mean ±SD or median (quartiles) n=50	Manual male workers Mean ±SD or median (quartiles) n=50	Unemployed men Mean ±SD or median (quartiles) n=50
Age [years]	63 (61-64)	63 (61-65)	63 (63-65)
Education [years]	16 (13-17)	12.0 (11.0-13.0)*	12.0 (11.0-13.0)*
BMI [kg/m²]	27.8 ±3.5	28.0 (25.5-32.1)	27.7±4.3
Waist circumference (cm)	98.5 (94-106)	103 (95-114.5)	102 (94-109.5)
WHR	1.0 ±0.1	1.0 ±0.1	1.0 ±0.1
TC [mg/dl]	197.8±35.8	190.3 ±37.4	192.5 ±40.1
LDL [mg/dl]	124.9 ±30.8	117.9 ±31.3	120.1 ±34.1
HDL [mg/dl]	48.2 (39.3-54.0)	44.7 (39.2-52.5)	41.5 (36.6-48.4)*
TG [mg/dl]	104.4 (70.9-139.3)	106.0 (74.9-158.6)	123.1 (88.3-188.5)*
Glucose [mg/dl]	99.2 (92.2-112.4)	102.3 (96.1-114.7)	102.3 (93.9-114.1)
Uric acid [mg/dl]	5.3 ±1.0	5.3 ±1.2	5.5 ±1.1
Homocysteine [µmol/l]	16.0 ±3.7	14.7 (12.7-17.5)	15.9 ±3.9
Blood platelets [10^3/mm³]	193.7 ±47.0	201.5 ±43.3	187.5 (165.0-237.0)
SBP [mmHg]	135 (125-145)	146.3 ±18.4*	135.9 ±18.3#
DBP [mmHg]	82 (75-93)	89.4 ±12.9*	83.2 ±12.8#
Metabolic syndrome	36 (72%)	39 (78%)	41 (82%)
PA-EE [kcal/kg^{-1} day^{-1}]	40.0 (36.6-48.1)	48.7 ±7.9*	40.9 (37.3-45.0)#
Stanford moderate- PA-HRB I	3.0 (1.0-4.0)	2.5 (1.0-4.0)	2.5 (1.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	9 (18%)	7 (14%)	8 (16%)
Diseases and drugs	**n**	**n**	**n**
HA	26	30	33
Hypercholesterolemia	26	32	35
Smoking	7	14	17
DM 2	6	6	7
MI	4	4	5
IHD	5	8	13
Stroke	1	2	3
Obesity	13	17	18
Antiplatelet drugs	10	6	10
B-blocker	11	14	16
Ca-blocker	8	8	5
Angiotensin converting enzyme inhibitor	11	14	12
Angiotensin II receptor blocker	2	3	5
Diuretics	12	11	5
Hypolipemic drugs	12	14	17
Antidiabetics	6	7	6

* statistically different from white-collar; # statistically different from manual workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Table 3 describes correlations between PA-EE, PA-HRB and major cardiovascular risk factors. In the whole studied group, PA-EE was directly related to SBP. Subjects with higher PA-HRB I showed lower body mass indices, lower TG, glucose, UA concentration and had a lower incidence of metabolic syndrome. Higher PA-HRB II was related to lower body mass indices, lower TG, glucose, higher HDL-C and lower frequency of metabolic syndrome. Women with higher PA-EE had higher WHR, while those with higher PA-HRB (both moderate and hard) had lower body mass indices (BMI and BMI/WHR respectively). Higher PA-HRB I correlated with lower TG, glucose and UA; higher PA-HRB II was associated with higher HDL-C and lower glucose and UA concentration. In men, higher PA-EE was

related to lower concentration of Hcy and higher SBP. Both PA-HRB I and PA-HRB II correlated negatively with WHR, and PA-HRB II also correlated negatively with BMI. Higher PA-HRB II was associated with lower TG, higher HDL-C and lower frequency of metabolic syndrome (Table 3).

Interestingly, in the whole group, PA-HRB I and PA-HRB II levels correlated with PA-EE (rho=0.17; p=0.003 and rho=0.18; p=0.002, respectively) but not with each other. PA-EE was related to PA-HRB I and PA-HRB II in men but only to PA-HRB II in women (not shown in the table).

Table 3. Associations (Spearman correlations; Mann-Whitney for metabolic syndrome) between PA indices and cardiovascular risk profile in the whole studied population and in groups according to sex.

	PA	BMI	WHR	TC	TG	HDL-C	LDL-C	Glucose	UA	Hcy	SBP	DBP	Metabolic syndrome
All participants N=300	PA-EE	0.02 (p=0.72)	0.02 (p=0.72)	0.03 (p=0.57)	-0.003 (p=0.95)	0.006 (p=0.91)	0.03 (p=0.55)	-0.02 (p=0.75)	-0.002 (p=0.97)	-0.06 (p=0.29)	0.14 (p=0.01)	0.06 (p=0.24)	p=0.77
	PA-HRBI	-0.18 (p=0.002)	-0.19 (p=0.001)	-0.003 (p=0.95)	-0.13 (p=0.02)	0.06 (p=0.26)	0.02 (p=0.73)	-0.19 (p=0.001)	-0.18 (p=0.001)	0.02 (p=0.72)	-0.03 (p=0.56)	0.04 (p=0.44)	p=0.019↓
	PA-HRBII	-0.19 (p=0.001)	-0.17 (p=0.003)	0.05 (p=0.35)	-0.15 (p=0.008)	0.18 (p=0.001)	0.05 (p=0.38)	-0.12 (p=0.03)	-0.10 (p=0.07)	0.01 (p=0.77)	0.01 (p=0.86	(-0.05 (p=0.35)	p=0.004↓
Women N=150	PA-EE	-0.02 (p=0.78)	0.17 p=0.03)	0.02 (p=0.77)	0.02 (p=0.81)	-0.11 (p=0.19	0.053 (p=0.52)	-0.08 (p=0.31)	-0.06 (p=0.48)	0.09 (p=0.25)	0.13 (p=0.10)	0.07 (p=0.37)	p=0.30
	PA-HRBI	-0.23 (p=0.004)	-0.14 (p=0.09)	0.01 (p=0.85)	-0.16 (p=0.05)	0.08 (p=0.28)	0.04 (p=0.57)	-0.22 (p=0.007)	-0.28 (p=0.000)	0.02 (p=0.81)	-0.08 (p=0.32)	0.03 (p=0.67)	p=0.17
	PA-HRBII	-0.21 (p=0.01)	-0.22 (p=0.006)	0.05 (p=0.51)	-0.14 (p=0.92)	0.20 (p=0.01)	0.03 (p=0.67)	-0.17 (p=0.03)	-0.19 (p=0.01)	0.15 (p=0.07)	-0.03 (p=0.69)	-0.01 (p=0.95)	P=0.07
Men N=150	PA-EE	0.07 (p=0.42)	-0.03 (p=0.71)	0.01 (p=0.89	-0.01 (p=0.85)	0.09 (p=0.25)	-0.01 (p=0.84)	0.56 (p=0.49)	0.10 (p=0.19)	-0.19 (p=0.01)	0.16 (p=0.05)	0.08 (p=0.31)	P=0.47
	PA-HRBI	-0.12 (p=0.15)	-0.29 (p=0.000)	-0.07 (p=0.38)	-0.10 (p=0.21)	0.001 (p=0.99)	-0.05 (p=0.57)	-0.15 (p=0.07)	-0.61 (p=0.46)	0.04 (p=0.62)	0.02 (p=0.80)	0.07 (p=0.37	p=0.11
	PA-HRBII	-0.17 (p=0.04)	-0.29 (p=0.000)	0.07 (p=0.37)	-0.16 (p=0.04)	0.20 (p=0.01)	0.09 (p=0.28)	-0.07 (p=0.38)	-0.04 (p=0.66)	-0.12 (p=0.13	0.04 (p=0.61)	-0.10 (p=0.20)	p=0.009↓

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy-homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PLT- blood platelets, PA-EE-physical activity related to energy expenditure, PA-HRB I - physical activity moderate health related behaviours, PA-HRB II - physical activity hard health related behaviours. No correlation for PLT count was found. ↓ - decreases incidence of metabolic syndrome

Multivariate analyses

General linear model and logistic regression were further used to select variables that independently predict major cardiovascular risk factors (Table 4). PA-HRB I was an independent predictor of lower BMI, WHR, glucose, UA and frequency of metabolic syndrome. PA-HRB II decreased BMI, WHR, TG, glucose and frequency of metabolic syndrome while increasing HDL-C level. White-collar workers had lower SBP and DBP while manual workers had higher SPB, DBP as well as WHR when compared to unemployed subjects. Women had higher TC, HDL-C, LDL-C and Hcy but lower WHR, glucose, UA, SBP, DBP and frequency of metabolic syndrome as compared to men. Smoking was an independent predictor of higher TG levels. Hypolipemic drugs use was related to lower TC and LDL-C, ACEI use to lower LDL-C and antidiabetics intake was associated with lower Hcy levels (Table 4).

Tab. 4 Independent variables selected in multivariate analyses influencing cardiovascular risk profile in the whole studied population (n=300).

	BMI	WHR	TC	TG	HDL-C	LDL-C	Glucose	UA	Hcy	SBP	DBP	Metabolic syndrome
PA	PA-HRBI↓ PA-HRBII↓	PA-HRBI↓ PA-HRBII↓		PA-HRBII↓	PA-HRBII↑		PA-HRBI↓ PA-HRBII↓	PA-HRBI↓				PA-HRBI↓ PA-HRBII↓
Occupational status – unemployed as a reference group		White-collar↔ Manual↑								White-collar ↓ Manual ↑	White-collar ↓ Manual↑	
Sex		Female sex↓	Female sex↑		Female sex↑	Female sex↑	Female sex↓	Female sex↓	Female sex↑	Female sex↓	Female sex↓	Female sex↓
Smoking and drugs			Hypolipemic drugs ↓	Smoking↑		Hypolipemic drugs ↓ ACEI ↓			Antidiabetics ↓			

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy-homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PLT- blood platelets, PA-EE-physical activity related to energy expenditure, PA-HRB I - physical activity moderate health-related behaviours, PA-HRB II - physical activity hard health-related behaviours, ACEI - Angiotensin converting enzyme inhibitors. No correlation for PLT count was found. ↑ - increase; ↓ - decrease; ↔ - no difference

Discussion

The major finding of the present study is that in 60-65 year-old subjects, physical activity (PA)-related behaviours have a greater influence on cardiometabolic risk than overall energy expenditure or employment status. The prevalence of cardiometabolic diseases is similar across this group of pre-elderly subjects, independent of workload, with no apparent relationship being found between PA and health status. However, the prevalence of cardiometabolic risk factors was found to vary depending on workload, with the group of manual workers displaying the worst profile.

