




Association Between Objectively Measured Physical Activity And Musculoskeletal Disorders, And Perceived Work Ability Among Adult, Middle-Aged And Older Women

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Purpose: The purpose of this study was to assess the relationship between objectively measured physical activity and perceived work ability and musculoskeletal disorders among adult, middle-aged, and older women.

Patients and methods: This study used a cross-sectional design with a convenience sample of 348 women divided into 3 age groups: 30–49 years (n=111), 50–65 years (n=120), 66–75 years (n=117). Weekly physical activity was monitored using tri-axial accelerometer ActiGraph Gt3X. Perceived work ability was assessed using the standardized Work Ability Index (WAI) questionnaire. Information about the occurrence and intensity of musculoskeletal disorders was collected using standardized Nordic Musculoskeletal Questionnaire (NMQ) expanded by visual analog pain intensity scale (VAS).

Results: Regardless of age, women who met physical activity recommendations achieved higher scores in each part of the WAI, and also in the total WAI scores. However, the most significant differences were found in women aged 50–64 years, and included the following items: subjective work ability, work ability in relation to demands, work impairments, sick leave in the past year. Total WAI scores were also significantly higher in women aged 30–49 and 50–64 years who met PA recommendations in comparison to women who did not meet recommendations. Also, significant relations between the frequency of occurrence of musculoskeletal problems and meeting physical activity recommendations were found in women aged 50–64 years. Those who were more physically active reported less musculoskeletal problems in shoulders ($p=0.006$) and ankles/feet ($p=0.018$) regions.

Conclusion: Adherence to Global Recommendations on Physical Activity for Health disseminated by WHO is related to better-perceived work ability among adult (30–49 years) and middle-aged (50–64 years) women. There is also a relationship between adherence to recommendations of physical activity and frequency and intensity of musculoskeletal pain among middle-aged women.

Keywords: WHO recommendations, actigraph, WAI, NMQ, accelerometry, exercises

Introduction

Strong evidence has been gathered over the years about health benefits of regular physical activity.^{1–3} Physical exercise can be effective in primary and secondary prevention of chronic diseases (eg, heart disease, stroke, chronic respiratory diseases, cancer, and diabetes),^{4–6} which are the leading cause of premature death and disability. Numerous studies also confirmed that regular exercise reduces the risk of

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anxiety and depression,⁷⁻⁹ improves well-being^{10,11} and quality of life.¹²⁻¹⁴ Furthermore, physical activity is indicated as an independent predictor of successful aging.¹⁵⁻¹⁷ Physical activity in older people is critically important in the prevention of diseases, maintenance of functional capacity that guarantees one's independence. This has contributed to a systematic increase in the amount of research concerning health-related effects of various physical training interventions in middle-aged and older people.¹⁸⁻²¹

Physical activity can prevent and reduce the occurrence of musculoskeletal disorders in populations of all ages.²²⁻²⁵ However, this is especially important in professionally active workers, as musculoskeletal pain can be the factor that reduces the ability and capacity to work.^{26,27} It should also be noted that the prevalence of musculoskeletal disorders (MSD)(including the joints, muscles, ligaments, nerves, tendons, and structures that support limbs, neck and back) increases with age.²⁸ Therefore, special attention should be paid to the relation between physical activity and musculoskeletal symptoms among middle-aged and older adults who are still professionally active. Rapid aging in populations implies the need to implement a policy encouraging and supporting employment at an older age.

Some studies have shown the significant relationship between physical activity and the ability to work.²⁹⁻³¹ Work ability can be defined as

having the health, competence and relevant occupational virtues required for managing some kind of job, assuming that the work tasks are reasonable and that the work environment is acceptable.³²

Therefore, it should be noted that the concept of work ability is holistic and can be affected by various factors, such as, eg, work stressors, individual characteristics, and diseases. This raises the question of how work ability changes during work life and beyond. One of the factors related to better work ability is lifestyle, especially regular physical activity. To determine the minimal amount of health-related physical activity, the Global Recommendations on Physical Activity for Health were developed and disseminated by World Health Organization (WHO). According to these guidelines, adults and older adults should do at least 150 mins of moderate physical activity per week or at least 75 mins of vigorous physical activity per week.

The majority of studies that confirmed the relationship between health-related physical activity and work ability and musculoskeletal disorders were performed using the

subjective method of physical activity assessment (questionnaires, self-assessment). The aim of this study was to assess the level of objectively measured physical activity according to health recommendations and to verify whether the perceived work ability and self-reported musculoskeletal disorders are associated with adherence to physical activity recommendations. We hypothesized that, regardless of age, women with a higher level of physical activity would achieve a better level of work ability and would report less musculoskeletal disorders.