Manual workers presented higher indices for body mass than white-collar workers and unemployed subjects, with WHR being significantly greater. Nevertheless, all three groups demonstrated similar levels of obesity, defined as BMI equal or greater than 30kg/m^2. Some indications exist that occupational PA may have a protective impact against obesity[31,37]; however, our data indicates that higher body mass indices in 60- to 65-year-old subjects are associated with the higher PA-EE scores observed in the manual labour group, which is coherent with some literature data[27].

As the highest values of blood pressure were observed in the manual labour group, hypertension may be associated with physical workload[38]. Despite demonstrating a similar ratio of hypertensive treatment and diagnosed HA to the other groups, manual workers presented higher BP. Engaging in physical work each working day for several hours may result in elevated blood pressure and increased cardiovascular risk[1,39]. Furthermore, some studies characterise manual labourers with the highest rate of obesity, another important risk factor for hypertension[40]. Importantly, despite the fact that over 50% of subjects were diagnosed with HA, BP measures indicate that manual workers may be still underdiagnosed and undertreated. Furthermore, manual work may be associated with other sex-related cardiovascular risk factors, i.e. higher glucose and UA concentration among women and greater lipid imbalance among men. Overall, these results indicate that of the three tested professional groups, the highest global cardiovascular risk is found among manual workers.

One of the most important findings is that in contrast to leisure-time PA, higher work-related PA (PA-EE) demonstrated no negative association with cardiovascular risk factors. PA-EE demonstrates no association with BMI, WHR, lipid fractions or glucose. This may indicate that PA related to work or occupational activity has no positive impact on basic cardiovascular risk factors, or that this impact is counterbalanced by other risk factors. Furthermore, it is possible that work-related PA may have a negative impact on some cardiovascular risk factors, i.e. to increased blood pressure. Among the whole group, PA-EE was connected with higher SBP. This correlation may be explained by the fact that manual workers, those with highest PA-EE, presented increased blood pressure values. Within the sample, the men with the greatest energy expenditure tended to present not only the lowest education level (manual workers) but interestingly, also the lowest Hcy concentration. Some literature data indicates that PA may decrease Hcy level[37]. Therefore, among the tested older subjects, the overall worse cardiometabolic risk profile displayed by manual workers is counterbalanced by higher PA-EE, as compared to white-collar workers and unemployed subjects. However, PA-HRB appears to have a closer relationship with cardiometabolic risk profile than PA-EE, which may be related to the relationship between PA-EE profile and socioeconomic status.

Both moderate and hard PA-HRBs were found to exert beneficial impact on body mass indices and improve metabolic markers such as TG (both PA-HRB I and II), HDL-C (PA-HRBII) glucose (both PA-HRBI and II) or UA (PA-HRBI). All these correlations are consistent with previous findings [41-43].

When analysed according to sex, these observations were found to apply particularly closely to the group of women. In the case of men, PA-HRB may decrease body mass indices (BMI, WHR) and improve the concentrations of lipids like TG or HDL-C; although, in case of lipids, this relationship was only observed for PA-HRBII. It should be emphasized that the Stanford Usual Activity questionnaire assesses different dimensions of non-work-related PA. PA-HRB I and PA-HRB II were not found to be interrelated; however, each was associated with PA-EE.

To the best of our knowledge this is the first work to compare cardiovascular risk factors and different dimensions of PA in three groups of seniors according to type of the employment status. Its key strength is its sex and age-matching of subjects. However, the present cross-sectional study has some limitations. PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be incorrect. Finally, our findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Practical implications

All presented data suggest that promoting everyday life and leisure time PA behaviour is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in manual workers with high work-related energy expenditure. Whether that beneficial effect results only from PA *per se* or also from social and health awareness behaviours requires further prospective studies.

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Competing interest statement

The authors declare no competing financial interest.

Contributorship statement

Hereby we present contribution of work in the presented publication:

Bartłomiej K. Sołtysik

- recruitment of subjects, medical history, physical examination, anthropometric examination, database preparation, basic statistical calculations, manuscript writing;

Joanna Kostka

- conducting questionnaire surveys on physical activity, performing statistical calculations on cardiovascular risk factors and physical activity, substantive supervision, manuscript drafting and revising;

Kamil Karolczak

- laboratory tests conduction, substantive supervision, manuscript revising;

Cezary Watała

- laboratory tests conduction, substantive supervision, manuscript revising;

Tomasz Kostka

- preparing of the study design, performing statistical calculations, substantive supervision, manuscript drafting and revising.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found Page 1
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported Page 3
Objectives	3	State specific objectives, including any prespecified hypotheses Page 4
Methods		
Study design	4	Present key elements of study design early in the paper Page 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection Page 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants Page 5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable Page 5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group Page 5 and 6
Bias	9	Describe any efforts to address potential sources of bias Page 6
Study size	10	Explain how the study size was arrived at Page 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding Page 6/7
		(*b*) Describe any methods used to examine subgroups and interactions Page 6/7
		(*c*) Explain how missing data were addressed
		(*d*) If applicable, describe analytical methods taking account of sampling strategy Page 6/7
		(*e*) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study,

		completing follow-up, and analysed Page 5
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram unnecessary
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders Page 5
		(b) Indicate number of participants with missing data for each variable of interest -
Outcome data	15*	Report numbers of outcome events or summary measures -
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included Page 7-15
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses Page 7-15
Discussion		
Key results	18	Summarise key results with reference to study objectives Page 16-17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias Page 16-17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence Page 16-17
Generalisability	21	Discuss the generalisability (external validity) of the study results Page 16-17
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based Page 17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

What is the most important determinant of cardiometabolic risk in 60-65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland.

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Keywords:	white-collar workers, occupational status, cardiovascular risk factors, metabolic syndrome, pre-elderly, blue-collar workers

What is the most important determinant of cardiometabolic risk in 60-65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland.

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Abstract:

Objectives: The aim of the study was to determine whether cardiovascular risk factors may differ according to occupational status and whether physical activity related to total energy expenditure (PA-EE) and related to health related behaviours (PA-HRB) is associated with common cardiovascular risk factors or metabolic syndrome in pre-elderly subjects.

Methods: Three hundred subjects aged 60-65, were recruited and divided into three equal groups of white-collar, blue-collar workers and unemployed subjects; 50% were women. The subjects were tested for major cardiovascular risk factors such as smoking, anthropometric indices, blood pressure, lipid levels, glucose, uric acid and homocysteine. PA-EE and PA-HRB were assessed with PA questionnaires.

Results: Blue-collar workers displayed higher anthropometric indices, blood pressure and higher PA-EE in comparison with other two group. PA-HRB had a positive impact on body mass indices, lipids, glucose, uric acid and the prevalence of metabolic syndrome, with no such relationship observed for PA-EE.

Conclusions: The greatest cardiovascular risk was observed in the blue-collar workers group. Only PA-HRB had a positive association with cardiometabolic risk profile. No relationship was observed for PA-EE. Thus, promoting everyday life and leisure time PA behaviours is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in blue-collar workers with high work-related energy expenditure.

Article Summary

Strengths and limitations of the study:

- Three sex- and age-matched groups of subjects with different occupational status were recruited in the study.
- The paper promotes the idea that everyday life and leisure time PA behaviours are crucial for preventing cardiometabolic risk in pre-elderly subjects, even in blue-collar workers with high work-related energy expenditure.
- PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be biased.
- The findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Key words: white-collar workers, blue-collar workers, occupational status, cardiovascular risk factors, metabolic syndrome, pre-elderly.

Introduction:

Cardiometabolic diseases are a major cause of death and important reason of disability in developed countries. The occurrence of cardiovascular disease is related to the presence of risk factors. Smoking increases morbidity and mortality associated with cardiovascular diseases[1-2]. Abdominal distribution of fat has a negative impact on blood pressure (BP), lipid metabolism, glucose tolerance or insulin resistance[3]. Obesity correlates with left ventricular hypertrophy, and weight reduction is a factor restoring normal heart muscle mass [4]. Cardiovascular risk is related to high blood pressure, especially to isolated systolic hypertension as a cause of coronary heart disease and stroke[5-6]. Hyperglycaemia is associated with increased risk of coronary heart disease. Diabetes worsens the long term prognosis for life expectancy[7], as 2/3 of diabetic deaths are related to cardiovascular disease[8]. Atherosclerosis is positively correlated with low density lipoprotein cholesterol (LDL-C) but negatively with high density lipoprotein cholesterol (HDL-C) concentration [9]. Homocysteine(Hcy) accelerates the development of atherosclerosis by enhancing the proliferation of vascular myocytes, endothelial dysfunction, oxidative stress and collagen synthesis, resulting in a deterioration of the elasticity of blood vessels[10].

The elongation of the working period reinforces the need for research into how employment status influences the risk factors among seniors. The nature of work seems to have a direct impact on cardiovascular risk. Available data indicates that of various working groups, blue-collar workers demonstrate the greatest cardiovascular risk [11] and that their workload may increase the risk of coronary heart disease[12]. The prolonged working time of middle-aged men, especially those with current cardiovascular disease, can cause the progression of carotid atherosclerosis[13]. There is some evidence that blue-collar work may be related to greater occurrence of increased blood pressure than white-collar work [14-15], even after adjustment for age, obesity or self-reported alcohol consumption[16]. Furthermore, studies on some areas of work highlight the impact of job strain on arterial hypertension[17]. Psychosocial factors (low economic status, social isolation, chronic stress or depression) have a negative impact on cardiovascular risk, and significantly worsen the effects of treatment and prognosis of patients who already have developed the disease [18].

Blue-collar workers have often been found to demonstrate a higher prevalence of daily smoking than white-collar co-workers[19-20]. Some data indicates also that the unemployed are heavier tobacco users than professional workers[21]. Subjects with occupations requiring lower qualifications may be more likely to demonstrate cardiovascular risk factors, such as obesity or lack of adequate physical activity (PA)[22]. Prevention in psychological factors or restoring a healthy lifestyle can reduce the risk or moderate the progression of cardiovascular disease[23].

Insufficient PA associated with a sedentary lifestyle increases cardiovascular risk, and an adequate level of activity can prolong the lifespan[24-26]. Moderate or strong PA inhibits the development of atherosclerosis and reduces total mortality by 20-25% [27], which has been attributed to a range of effects such as reducing body weight, improving glucose tolerance[28] or lipid profile. Blue-collar workers usually report high PA as a consequence of work conditions[29]. The relationship observed between unemployment and low PA may be connected with higher susceptibility for cardiovascular diseases[30].

It has recently been shown that sub-populations of older people differ with regard to their level of PA and its association with sociodemographic data and concomitant diseases[31]. Furthermore, the relationship between PA and health profile may vary depending on the PA assessment methodology (PA related energy expenditure – PA-EE and PA-related health-related behaviors – PA-HRB). One of the most important questions in contemporary geriatric and occupational medicine is how socioeconomic status, workload and PA co-determine cardiovascular risk with regard to prolonged working time. Therefore, the aim of this work was to identify the occurrence of cardiovascular risk factors and diseases, and determine their relationships with different aspects of PA in three groups of pre-elderly: white-collar workers, blue-collar workers and unemployed seniors.

Methods

Subjects

The study was conducted in three age- and sex-matched groups of inhabitants of the Łódź region aged 60 to 65 years. Participants were divided into three groups depending on the character of their professions: white-collar workers, blue-collar workers and unemployed subjects. The subjects were recruited through local media (TV, radio and newspapers). All the volunteers were initially checked for the basic recruitment criteria and classified according to the occupational status. As blue-collar workers were the least common group in this age range, they were qualified first for the study. An age- and sex-matched consecutive peer was assigned for each recruited worker from the white-collar and unemployed groups. Each group included 100 volunteers (50 men and 50 women). The procedure for defining the type of profession has been described previously in a work concerning differences in the quality of work and life among the three senior groups[32].

Subjects were asked about the presence of arterial hypertension (HA), diabetes mellitus type 2 (DM2), dyslipidaemia and smoking habit. Blood pressure was measured twice with an auscultation sphygmomanometer in accordance with the current guidelines[33]. Fasting blood samples were drawn from the antecubital vein into test tubes. The blood serum was assayed spectrophotometrically for fasting glucose concentration, total cholesterol (TC), LDL-C, HDL-C, triglycerides (TG), uric acid (UA) (DIRUI CS 400, Changchun, China). Hcy was estimated in blood serum by immunochemiluminescence (Immulite 2000XPi analyser, Siemens, Germany). Blood morphology was evaluated with 5-Diff Sysmex XS-1000i haematological analyser (Sysmex, Kobe, Japan). Weight and height were measured in participants while barefoot, and waist and hip circumference were measured [34]; Body mass index (BMI) and waist-hip ratio (WHR) were then calculated based on the results. Metabolic syndrome was assessed according to International Diabetes Federation[35].

Physical activity assessment

Physical activity was assessed by two popular PA questionnaires: the Seven-Day Recall PA Questionnaire[36] and the Stanford Usual Activity Questionnaire[37]. Both questionnaires used in the present study have been previously described in detail[38]. Both have demonstrated high validity in older individuals against doubly labelled water and have been assessed in the present study in accordance with standardized protocols[31,39].

All participants were informed that the questionnaires were anonymous and that only the researchers will have access to the results. For the Seven-Day Recall PA Questionnaire, a list of examples of different level of activities was included. Additionally, if in doubt, participants were allowed to ask questions to the interviewer.

The Seven-Day Recall PA Questionnaire determines the hours spent sleeping for the week, sums up the time spent in light (activities with energy expenditure of 1.5 $kcal \cdot min^{-1}$), moderate (activities with energy expenditure of 4 $kcal \cdot min^{-1}$), hard (activities with energy expenditure of 6 $kcal \cdot min^{-1}$), and very hard (activities with energy expenditure of 10 $kcal \cdot min^{-1}$) activities and estimates overall weekly energy expenditure through analysis of PA during the previous seven days. The Seven-Day Recall Total score (total energy expenditure over past week – $kcal \cdot kg^{-1} \cdot day^{-1}$) was then calculated and used for further comparisons as PA-energy expenditure (PA-EE).

The Stanford moderate index allows an assessment of health-related PA behaviors of light and moderate intensity. The respondents indicate the type of behavior typical of their exercise habits: climbing the stairs instead of using the elevator, walking instead of driving for a short distance, parking the car further away from the destination in order to approach on foot, walking before or after lunch or dinner, exiting the bus or tram a stop earlier in order to walk the remaining distance, or performing other activities of a similar nature. In the Stanford Hard (vigorous) index, the respondent indicates the following activities performed regularly for at least the last three months: jogging or running at least 10 miles per week, play strenuous racquet sports at least five hours per week, play other strenuous sports at least five hours per week, ride a bicycle at least 50 miles per week, swim at least two miles per week. The Stanford Moderate (six habitual moderate activities; scoring points 0-6) and Hard (five habitual intensive activities; scoring points 0-5) indices were calculated as a numerical sum of points for each activity and used for further comparisons. These two PA indices are expressed as PA-health-related behaviors I (PA-HRB I) and PA-health-related behaviors II (PA-HRB II), respectively.

Statistical analysis

Data was verified for normality of distribution and equality of variances. The one-way analysis of variance (ANOVA) with Tukey post hoc testing, Kruskal-Wallis test, and 3x2 chi-square test were used to compare the three groups. The Student's t-test, Mann-Whitney test and chi-square test (2x2 with Yates' correction) were used to make comparisons between the two groups with applied Bonferroni correction. The correlations were assessed with Spearman's correlation coefficients. The results of the quantitative variables are presented as mean ± (standard deviation) or median (interquartile ranges). Multivariate analyses were performed to identify factors independently predicting cardiometabolic risk, general linear models were constructed for the main cardiovascular risk factors and logistic regression was employed for dichotomized variables. All the variables statistically significant in bivariate relationships were entered into the multivariate analyses. Age, sex, occupational status, physical activity variables, smoking and drugs were taken into consideration as

potential independent variables. Non-normally distributed variables were log-transformed for the purpose of multivariate analyses; however, the results are presented in standard values. PA-HRB II was dichotomized for multivariate analyses as no PA-HRB II versus at least one PA-HRB II. The limit of significance was regarded as p≤0.05 for all analyses. Statistical analysis were performed using Statistica 12 software.

Ethical considerations

The study was approved by the Ethics Committee of the Medical University of Łódź (No RNN/648/14/KB). All subjects signed an informed consent form prior to participation in the study.

Data sharing statement

No additional data available.

Patient and public involvement statement

The study design was based on the fact that Łódź region is one with the fastest ageing population in Europe. The study was important for the understanding of the impact of occupational status on cardiovascular risk among pre-elderly seniors. The respondents obtained information on individual test results. In addition, they are informed about the results obtained on the basis of the collected data.

No additional involvement of patients has been stated.

Results

Table 1 presents differences between the three working group. The median age of the unemployed subjects was slightly higher than those of both working groups. White-collar workers were better educated than blue-collar workers and the unemployed subjects. Blue-collar workers presented higher WHR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and PA-EE than the other two groups. Blue-collar workers also presented a significantly higher platelet count in comparison with white-collar workers.

Table 1. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups.

Variable	**White-collar workers Mean ±SD or median (quartiles) n=100**	**Blue-collar workers Mean ±SD or median (quartiles) n=100**	**Unemployed subjects Mean ±SD or median (quartiles) n=100**
Age [years]	62.5 (61-64)	62 (61-64)	63 (63-64)*#
Education [years]	15.5 (12.5-17)	12 (11-13)*	12 (11-14.5)*
BMI [kg/m^2]	27.7 ±3.9	28.2 (25.5-31.5)	27.5 (23.9-30.8)
Waist circumference (cm)	95 (87.5-102)	97 (90-107.7)*	96 (83-105)
WHR	0.9 (0.8-1.0)	0.9 ±0.1*	0.9 (0.8-1.0)#
TC [mg/dl]	207.4 (178.6-233.5)	203.5 (172.5-235.0)	203.1 (167.1-239.3)
LDL [mg/dl]	126.5 (103.3-152.1)	130.9 ±38.6	127.4 ±38.8
HDL [mg/dl]	50.0 (42.5-57.6)	46.9 (40.7-56.2)	47.9 (39.9-59.6)
TG [mg/dl]	107.7 (74.9-148.9)	109.2 (74.5-158.7)	116.5 (82.2-173.9)
Glucose [mg/dl]	97.2 (90.1-110.3)	101.9 (93.7-113.2)	98.8 (90.8-111.5)
Uric acid [mg/dl]	4.9 ±1.2	4.8 (4.0-5.7)	4.8 ±1.4
Homocysteine [µmol/l]	14.0 (12.5-17.0)	14.45 (12.2-16.8)	14.8 (12.9-17.1)
Blood platelets [$10^3/mm^3$]	207.0 ±48.1	223.6 ±50.1*	214.5 (173.0-250.5)
SBP [mmHg]	133.5 ±17.0	143.4 ±17.0*	134.5 ±16.0#
DBP [mmHg]	80.0 (72.0-88.0)	87.0±11.7*	81.9 ±12.4#
Metabolic syndrome	63%	69%	63%
PA-EE [kcal/kg^{-1} day^{-1}]	41.3 (37.3-48.6)	49.6 ±7.6*	41.0 (37.5-44.7)#
Stanford moderate PA-HRB I	3.0 (1.0-4.0)	3.0 (1.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0(0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	17%	12%	18%
Diseases and drugs	**n**	**n**	**n**
HA	50	53	54
Hypercholesterolemia	60	67	71
Smoking	20	26	23
DM 2	10	13	12
MI	5	4	6
IHD	11	13	19
Stroke	4	4	4
Obesity	30	33	32
Antiplatelet drugs	16	15	23
B-blocker	26	28	31
Ca-blocker	13	13	7
Angiotensin converting enzyme inhibitor	21	27	22
Angiotensin II receptor blocker	12	6	9
Diuretics	24	23	10
Hypolipemic drugs	21	26	30
Antidiabetics	9	14	11

* statistically different from white-collar; # statistically different from blue-collar workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease.

The prevalence of cardiovascular diseases and risk factors throughout the whole studied population was as follows: hypercholesterolemia - 66%, HA - 52.33%, DM2 - 11.67%, previous myocardial infarction (MI) - 5%, ischaemic heart disease (IHD) - 14.33%, previous stroke - 4%, obesity (counted as a BMI equal or greater than 30kg*m^{-2}) - 31.67%, and metabolic syndrome - 65% of subjects. No differences were seen between the three groups regarding the incidence of diseases, smoking prevalence or drug intake.

Regarding the female respondents, the unemployed subjects were significantly older than working subjects, and those in white-collar work were better educated than the other two groups. Blue-collar workers were significantly more obese (WHR), with higher SBP and PA-EE values, than the white-collar and unemployed groups. The women in blue-collar work had higher platelet count and DBP in than those in white-collar positions, and displayed significantly higher UA concentration than unemployed respondents. Table 2a displays differences between groups of women in more detail.

Table 2a. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups of women.