Materials And Methods

Participants

This study was approved by the Ethics Committee of The Jerzy Kukuczka Academy of Physical Education in Katowice. The study used a cross-sectional design with a convenience sample of volunteers from Katowice (Poland) who met the following inclusion criteria:

age (30–75 years), gender (female), work experience (at least 5 years), white-collar worker (declared mainly mentally demanding occupation or sedentary type of job for the majority of professional activity), consent to participate in the full research protocol (weekly monitoring of physical activity using accelerometer, completing WAI and NMQ questionnaires). Participants were recruited from purposely selected corporations in South Poland. The research project was promoted by posters and brochures. People interested in participation in the research were invited to meetings, where the aim of the study, protocol, and research tools were presented. The participants who did not meet the inclusion criteria, and those with missing data (incomplete measurement of physical activity based on adopted settings described in physical activity assessment section, incomplete questionnaires) were excluded from the analysis. Finally, 348 women were included in the analysis and divided into 3 age groups: 30–49 years (n=111), 50–65 years (n=120), 66–75 years (n=117). The detailed participant characteristics are presented in Table 1.

This study was conducted in accordance with the Declaration of Helsinki and written informed consent was obtained from all participants.

Physical Activity Assessment

Physical activity was monitored using a 3-axial accelerometer ActiGraph Gt3X, worn on the right side of hip on the waistband. Women wore the physical activity monitor

Table 1 Physical Features And Characteristics Of The Participants

Variables	n	%
Age		
30–49 years	111	31.9%
50–64 years	120	34.5%
65–75 years	117	33.6%
BMI [kg/m ²]		
18–24.9	134	38.5%
25–30	114	32.8%
>30	100	28.7%
Physical activity recommendations		
Did not meet	180	51.7%
Met	168	48.3%
Work ability		
Poor	55	15.8%
Moderate	129	37.1%
Good	84	24.1%
Excellent	80	23.0%
Musculoskeletal pain		
No pain	32	9.2%
1–3 anatomical regions	145	41.7%
4–6 anatomical regions	127	36.5%
>6 anatomical regions	44	12.6%
Total	348	100.0%

for seven consecutive days of the week, with the exception of sleeping and water activities (eg, bathing, swimming). Data from physical activity monitors were collected according to the following settings: acceleration from three axes (vertical, mediolateral, anterior-posterior) combined into a vector magnitude score (VM), valid day defined as at least 10 hrs of wear time, data integrated into 60-second epochs and expressed as counts per minutes (cpm), non-wear time defined as 60 consecutive minutes of 0 cpm, with allowance for 1–2 mins of counts 0–200 cpm (Troiano algorithm modified for VM data),^{33,34} threshold counts values to identify the intensity of physical activity: 200–2689 cpm for light physical activity (LPA), 2690–6166 cpm for moderate physical activity (MPA), and more than 6167 cpm for vigorous physical activity (VPA).³⁵

Data collected from the Actigraph were analyzed with Actilife software to estimate the total time of performing moderate (MPA) and vigorous (VPA) physical activity during the monitored week. It allowed us to determine which of the studied women met the Global Recommendations on Physical Activity for Health popularized by the World Health Organization (WHO).³⁶ According to these

recommendations, participants were considered sufficiently physically active when they accumulated at least 150 mins of moderate physical activity (MPA) or at least 75 mins of vigorous physical activity (VPA) or an equivalent combination of moderate and vigorous physical activity (MVPA) during the week.

Work Ability Assessment

Perceived work ability was assessed using the standardized Work Ability Index (WAI) questionnaire.^{37,38} The index was derived as the sum of the ratings on the seven items, including current work ability compared with the lifetime best, work ability in relation to the demands of the job, number of current diseases diagnosed by physician, estimated work impairment due to diseases, sick leave during the past year (12 months), own prognosis of work ability two years from now, and mental resources.

The sum of scores was calculated (7 to 49 points), and also the four levels of the WAI were identified: poor (7–27 total scores), moderate (28–36 scores), good (37–43 scores), and excellent (44–49 scores). Therefore, this study included the results analyzed from each item, total WAI scores and the level of work ability.