Variable	**White-collar female workers Mean ±SD or median (quartiles) n=50**	**Blue-collar female workers Mean ±SD or median (quartiles) n=50**	**Unemployed females Mean ±SD or median (quartiles) n=50**
Age [years]	62 (61-64)	62 (61-63)	63 (63-64)* #
Education [years]	14.5 (12-17)	13 (11-14)*	13 (12-16)*
BMI [kg/m²]	27.6 ±4.4	28.24 (25.3-31.3)	27.0 (23.4-31.6)
Waist circumference (cm)	88.5 (81-97)	93 (86-100)	85.5 (77.5-100)
WHR	0.8 ±0.1	0.9 ±0.1*	0.8 ±0.1#
TC [mg/dl]	214.5 (185.0-249.0)	221.3 ±51.5	216.4 ±44.3
LDL [mg/dl]	140.4 (104.9-156.3)	143.7 ±41.1	134.5 ±41.9
HDL [mg/dl]	52.9 (45.4-69.0)	51.2 (45.2-51.9)	57.0 ±14.6
TG [mg/dl]	107.9 (78.6-159.8)	114.7 (74.0-158.7)	113.0 (76.8-159.4)
Glucose [mg/dl]	95.8 (89.0-105.6)	101.6 (92.6-108.9)	94.7 (88.7-106.9)
Uric acid [mg/dl]	4.4 ±1.2	4.3 (3.9-5.1)	3.8 (3.2-4.9)#
Homocysteine [µmol/l]	13.3 (11.9-16.2)	14.25 (12.1-15.9)	14.3 (12.7-16.0)
Blood platelets [10³/mm³]	220.1 ±45.9	246.2 ±46.7*	224.5 (196-256)
SBP [mmHg]	130.5 ±15.48	140.5 ±15.1*	133.1 ±13.2#
DBP [mmHg]	78.2 ±11.6	84.6 ±9.9*	80.5 ±11.9
Metabolic syndrome	27 (54%)	30 (60%)	22 (44%)
PA-EE [kcal/kg⁻¹ day⁻¹]	44.1 (38.7-48.7)	50.52 ±7.33*	41.0 (38.1-43.8)#
Stanford moderate- PA-HRB I	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	8 (16%)	5 (10%)	10 (20%)
Diseases and drugs	**n**	**n**	**n**
HA	24	23	21
Hypercholesterolemia	34	35	36
Smoking	13	12	6
DM 2	4	7	5
MI	1	0	1
IHD	6	5	6
Stroke	3	2	1
Obesity	17	16	14
Antiplatelet drugs	6	9	13
B-blocker	15	14	15
Ca-blocker	5	5	2
Angiotensin converting enzyme inhibitor	10	13	10
Angiotensin II receptor blocker	10	3	4
Diuretics	12	12	5
Hypolipemic drugs	9	12	13
Antidiabetics	3	7	5

* statistically different from white-collar; # statistically different from blue-collar workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Regarding the men, white-collar workers were better educated than blue-collar workers and unemployed men. Blue-collar workers had significantly higher SBP, DBP and PA-EE than the other two groups. Unemployed men had higher TG and lower HDL-C than the white-collar workers. These differences are highlighted in Table 2b. No differences were found between the three groups concerning PA-HRB, incidence of diseases, smoking prevalence or drug intake either with or without division by sex.

Table 2b. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups of men.

Variable	White-collar male workers Mean ±SD or median (quartiles) n=50	Blue-collar male workers Mean ±SD or median (quartiles) n=50	Unemployed men Mean ±SD or median (quartiles) n=50
Age [years]	63 (61-64)	63 (61-65)	63 (63-65)
Education [years]	16 (13-17)	12.0 (11.0-13.0)*	12.0 (11.0-13.0)*
BMI [kg/m²]	27.8 ±3.5	28.0 (25.5-32.1)	27.7±4.3
Waist circumference (cm)	98.5 (94-106)	103 (95-114.5)	102 (94-109.5)
WHR	1.0 ±0.1	1.0 ±0.1	1.0 ±0.1
TC [mg/dl]	197.8±35.8	190.3 ±37.4	192.5 ±40.1
LDL [mg/dl]	124.9 ±30.8	117.9 ±31.3	120.1 ±34.1
HDL [mg/dl]	48.2 (39.3-54.0)	44.7 (39.2-52.5)	41.5 (36.6-48.4)*
TG [mg/dl]	104.4 (70.9-139.3)	106.0 (74.9-158.6)	123.1 (88.3-188.5)*
Glucose [mg/dl]	99.2 (92.2-112.4)	102.3 (96.1-114.7)	102.3 (93.9-114.1)
Uric acid [mg/dl]	5.3 ±1.0	5.3 ±1.2	5.5 ±1.1
Homocysteine [µmol/l]	16.0 ±3.7	14.7 (12.7-17.5)	15.9 ±3.9
Blood platelets [10^3/mm^3]	193.7 ±47.0	201.5 ±43.3	187.5 (165.0-237.0)
SBP [mmHg]	135 (125-145)	146.3 ±18.4*	135.9 ±18.3#
DBP [mmHg]	82 (75-93)	89.4 ±12.9*	83.2 ±12.8#
Metabolic syndrome	36 (72%)	39 (78%)	41 (82%)
PA-EE [kcal/kg^{-1} day^{-1}]	40.0 (36.6-48.1)	48.7 ±7.9*	40.9 (37.3-45.0)#
Stanford moderate- PA-HRB I	3.0 (1.0-4.0)	2.5 (1.0-4.0)	2.5 (1.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	9 (18%)	7 (14%)	8 (16%)
Diseases and drugs	**n**	**n**	**n**
HA	26	30	33
Hypercholesterolemia	26	32	35
Smoking	7	14	17
DM 2	6	6	7
MI	4	4	5
IHD	5	8	13
Stroke	1	2	3
Obesity	13	17	18
Antiplatelet drugs	10	6	10
B-blocker	11	14	16
Ca-blocker	8	8	5
Angiotensin converting enzyme inhibitor	11	14	12
Angiotensin II receptor blocker	2	3	5
Diuretics	12	11	5
Hypolipemic drugs	12	14	17
Antidiabetics	6	7	6

* statistically different from white-collar; # statistically different from blue-collar workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Table 3 describes correlations between PA-EE, PA-HRB and major cardiovascular risk factors. In the whole studied group, PA-EE was directly related to SBP. Subjects with higher PA-HRB I showed lower body mass indices, lower TG, glucose, UA concentration and had a lower incidence of metabolic syndrome. Higher PA-HRB II was related to lower body mass indices, lower TG, glucose, higher HDL-C and lower frequency of metabolic syndrome. Women with higher PA-EE had higher WHR, while those with higher PA-HRB (both moderate and hard) had lower body mass indices (BMI and BMI/WHR respectively). Higher PA-HRB I correlated with lower TG, glucose and UA; higher PA-HRB II was associated with higher HDL-C and lower glucose and UA concentration. In men, higher PA-EE was

related to lower concentration of Hcy and higher SBP. Both PA-HRB I and PA-HRB II correlated negatively with WHR, and PA-HRB II also correlated negatively with BMI. Higher PA-HRB II was associated with lower TG, higher HDL-C and lower frequency of metabolic syndrome (Table 3).

Interestingly, in the whole group, PA-HRB I and PA-HRB II levels correlated with PA-EE (rho=0.17; p=0.003 and rho=0.18; p=0.002, respectively) but not with each other. PA-EE was related to PA-HRB I and PA-HRB II in men but only to PA-HRB II in women (not shown in the table).

Table 3. Associations (Spearman correlations; Mann-Whitney for metabolic syndrome) between PA indices and cardiovascular risk profile in the whole studied population and in groups according to sex.

	PA	BMI	WHR	TC	TG	HDL-C	LDL-C	Glucose	UA	Hcy	SBP	DBP	Metabolic syndrome
All participants N=300	PA-EE	0.02 (p=0.72)	0.02 (p=0.72)	0.03 (p=0.57)	-0.003 (p=0.95)	0.006 (p=0.91)	0.03 (p=0.55)	-0.02 (p=0.75)	-0.002 (p=0.97)	-0.06 (p=0.29)	0.14 (p=0.01)	0.06 (p=0.24)	p=0.77
	PA-HRBI	-0.18 (p=0.002)	-0.19 (p=0.001)	-0.003 (p=0.95)	-0.13 (p=0.02)	0.06 (p=0.26)	0.02 (p=0.73)	-0.19 (p=0.001)	-0.18 (p=0.001)	0.02 (p=0.72)	-0.03 (p=0.56)	0.04 (p=0.44)	p=0.019↓
	PA-HRBII	-0.19 (p=0.001)	-0.17 (p=0.003)	0.05 (p=0.35)	-0.15 (p=0.008)	0.18 (p=0.001)	0.05 (p=0.38)	-0.12 (p=0.03)	-0.10 (p=0.07)	0.01 (p=0.77)	0.01 (p=0.86	(-0.05 (p=0.35)	p=0.004↓
Women N=150	PA-EE	-0.02 (p=0.78)	0.17 p=0.03)	0.02 (p=0.77)	0.02 (p=0.81)	-0.11 (p=0.19	0.053 (p=0.52)	-0.08 (p=0.31)	-0.06 (p=0.48)	0.09 (p=0.25)	0.13 (p=0.10)	0.07 (p=0.37)	p=0.30
	PA-HRBI	-0.23 (p=0.004)	-0.14 (p=0.09)	0.01 (p=0.85)	-0.16 (p=0.05)	0.08 (p=0.28)	0.04 (p=0.57)	-0.22 (p=0.007)	-0.28 (p=0.000)	0.02 (p=0.81)	-0.08 (p=0.32)	0.03 (p=0.67)	p=0.17
	PA-HRBII	-0.21 (p=0.01)	-0.22 (p=0.006)	0.05 (p=0.51)	-0.14 (p=0.92)	0.20 (p=0.01)	0.03 (p=0.67)	-0.17 (p=0.03)	-0.19 (p=0.01)	0.15 (p=0.07)	-0.03 (p=0.69)	-0.01 (p=0.95)	P=0.07
Men N=150	PA-EE	0.07 (p=0.42)	-0.03 (p=0.71)	0.01 (p=0.89	-0.01 (p=0.85)	0.09 (p=0.25)	-0.01 (p=0.84)	0.56 (p=0.49)	0.10 (p=0.19)	-0.19 (p=0.01)	0.16 (p=0.05)	0.08 (p=0.31)	P=0.47
	PA-HRBI	-0.12 (p=0.15)	-0.29 (p=0.000)	-0.07 (p=0.38)	-0.10 (p=0.21)	0.001 (p=0.99)	-0.05 (p=0.57)	-0.15 (p=0.07)	-0.61 (p=0.46)	0.04 (p=0.62)	0.02 (p=0.80)	0.07 (p=0.37	p=0.11
	PA-HRBII	-0.17 (p=0.04)	-0.29 (p=0.000)	0.07 (p=0.37)	-0.16 (p=0.04)	0.20 (p=0.01)	0.09 (p=0.28)	-0.07 (p=0.38)	-0.04 (p=0.66)	-0.12 (p=0.13	0.04 (p=0.61)	-0.10 (p=0.20)	p=0.009↓

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy-homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PA-EE-physical activity related to energy expenditure, PA-HRB I - physical activity moderate health related behaviours, PA-HRB II - physical activity hard health related behaviours. No correlation for PLT count was found. ↓ - decreases incidence of metabolic syndrome

Multivariate analyses

General linear model and logistic regression were further used to select variables that independently predict major cardiovascular risk factors (Table 4). PA-HRB I was an independent predictor of lower BMI, WHR, glucose, UA and frequency of metabolic syndrome. PA-HRB II decreased BMI, WHR, TG, glucose and frequency of metabolic syndrome while increasing HDL-C level. White-collar workers had lower SBP and DBP while blue-collar workers had higher SPB, DBP as well as WHR when compared to unemployed subjects. Women had higher TC, HDL-C, LDL-C and Hcy but lower WHR, glucose, UA, SBP, DBP and frequency of metabolic syndrome as compared to men. Smoking was an independent predictor of higher TG levels. Hypolipemic drugs use was related to lower TC and LDL-C, ACEI use to lower LDL-C and antidiabetics intake was associated with lower Hcy levels (Table 4).In multivariate models PA-EE had no impact on presented cardiovascular risk factors.

Tab. 4 Independent variables selected in multivariate analyses influencing cardiovascular risk profile in the whole studied population (n=300).

	BMI	WHR	TC	TG	HDL-C	LDL-C	Glucose	UA	Hcy	SBP	DBP	Metabolic syndrome
PA	PA-HRBI↓ PA-HRBII↓	PA-HRBI↓ PA-HRBII↓		PA-HRBII↓	PA-HRBII↑		PA-HRBI↓ PA-HRBII↓	PA-HRBI↓				PA-HRBI↓ PA-HRBII↓
Occupational status – unemployed as a reference group		White-collar↔ Blue-collar↑								White-collar ↓ Blue-collar ↑	White-collar ↓ Blue-collar↑	
Sex		Female sex↓	Female sex↑		Female sex↑	Female sex↑	Female sex↓	Female sex↓	Female sex↑	Female sex↓	Female sex↓	Female sex↓
Smoking and drugs			Hypolipemic drugs ↓	Smoking↑		Hypolipemic drugs ↓ ACEI ↓			Antidiabetics ↓			

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy- homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PA-HRB I - physical activity moderate health-related behaviours, PA-HRB II - physical activity hard health-related behaviours, ACEI - Angiotensin converting enzyme inhibitors. ↑ - increase; ↓ - decrease; ↔ - no difference

Discussion

The major finding of the present study is that in 60-65 year-old subjects, physical activity (PA)-related behaviours have a greater influence on cardiometabolic risk than overall energy expenditure or employment status. The prevalence of cardiometabolic diseases is similar across this group of pre-elderly subjects, independent of workload, with no apparent relationship being found between PA and health status. However, the prevalence of cardiometabolic risk factors was found to vary depending on workload, with the group of blue-collar workers displaying the worst profile.

Blue-collar workers presented higher indices for body mass than white-collar workers and unemployed subjects, with WHR being significantly greater. Nevertheless, all three groups demonstrated similar levels of obesity, defined as BMI equal or greater than 30kg/m^2. Some indications exist that occupational PA may have a protective impact against obesity[34,40]; however, our data indicates that higher body indices and higher PA-EE scores were observed in the blue-collar group, which is coherent with some literature data[30].

As the highest values of blood pressure were observed in the blue-collar group, hypertension may be associated with physical workload[41]. Despite demonstrating a similar ratio of hypertensive treatment and diagnosed HA to the other groups, blue-collar workers presented higher BP. Engaging in physical work each working day for several hours may result in elevated blood pressure and increased cardiovascular risk[1,42]. Furthermore, some studies characterise blue-collar workers with the highest rate of obesity, another important risk factor for hypertension[43]. Importantly, despite the fact that over 50% of subjects were diagnosed with HA, BP measures indicate that blue-collar workers may be still underdiagnosed and undertreated. Furthermore, blue-collar work may be associated with other sex-related cardiovascular risk factors, i.e. higher glucose and UA concentration among women and greater lipid imbalance among men. Overall, these results indicate that of the three tested professional groups, the highest global cardiovascular risk is found among blue-collar workers.

One of the most important findings is that in contrast to leisure-time PA, higher work-related PA (PA-EE) demonstrated no inverse association with cardiovascular risk factors. PA-EE demonstrates no association with BMI, WHR, lipid fractions or glucose in the whole studied population. This may indicate that PA related to work or occupational activity has no positive impact on basic cardiovascular risk profile, or that this impact is counterbalanced by other risk factors. Furthermore, it is possible that work-related PA may have a negative impact on some cardiovascular risk factors, i.e. to increased blood pressure. Among the whole group, PA-EE was connected with higher SBP. This correlation may be explained by the fact that blue-collar workers, those with highest PA-EE, presented increased blood pressure values. Within the sample, the men with the greatest energy expenditure tended to present not only the lowest education level (blue-collar workers) but interestingly, also the lowest Hcy concentration. Some literature data indicates that PA may decrease Hcy level[40]. Therefore, among the tested older subjects, the overall worse cardiometabolic risk profile displayed by blue-collar workers is counterbalanced by higher PA-EE, as compared to white-collar workers and unemployed subjects. However, PA-HRB appears to have a closer relationship with cardiometabolic risk profile than PA-EE, which may be related to the relationship between PA-EE profile and socioeconomic status.

Both moderate and hard PA-HRBs were found to exert beneficial impact on body mass indices and improve metabolic markers such as TG (both PA-HRB I and II), HDL-C (PA-HRBII) glucose (both PA-HRBI and II) or UA (PA-HRBI). All these correlations are consistent with previous findings [44-46].

When analysed according to sex, these observations were found to apply particularly closely to the group of women. In the case of men, PA-HRB may decrease body mass indices (BMI, WHR) and improve the concentrations of lipids like TG or HDL-C; although, in case of lipids, this relationship was only observed for PA-HRBII. It should be emphasized that the Stanford Usual Activity questionnaire assesses different dimensions of non-work-related PA. PA-HRB I and PA-HRB II were not found to be interrelated; however, each was associated with PA-EE.

To the best of our knowledge this is the first work to compare cardiovascular risk factors and different dimensions of PA in three groups of seniors according to type of the employment status. Its key strength is its sex and age-matching of subjects. However, the present cross-sectional study has some limitations. PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be incorrect. Finally, our findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Practical implications

All presented data suggest that promoting everyday life and leisure time PA behaviour is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in blue-collar workers with high work-related energy expenditure. Whether that beneficial effect results only from PA *per se* or also from social and health awareness behaviours requires further prospective studies.

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Competing interest statement

The authors declare no competing financial interest.

Contributorship statement

Hereby we present contribution of work in the presented publication:

Bartłomiej K. Sołtysik

- recruitment of subjects, medical history, physical examination, anthropometric examination, database preparation, basic statistical calculations, manuscript writing;

Joanna Kostka

- conducting questionnaire surveys on physical activity, performing statistical calculations on cardiovascular risk factors and physical activity, substantive supervision, manuscript drafting and revising;

Kamil Karolczak

- laboratory tests conduction, substantive supervision, manuscript revising;

Cezary Watała

- laboratory tests conduction, substantive supervision, manuscript revising;

Tomasz Kostka

- preparing of the study design, performing statistical calculations, substantive supervision, manuscript drafting and revising.

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What is the most important determinant of cardiometabolic risk in 60-65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland.

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What is the most important determinant of cardiometabolic risk in 60-65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland.

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Abstract:

Objectives: The aim of the study was to determine whether cardiovascular risk factors may differ according to occupational status and whether physical activity related to total energy expenditure (PA-EE) and related to health related behaviours (PA-HRB) is associated with common cardiovascular risk factors or metabolic syndrome in pre-elderly subjects.

Methods: Three hundred subjects aged 60-65, were recruited and divided into three equal groups of white-collar, blue-collar workers and unemployed subjects; 50% were women. The subjects were tested for major cardiovascular risk factors such as smoking, anthropometric indices, blood pressure, lipid levels, glucose, uric acid and homocysteine. PA-EE and PA-HRB were assessed with PA questionnaires.

Results: Blue-collar workers displayed higher anthropometric indices, blood pressure and higher PA-EE in comparison with other two group. PA-HRB had a positive impact on body mass indices, lipids, glucose, uric acid and the prevalence of metabolic syndrome, with no such relationship observed for PA-EE.

Conclusions: The greatest cardiovascular risk was observed in the blue-collar workers group. Only PA-HRB had a positive association with cardiometabolic risk profile. No relationship was observed for PA-EE. Thus, promoting everyday life and leisure time PA behaviours is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in blue-collar workers with high work-related energy expenditure.

Article Summary

Strengths and limitations of the study:

- Three sex- and age-matched groups of subjects with different occupational status were recruited in the study.
- The paper promotes the idea that everyday life and leisure time PA behaviours are crucial for preventing cardiometabolic risk in pre-elderly subjects, even in blue-collar workers with high work-related energy expenditure.
- PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be biased.
- The findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Key words: white-collar workers, blue-collar workers, occupational status, cardiovascular risk factors, metabolic syndrome, pre-elderly.

Introduction:

Cardiometabolic diseases are a major cause of death and important reason of disability in developed countries. The occurrence of cardiovascular disease is related to the presence of risk factors. Smoking increases morbidity and mortality associated with cardiovascular diseases[1-2]. Abdominal distribution of fat has a negative impact on blood pressure (BP), lipid metabolism, glucose tolerance or insulin resistance[3]. Obesity correlates with left ventricular hypertrophy, and weight reduction is a factor restoring normal heart muscle mass [4]. Cardiovascular risk is related to high blood pressure, especially to isolated systolic hypertension as a cause of coronary heart disease and stroke[5-6]. Hyperglycaemia is associated with increased risk of coronary heart disease. Diabetes worsens the long term prognosis for life expectancy[7], as 2/3 of diabetic deaths are related to cardiovascular disease[8]. Atherosclerosis is positively correlated with low density lipoprotein cholesterol (LDL-C) but negatively with high density lipoprotein cholesterol (HDL-C) concentration [9]. Homocysteine(Hcy) accelerates the development of atherosclerosis by enhancing the proliferation of vascular myocytes, endothelial dysfunction, oxidative stress and collagen synthesis, resulting in a deterioration of the elasticity of blood vessels[10].

The elongation of the working period reinforces the need for research into how employment status influences the risk factors among seniors. The nature of work seems to have a direct impact on cardiovascular risk. Available data indicates that of various working groups, blue-collar workers demonstrate the greatest cardiovascular risk [11] and that their workload may increase the risk of coronary heart disease[12]. The prolonged working time of middle-aged men, especially those with current cardiovascular disease, can cause the progression of carotid atherosclerosis[13]. There is some evidence that blue-collar work may be related to greater occurrence of increased blood pressure than white-collar work [14-15], even after adjustment for age, obesity or self-reported alcohol consumption[16]. Furthermore, studies on some areas of work highlight the impact of job strain on arterial hypertension[17]. Psychosocial factors (low economic status, social isolation, chronic stress or depression) have a negative impact on cardiovascular risk, and significantly worsen the effects of treatment and prognosis of patients who already have developed the disease [18].

Blue-collar workers have often been found to demonstrate a higher prevalence of daily smoking than white-collar co-workers[19-20]. Some data indicates also that the unemployed are heavier tobacco users than professional workers[21]. Subjects with occupations requiring lower qualifications may be more likely to demonstrate cardiovascular risk factors, such as obesity or lack of adequate physical activity (PA)[22]. Prevention in psychological factors or restoring a healthy lifestyle can reduce the risk or moderate the progression of cardiovascular disease[23].

Insufficient PA associated with a sedentary lifestyle increases cardiovascular risk, and an adequate level of activity can prolong the lifespan[24-26]. Moderate or strong PA inhibits the development of atherosclerosis and reduces total mortality by 20-25% [27], which has been attributed to a range of effects such as reducing body weight, improving glucose tolerance[28] or lipid profile. Blue-collar workers usually report high PA as a consequence of work conditions[29]. The relationship observed between unemployment and low PA may be connected with higher susceptibility for cardiovascular diseases[30].

It has recently been shown that sub-populations of older people differ with regard to their level of PA and its association with sociodemographic data and concomitant diseases[31]. Furthermore, the relationship between PA and health profile may vary depending on the PA assessment methodology (PA related energy expenditure – PA-EE and PA-related health-related behaviors – PA-HRB). One of the most important questions in contemporary geriatric and occupational medicine is how socioeconomic status, workload and PA co-determine cardiovascular risk with regard to prolonged working time. Therefore, the aim of this work was to identify the occurrence of cardiovascular risk factors and diseases, and determine their relationships with different aspects of PA in three groups of pre-elderly: white-collar workers, blue-collar workers and unemployed seniors.

Methods

Subjects

The study was conducted in three age- and sex-matched groups of inhabitants of the Łódź region aged 60 to 65 years. Participants were divided into three groups depending on the character of their professions: white-collar workers, blue-collar workers and unemployed subjects. The subjects were recruited through local media (TV, radio and newspapers). All the volunteers were initially checked for the basic recruitment criteria and classified according to the occupational status. As blue-collar workers were the least common group in this age range, they were qualified first for the study. An age- and sex-matched consecutive peer was assigned for each recruited worker from the white-collar and unemployed groups. Each group included 100 volunteers (50 men and 50 women). The procedure for defining the type of profession has been described previously in a work concerning differences in the quality of work and life among the three senior groups[32].

Subjects were asked about the presence of arterial hypertension (HA), diabetes mellitus type 2 (DM2), dyslipidaemia and smoking habit. Blood pressure was measured twice with an auscultation sphygmomanometer in accordance with the current guidelines[33]. Fasting blood samples were drawn from the antecubital vein into test tubes. The blood serum was assayed spectrophotometrically for fasting glucose concentration, total cholesterol (TC), LDL-C, HDL-C, triglycerides (TG), uric acid (UA) (DIRUI CS 400, Changchun, China). Hcy was estimated in blood serum by immunochemiluminescence (Immulite 2000XPi analyser, Siemens, Germany). Blood morphology was evaluated with 5-Diff Sysmex XS-1000i haematological analyser (Sysmex, Kobe, Japan). Weight and height were measured in participants while barefoot, and waist and hip circumference were measured [34]; Body mass index (BMI) and waist-hip ratio (WHR) were then calculated based on the results. Metabolic syndrome was assessed according to International Diabetes Federation[35].

Physical activity assessment

Physical activity was assessed by two popular PA questionnaires: the Seven-Day Recall PA Questionnaire[36] and the Stanford Usual Activity Questionnaire[37]. Both questionnaires used in the present study have been previously described in detail[38]. Both have demonstrated high validity in older individuals against doubly labelled water and have been assessed in the present study in accordance with standardized protocols[31,39].

All participants were informed that the questionnaires were anonymous and that only the researchers will have access to the results. For the Seven-Day Recall PA Questionnaire, a list of examples of different level of activities was included. Additionally, if in doubt, participants were allowed to ask questions to the interviewer.

The Seven-Day Recall PA Questionnaire determines the hours spent sleeping for the week, sums up the time spent in light (activities with energy expenditure of 1.5 $kcal{\cdot}min^{-1}$), moderate (activities with energy expenditure of 4 $kcal{\cdot}min^{-1}$), hard (activities with energy expenditure of 6 $kcal{\cdot}min^{-1}$), and very hard (activities with energy expenditure of 10 $kcal{\cdot}min^{-1}$) activities and estimates overall weekly energy expenditure through analysis of PA during the previous seven days. The Seven-Day Recall Total score (total energy expenditure over past week – $kcal{\cdot}kg^{-1}{\cdot}day^{-1}$) was then calculated and used for further comparisons as PA-energy expenditure (PA-EE).

The Stanford moderate index allows an assessment of health-related PA behaviors of light and moderate intensity. The respondents indicate the type of behavior typical of their exercise habits: climbing the stairs instead of using the elevator, walking instead of driving for a short distance, parking the car further away from the destination in order to approach on foot, walking before or after lunch or dinner, exiting the bus or tram a stop earlier in order to walk the remaining distance, or performing other activities of a similar nature. In the Stanford Hard (vigorous) index, the respondent indicates the following activities performed regularly for at least the last three months: jogging or running at least 10 miles per week, play strenuous racquet sports at least five hours per week, play other strenuous sports at least five hours per week, ride a bicycle at least 50 miles per week, swim at least two miles per week. The Stanford Moderate (six habitual moderate activities; scoring points 0-6) and Hard (five habitual intensive activities; scoring points 0-5) indices were calculated as a numerical sum of points for each activity and used for further comparisons. These two PA indices are expressed as PA-health-related behaviors I (PA-HRB I) and PA-health-related behaviors II (PA-HRB II), respectively.

Statistical analysis

Data was verified for normality of distribution and equality of variances. The one-way analysis of variance (ANOVA) with Tukey post hoc testing, Kruskal-Wallis test, and 3x2 chi-square test were used to compare the three groups. The Student's t-test, Mann-Whitney test and chi-square test (2x2 with Yates' correction) were used to make comparisons between the two groups with applied Bonferroni correction. The correlations were assessed with Spearman's correlation coefficients. The results of the quantitative variables are presented as mean ± (standard deviation) or median (interquartile ranges). Multivariate analyses were performed to identify factors independently predicting cardiometabolic risk, general linear models were constructed for the main cardiovascular risk factors and logistic regression was employed for dichotomized variables. All the variables statistically significant in bivariate relationships were entered into the multivariate analyses. Age, sex, occupational status, physical activity variables, smoking and drugs were taken into consideration as

potential independent variables. Non-normally distributed variables were log-transformed for the purpose of multivariate analyses; however, the results are presented in standard values. PA-HRB II was dichotomized for multivariate analyses as no PA-HRB II versus at least one PA-HRB II. The limit of significance was regarded as p≤0.05 for all analyses. Statistical analysis were performed using Statistica 12 software.

Ethical considerations

The study was approved by the Ethics Committee of the Medical University of Łódź (No RNN/648/14/KB). All subjects signed an informed consent form prior to participation in the study.

Data sharing statement

No additional data available.

Patient and public involvement statement

The study design was based on the fact that Łódź region is one with the fastest ageing population in Europe. The study was important for the understanding of the impact of occupational status on cardiovascular risk among pre-elderly seniors. The respondents obtained information on individual test results. In addition, they are informed about the results obtained on the basis of the collected data. No additional involvement of patients has been stated.

Results

Table 1 presents differences between the three working group. The median age of the unemployed subjects was slightly higher than those of both working groups. White-collar workers were better (p<0001) educated than blue-collar workers and the unemployed subjects. Blue-collar workers presented statistically significantly higher WHR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and PA-EE than the other two groups. Blue-collar workers also presented a significantly higher platelet count in comparison with white-collar workers (p=0.02).

Table 1. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups.

Variable	**White-collar workers Mean ±SD or median (quartiles) n=100**	**Blue-collar workers Mean ±SD or median (quartiles) n=100**	**Unemployed subjects Mean ±SD or median (quartiles) n=100**
Age [years]	62.5 (61-64)	62 (61-64)	63 (63-64)$^{*(p<0.001)\# (p<0.001)}$
Education [years]	15.5 (12.5-17)	12 (11-13)$^{*(p<0.001)}$	12 (11-14.5) $^{*(p<0.001)}$
BMI [kg/m²]	27.7 ±3.9	28.2 (25.5-31.5)	27.5 (23.9-30.8)
Waist circumference (cm)	95 (87.5-102)	97 (90-107.7)$^{*(p=0.03)}$	96 (83-105)
WHR	0.9 (0.8-1.0)	0.9 ±0.1$^{*(p=0.01)}$	0.9 (0.8-1.0) $^{\#(p=0.01}$)
TC [mg/dl]	207.4 (178.6-233.5)	203.5 (172.5-235.0)	203.1 (167.1-239.3)
LDL [mg/dl]	126.5 (103.3-152.1)	130.9 ±38.6	127.4 ±38.8
HDL [mg/dl]	50.0 (42.5-57.6)	46.9 (40.7-56.2)	47.9 (39.9-59.6)
TG [mg/dl]	107.7 (74.9-148.9)	109.2 (74.5-158.7)	116.5 (82.2-173.9)
Glucose [mg/dl]	97.2 (90.1-110.3)	101.9 (93.7-113.2)	98.8 (90.8-111.5)
Uric acid [mg/dl]	4.9 ±1.2	4.8 (4.0-5.7)	4.8 ±1.4
Homocysteine [µmol/l]	14.0 (12.5-17.0)	14.45 (12.2-16.8)	14.8 (12.9-17.1)
Blood platelets [10³/mm³]	207.0 ±48.1	223.6 ±50.1$^{*(p=0.02)}$	214.5 (173.0-250.5)
SBP [mmHg]	133.5 ±17.0	143.4 ±17.0$^{*(p<0.001)}$	134.5 ±16.0 $^{\#(p<0.001)}$
DBP [mmHg]	80.0 (72.0-88.0)	87.0±11.7$^{*(p<0.001)}$	81.9 ±12.4 $^{\#(p=0.001)}$
Metabolic syndrome	63%	69%	63%
PA-EE [kcal/kg^{-1} day^{-1}]	41.3 (37.3-48.6)	49.6 ±7.6$^{*(p<0.001)}$	41.0 (37.5-44.7) $^{\#(p<0.001)}$
Stanford moderate PA-HRB I	3.0 (1.0-4.0)	3.0 (1.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	17%	12%	18%
Diseases and drugs	**n**	**n**	**n**
HA	50	53	54
Hypercholesterolemia	60	67	71
Smoking	20	26	23
DM 2	10	13	12
MI	5	4	6
IHD	11	13	19
Stroke	4	4	4
Obesity	30	33	32
Antiplatelet drugs	16	15	23
B-blocker	26	28	31
Ca-blocker	13	13	7
Angiotensin converting enzyme inhibitor	21	27	22
Angiotensin II receptor blocker	12	6	9
Diuretics	24	23	10
Hypolipemic drugs	21	26	30
Antidiabetics	9	14	11

* statistically different from white-collar; # statistically different from blue-collar workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease.

The prevalence of cardiovascular diseases and risk factors throughout the whole studied population was as follows: hypercholesterolemia - 66%, HA - 52.33%, DM2 - 11.67%, previous myocardial infarction (MI) - 5%, ischaemic heart disease (IHD) - 14.33%, previous stroke - 4%, obesity (counted as a BMI equal or greater than 30kg*m^{-2}) - 31.67%, and metabolic syndrome - 65% of subjects. No differences were seen between the three groups regarding the incidence of diseases, smoking prevalence or drug intake.

Regarding the female respondents, the unemployed subjects were significantly older than working subjects, and those in white-collar work were statistically significantly better educated than the other two groups. Blue-collar workers were statistically significantly more obese (WHR), with higher SBP and PA-EE values, than the white-collar and unemployed groups. The women in blue-collar work had statistically significantly higher platelet count and DBP in than those in white-collar positions, and displayed significantly higher UA concentration than unemployed respondents. Table 2a displays differences between groups of women in more detail.

Table 2a. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups of women.

Variable	**White-collar female workers Mean ±SD or median (quartiles) n=50**	**Blue-collar female workers Mean ±SD or median (quartiles) n=50**	**Unemployed females Mean ±SD or median (quartiles) n=50**
Age [years]	62 (61-64)	62 (61-63)	63 (63-64) *(p<0.001) #(p<0.001)
Education [years]	14.5 (12-17)	13 (11-14) *(p<0.001)	13 (12-16) *(p=0.04)
BMI [kg/m²]	27.6 ±4.4	28.24 (25.3-31.3)	27.0 (23.4-31.6)
Waist circumference (cm)	88.5 (81-97)	93 (86-100)	85.5 (77.5-100)
WHR	0.8 ±0.1	0.9 ±0.1 *(p=0.01)	0.8 ±0.1 #(p<0.001)
TC [mg/dl]	214.5 (185.0-249.0)	221.3 ±51.5	216.4 ±44.3
LDL [mg/dl]	140.4 (104.9-156.3)	143.7 ±41.1	134.5 ±41.9
HDL [mg/dl]	52.9 (45.4-69.0)	51.2 (45.2-51.9)	57.0 ±14.6
TG [mg/dl]	107.9 (78.6-159.8)	114.7 (74.0-158.7)	113.0 (76.8-159.4)
Glucose [mg/dl]	95.8 (89.0-105.6)	101.6 (92.6-108.9)	94.7 (88.7-106.9)
Uric acid [mg/dl]	4.4 ±1.2	4.3 (3.9-5.1)	3.8 (3.2-4.9) #(p=0.01)
Homocysteine [µmol/l]	13.3 (11.9-16.2)	14.25 (12.1-15.9)	14.3 (12.7-16.0)
Blood platelets [10³/mm³]	220.1 ±45.9	246.2 ±46.7 *(p=0.005)	224.5 (196-256)
SBP [mmHg]	130.5 ±15.48	140.5 ±15.1 *(p=0.003)	133.1 ±13.2 #(p=0.01)
DBP [mmHg]	78.2 ±11.6	84.6 ±9.9 *(p=0.004)	80.5 ±11.9
Metabolic syndrome	27 (54%)	30 (60%)	22 (44%)
PA-EE [kcal/kg^{-1} day^{-1}]	44.1 (38.7-48.7)	50.52 ±7.33 *(p<0.001)	41.0 (38.1-43.8) #(p<0.001)
Stanford moderate- PA-HRB I	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	8 (16%)	5 (10%)	10 (20%)
Diseases and drugs	**n**	**n**	**n**
HA	24	23	21
Hypercholesterolemia	34	35	36
Smoking	13	12	6
DM 2	4	7	5
MI	1	0	1
IHD	6	5	6
Stroke	3	2	1
Obesity	17	16	14
Antiplatelet drugs	6	9	13
B-blocker	15	14	15
Ca-blocker	5	5	2
Angiotensin converting enzyme inhibitor	10	13	10
Angiotensin II receptor blocker	10	3	4
Diuretics	12	12	5
Hypolipemic drugs	9	12	13
Antidiabetics	3	7	5

* statistically different from white-collar; # statistically different from blue-collar workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Regarding the men, white-collar workers were statistically significantly better educated than blue-collar workers and unemployed men. Blue-collar workers had statistically significantly higher SBP, DBP and PA-EE than the other two groups. Unemployed men had higher TG (p=0.01) and lower HDL-C (p=0.03) than the white-collar workers. These differences are highlighted in Table 2b. No differences were found between the three groups concerning PA-HRB, incidence of diseases, smoking prevalence or drug intake either with or without division by sex.

Table 2b. Comparison of the major anthropometric variables, cardiovascular risk factors, diseases and drug intake between the three groups of men.

Variable	**White-collar male workers Mean ±SD or median (quartiles) n=50**	**Blue-collar male workers Mean ±SD or median (quartiles) n=50**	**Unemployed men Mean ±SD or median (quartiles) n=50**
Age [years]	63 (61-64)	63 (61-65)	63 (63-65)
Education [years]	16 (13-17)	12.0 (11.0-13.0) $^{*(p<0.001)}$	12.0 (11.0-13.0) $^{*(p<0.001)}$
BMI [kg/m²]	27.8 ±3.5	28.0 (25.5-32.1)	27.7±4.3
Waist circumference (cm)	98.5 (94-106)	103 (95-114.5)	102 (94-109.5)
WHR	1.0 ±0.1	1.0 ±0.1	1.0 ±0.1
TC [mg/dl]	197.8±35.8	190.3 ±37.4	192.5 ±40.1
LDL [mg/dl]	124.9 ±30.8	117.9 ±31.3	120.1 ±34.1
HDL [mg/dl]	48.2 (39.3-54.0)	44.7 (39.2-52.5)	41.5 (36.6-48.4) $^{*(p=0.03)}$
TG [mg/dl]	104.4 (70.9-139.3)	106.0 (74.9-158.6)	123.1 (88.3-188.5) $^{*(p=0.01)}$
Glucose [mg/dl]	99.2 (92.2-112.4)	102.3 (96.1-114.7)	102.3 (93.9-114.1)
Uric acid [mg/dl]	5.3 ±1.0	5.3 ±1.2	5.5 ±1.1
Homocysteine [µmol/l]	16.0 ±3.7	14.7 (12.7-17.5)	15.9 ±3.9
Blood platelets [10^3/mm³]	193.7 ±47.0	201.5 ±43.3	187.5 (165.0-237.0)
SBP [mmHg]	135 (125-145)	146.3 ±18.4 $^{*(p=0.002)}$	135.9 ±18.3 $^{\#(p=0.008)}$
DBP [mmHg]	82 (75-93)	89.4 ±12.9 $^{*(p=0.03)}$	83.2 ±12.8 $^{\#(p=0.01)}$
Metabolic syndrome	36 (72%)	39 (78%)	41 (82%)
PA-EE [kcal/kg^{-1} day^{-1}]	40.0 (36.6-48.1)	48.7 ±7.9 $^{*(p<0.001)}$	40.9 (37.3-45.0) $^{\#(p<0.001)}$
Stanford moderate- PA-HRB I	3.0 (1.0-4.0)	2.5 (1.0-4.0)	2.5 (1.0-4.0)
Stanford hard PA-HRB II	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Stanford hard PA-HRB II (at least one)	9 (18%)	7 (14%)	8 (16%)
Diseases and drugs	**n**	**n**	**n**
HA	26	30	33
Hypercholesterolemia	26	32	35
Smoking	7	14	17
DM 2	6	6	7
MI	4	4	5
IHD	5	8	13
Stroke	1	2	3
Obesity	13	17	18
Antiplatelet drugs	10	6	10
B-blocker	11	14	16
Ca-blocker	8	8	5
Angiotensin converting enzyme inhibitor	11	14	12
Angiotensin II receptor blocker	2	3	5
Diuretics	12	11	5
Hypolipemic drugs	12	14	17
Antidiabetics	6	7	6

* statistically different from white-collar; # statistically different from blue-collar workers.
Abbreviations: BMI, body mass index; WHR, waist-hip ratio; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; PA-EE, physical activity related to energy expenditure; PA-HRB I, physical activity moderate health related behaviours; PA-HRB II, physical activity hard health related behaviours; HA, arterial hypertension; DM2, diabetes mellitus type 2; IHD, ischaemic heart disease

Table 3 describes correlations between PA-EE, PA-HRB and major cardiovascular risk factors. In the whole studied group, PA-EE was directly related to SBP. Subjects with higher PA-HRB I showed lower body mass indices, lower TG, glucose, UA concentration and had a lower incidence of metabolic syndrome. Higher PA-HRB II was related to lower body mass indices, lower TG, glucose, higher HDL-C and lower frequency of metabolic syndrome. Women with higher PA-EE had higher WHR, while those with higher PA-HRB (both moderate and hard) had lower body mass indices (BMI and BMI/WHR respectively). Higher PA-HRB I correlated with lower TG, glucose and UA; higher PA-HRB II was associated with higher HDL-C and lower glucose and UA concentration. In men, higher PA-EE was

related to lower concentration of Hcy and higher SBP. Both PA-HRB I and PA-HRB II correlated negatively with WHR, and PA-HRB II also correlated negatively with BMI. Higher PA-HRB II was associated with lower TG, higher HDL-C and lower frequency of metabolic syndrome (Table 3).

Interestingly, in the whole group, PA-HRB I and PA-HRB II levels correlated with PA-EE (rho=0.17; p=0.003 and rho=0.18; p=0.002, respectively) but not with each other. PA-EE was related to PA-HRB I and PA-HRB II in men but only to PA-HRB II in women (not shown in the table).

Table 3. Associations (Spearman correlations; Mann-Whitney for metabolic syndrome) between PA indices and cardiovascular risk profile in the whole studied population and in groups according to sex.

	PA	BMI	WHR	TC	TG	HDL-C	LDL-C	Glucose	UA	Hcy	SBP	DBP	Metabolic syndrome
All participants N=300	PA-EE	0.02 (p=0.72)	0.02 (p=0.72)	0.03 (p=0.57)	-0.003 (p=0.95)	0.006 (p=0.91)	0.03 (p=0.55)	-0.02 (p=0.75)	-0.002 (p=0.97)	-0.06 (p=0.29)	0.14 (p=0.01)	0.06 (p=0.24)	p=0.77
	PA-HRBI	-0.18 (p=0.002)	-0.19 (p=0.001)	-0.003 (p=0.95)	-0.13 (p=0.02)	0.06 (p=0.26)	0.02 (p=0.73)	-0.19 (p=0.001)	-0.18 (p=0.001)	0.02 (p=0.72)	-0.03 (p=0.56)	0.04 (p=0.44)	p=0.019↓
	PA-HRBII	-0.19 (p=0.001)	-0.17 (p=0.003)	0.05 (p=0.35)	-0.15 (p=0.008)	0.18 (p=0.001)	0.05 (p=0.38)	-0.12 (p=0.03)	-0.10 (p=0.07)	0.01 (p=0.77)	0.01 (p=0.86	(-0.05 (p=0.35)	p=0.004↓
Women N=150	PA-EE	-0.02 (p=0.78)	0.17 p=0.03)	0.02 (p=0.77)	0.02 (p=0.81)	-0.11 (p=0.19	0.053 (p=0.52)	-0.08 (p=0.31)	-0.06 (p=0.48)	0.09 (p=0.25)	0.13 (p=0.10)	0.07 (p=0.37)	p=0.30
	PA-HRBI	-0.23 (p=0.004)	-0.14 (p=0.09)	0.01 (p=0.85)	-0.16 (p=0.05)	0.08 (p=0.28)	0.04 (p=0.57)	-0.22 (p=0.007)	-0.28 (p=0.000)	0.02 (p=0.81)	-0.08 (p=0.32)	0.03 (p=0.67)	p=0.17
	PA-HRBII	-0.21 (p=0.01)	-0.22 (p=0.006)	0.05 (p=0.51)	-0.14 (p=0.92)	0.20 (p=0.01)	0.03 (p=0.67)	-0.17 (p=0.03)	-0.19 (p=0.01)	0.15 (p=0.07)	-0.03 (p=0.69)	-0.01 (p=0.95)	P=0.07
Men N=150	PA-EE	0.07 (p=0.42)	-0.03 (p=0.71)	0.01 (p=0.89	-0.01 (p=0.85)	0.09 (p=0.25)	-0.01 (p=0.84)	0.56 (p=0.49)	0.10 (p=0.19)	-0.19 (p=0.01)	0.16 (p=0.05)	0.08 (p=0.31)	P=0.47
	PA-HRBI	-0.12 (p=0.15)	-0.29 (p=0.000)	-0.07 (p=0.38)	-0.10 (p=0.21)	0.001 (p=0.99)	-0.05 (p=0.57)	-0.15 (p=0.07)	-0.61 (p=0.46)	0.04 (p=0.62)	0.02 (p=0.80)	0.07 (p=0.37	p=0.11
	PA-HRBII	-0.17 (p=0.04)	-0.29 (p=0.000)	0.07 (p=0.37)	-0.16 (p=0.04)	0.20 (p=0.01)	0.09 (p=0.28)	-0.07 (p=0.38)	-0.04 (p=0.66)	-0.12 (p=0.13	0.04 (p=0.61)	-0.10 (p=0.20)	p=0.009↓

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy-homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PA-EE-physical activity related to energy expenditure, PA-HRB I - physical activity moderate health related behaviours, PA-HRB II - physical activity hard health related behaviours. No correlation for PLT count was found. ↓ - decreases incidence of metabolic syndrome

Multivariate analyses

General linear model and logistic regression were further used to select variables that independently predict major cardiovascular risk factors (Table 4). PA-HRB I was an independent predictor of lower BMI, WHR, glucose, UA and frequency of metabolic syndrome. PA-HRB II decreased BMI, WHR, TG, glucose and frequency of metabolic syndrome while increasing HDL-C level. White-collar workers had lower SBP and DBP while blue-collar workers had higher SPB, DBP as well as WHR when compared to unemployed subjects. Women had higher TC, HDL-C, LDL-C and Hcy but lower WHR, glucose, UA, SBP, DBP and frequency of metabolic syndrome as compared to men. Smoking was an independent predictor of higher TG levels. Hypolipemic drugs use was related to lower TC and LDL-C, ACEI use to lower LDL-C and antidiabetics intake was associated with lower Hcy levels (Table 4).In multivariate models PA-EE had no impact on presented cardiovascular risk factors.

Tab. 4 Independent variables selected in multivariate analyses influencing cardiovascular risk profile in the whole studied population (n=300).

	BMI	WHR	TC	TG	HDL-C	LDL-C	Glucose	UA	Hcy	SBP	DBP	Metabolic syndrome
PA	PA-HRBI↓ PA-HRBII↓	PA-HRBI↓ PA-HRBII↓		PA-HRBII↓	PA-HRBII↑		PA-HRBI↓ PA-HRBII↓	PA-HRBI↓				PA-HRBI↓ PA-HRBII↓
Occupational status – unemployed as a reference group		White-collar↔ Blue-collar↑								White-collar ↓ Blue-collar ↑	White-collar ↓ Blue-collar↑	
Sex		Female sex↓	Female sex↑		Female sex↑	Female sex↑	Female sex↓	Female sex↓	Female sex↑	Female sex↓	Female sex↓	Female sex↓
Smoking and drugs			Hypolipemic drugs ↓	Smoking↑		Hypolipemic drugs ↓ ACEI ↓			Antidiabetics ↓			

Abbreviations: BMI- body mass index, WHR- waist-hip ratio, TC- total cholesterol, TG- triglycerides, HDL-C – high density lipoprotein cholesterol, LDL-C low density lipoprotein cholesterol, UA- uric acid, Hcy- homocysteine, SBP- systolic blood pressure, DBP diastolic blood pressure, PA-HRB I - physical activity moderate health-related behaviours, PA-HRB II - physical activity hard health-related behaviours, ACEI - Angiotensin converting enzyme inhibitors. ↑ - increase; ↓ - decrease; ↔ - no difference

Discussion

The major finding of the present study is that in 60-65 year-old subjects, physical activity (PA)-related behaviours have a greater influence on cardiometabolic risk than overall energy expenditure or employment status. The prevalence of cardiometabolic diseases is similar across this group of pre-elderly subjects, independent of workload, with no apparent relationship being found between PA and health status. However, the prevalence of cardiometabolic risk factors was found to vary depending on workload, with the group of blue-collar workers displaying the worst profile.

Blue-collar workers presented higher indices for body mass than white-collar workers and unemployed subjects, with WHR being significantly greater. Nevertheless, all three groups demonstrated similar levels of obesity, defined as BMI equal or greater than 30kg/m^2. Some indications exist that occupational PA may have a protective impact against obesity[34,40]; however, our data indicates that higher body indices and higher PA-EE scores were observed in the blue-collar group, which is coherent with some literature data[30].

As the highest values of blood pressure were observed in the blue-collar group, hypertension may be associated with physical workload[41]. Despite demonstrating a similar ratio of hypertensive treatment and diagnosed HA to the other groups, blue-collar workers presented higher BP. Engaging in physical work each working day for several hours may result in elevated blood pressure and increased cardiovascular risk[1,42]. Furthermore, some studies characterise blue-collar workers with the highest rate of obesity, another important risk factor for hypertension[43]. Importantly, despite the fact that over 50% of subjects were diagnosed with HA, BP measures indicate that blue-collar workers may be still underdiagnosed and undertreated. Furthermore, blue-collar work may be associated with other sex-related cardiovascular risk factors, i.e. higher glucose and UA concentration among women and greater lipid imbalance among men. Overall, these results indicate that of the three tested professional groups, the highest global cardiovascular risk is found among blue-collar workers.

One of the most important findings is that in contrast to leisure-time PA, higher work-related PA (PA-EE) demonstrated no inverse association with cardiovascular risk factors. PA-EE demonstrates no association with BMI, WHR, lipid fractions or glucose in the whole studied population. This may indicate that PA related to work or occupational activity has no positive impact on basic cardiovascular risk profile, or that this impact is counterbalanced by other risk factors. Furthermore, it is possible that work-related PA may have a negative impact on some cardiovascular risk factors, i.e. to increased blood pressure. Among the whole group, PA-EE was connected with higher SBP. This correlation may be explained by the fact that blue-collar workers, those with highest PA-EE, presented increased blood pressure values. Within the sample, the men with the greatest energy expenditure tended to present not only the lowest education level (blue-collar workers) but interestingly, also the lowest Hcy concentration. Some literature data indicates that PA may decrease Hcy level[40]. Therefore, among the tested older subjects, the overall worse cardiometabolic risk profile displayed by blue-collar workers is counterbalanced by higher PA-EE, as compared to white-collar workers and unemployed subjects. However, PA-HRB appears to have a closer relationship with cardiometabolic risk profile than PA-EE, which may be related to the relationship between PA-EE profile and socioeconomic status.

Both moderate and hard PA-HRBs were found to exert beneficial impact on body mass indices and improve metabolic markers such as TG (both PA-HRB I and II), HDL-C (PA-HRBII) glucose (both PA-HRBI and II) or UA (PA-HRBI). All these correlations are consistent with previous findings [44-46].

When analysed according to sex, these observations were found to apply particularly closely to the group of women. In the case of men, PA-HRB may decrease body mass indices (BMI, WHR) and improve the concentrations of lipids like TG or HDL-C; although, in case of lipids, this relationship was only observed for PA-HRBII. It should be emphasized that the Stanford Usual Activity questionnaire assesses different dimensions of non-work-related PA. PA-HRB I and PA-HRB II were not found to be interrelated; however, each was associated with PA-EE.

To the best of our knowledge this is the first work to compare cardiovascular risk factors and different dimensions of PA in three groups of seniors according to type of the employment status. Its key strength is its sex and age-matching of subjects. However, the present cross-sectional study has some limitations. PA assessment tools (Seven Day Recall PA Questionnaire and the Stanford usual Activity Questionnaire) are self-reported subjective methods and the estimation of PA levels may be incorrect. Finally, our findings apply to balanced groups of Central-European pre-elderly people according to employment status and these values may be different in other populations and cultures.

Practical implications

All presented data suggest that promoting everyday life and leisure time PA behaviour is crucial for preventing cardiometabolic risk in pre-elderly subjects, even in blue-collar workers with high work-related energy expenditure. Whether that beneficial effect results only from PA *per se* or also from social and health awareness behaviours requires further prospective studies.

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Competing interest statement

The authors declare no competing financial interest.

Contributorship statement

Hereby we present contribution of work in the presented publication:

Bartłomiej K. Sołtysik

- recruitment of subjects, medical history, physical examination, anthropometric examination, database preparation, basic statistical calculations, manuscript writing;

Joanna Kostka

- conducting questionnaire surveys on physical activity, performing statistical calculations on cardiovascular risk factors and physical activity, substantive supervision, manuscript drafting and revising;

Kamil Karolczak

- laboratory tests conduction, substantive supervision, manuscript revising;

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- preparing of the study design, performing statistical calculations, substantive supervision, manuscript drafting and revising.

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