Musculoskeletal Disorders Assessment

For assessment of musculoskeletal problems among participants, the standardized Nordic Musculoskeletal Questionnaire was used.³⁹

This questionnaire includes a body map to indicate any musculoskeletal problems in nine anatomical regions (neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, knees, and ankles/feet) over the past year and over the past week. In this study the NMQ questionnaire was expanded by adding a visual analog scale (VAS), which in case of problem complaints, also allowed to assess the pain intensity on a numerical scale 1–10 (1 – no pain; 10 –unbearable/worst pain).

Statistical Analysis

Descriptive statistics, such as statistical means (Mean) and standard deviations (SD) were used to describe the basic features of the quantitative data in the study, while qualitative variables were presented as percentages and frequencies. The non-parametric Kruskal-Wallis test (without multiple comparison tests) was used to compare quantitative variables between three age groups. Analysis of the level of work ability and musculoskeletal disorders among participants who met or did not meet physical activity recommendations

was performed separately for each age group. The relations between physical activity level (defined as those who met or did not meet WHO physical activity recommendations) and quantitative variables (scores of work ability, total musculoskeletal symptoms and pain intensity) were assessed using Mann-Whitney U test, and for the qualitative variables (percentage of participants with musculoskeletal problems in each anatomical region) using Chi-squared test. All analyses were performed using IBM SPSS 20 software. The level of significance of the *p*-value was set at 0.05.

Results

The average amount of time spent on moderate physical activity (MPA) was insignificantly different in all studied groups (Table 2). The highest time of MPA was recognized in group aged 50–64 years (176 min/week), and the lowest in women aged 30–49 years (164 min/week). Opposite results were obtained in the case of vigorous physical activity (VPA). The average time of VPA significantly decreased with age and was respectively: 25.68 min/week in the youngest women, 13.07 min/week in women aged 50–64 years, and 9.5 min/week in women aged 65–75 years ($p=0.008$). It should also be noted that the number of women who performed vigorous intensity physical activity during the week was generally small and decreased with age.

Total work ability scores also significantly decreased with age ($p=0.000$). Although there were no significant differences in the level of musculoskeletal disorders (MSD) declared in the last year, there were found in reported MSD and pain intensity during the last week. The women aged 30–49 years did not report any complaints at all, and the women aged 65–75 years reported musculoskeletal disorders most frequently, and

the pain intensity was the highest in comparison to the younger participants.

Due to some significant differences between women of various ages, further analyses were performed and presented separately for each age group. The next step of analysis was to verify the level and differences of work ability and musculoskeletal disorders among women sufficiently physically active (those who met the physical activity recommendations) and insufficiently physically active (those who did not meet physical activity recommendations) (Table 3). Regardless of age, women who met PA recommendations achieved higher scores in each part of the WAI, and also in the total WAI scores. However, the most significant differences were found in women aged 50–64 years, and included the following items: subjective work ability, work ability in relation to demands, work impairments, sick leave during past year. Total WAI scores were also significantly higher in women aged 30–49 and 50–64 years who met PA recommendations in comparison to women who did not meet recommendations.

Our results showed that musculoskeletal problems were common in all studied groups, regardless of the level of physical activity. The analysis did not show many significant relations between the frequency of occurrence of musculoskeletal problems in a particular anatomic region in the past year and adherence to physical activity recommendations (Table 4). The only significant relations were found in women aged 50–64 years. Those who were more physically active reported less musculoskeletal problems in shoulders ($p=0.006$) and ankles/feet ($p=0.018$) regions.

The next step of the analysis was to calculate the total amount of musculoskeletal disorders by adding up the occurrence of MSD from all anatomical regions reported

Table 2 Physical Activity Parameters, Work Ability Index, And Musculoskeletal Disorders Among Various Age Groups

Variables	Age									p-value
	30–49 Years			50–64 Years			65–75 Years			
	n	Mean	SD	n	Mean	SD	n	Mean	SD	
MPA (min/week)	111	164.40	133.20	120	176.10	108.42	117	171.10	91.68	0.104
VPA (min/week)	63	25.68	34.46	46	13.07	18.24	45	9.50	16.92	0.008
WAI score	111	41.93	5.39	117	35.07	6.88	120	30.69	7.19	<0.001
MSD (last year)	111	3.21	2.03	117	3.83	2.31	120	3.80	2.64	0.112
MSD (last week)	-	-	-	59	1.43	1.97	81	2.57	2.60	<0.001
Pain intensity	-	-	-	59	1.60	1.29	81	2.67	2.12	0.002

Note: Bold values indicate statistical significance.

Abbreviations: MPA, moderate physical activity; VPA, vigorous physical activity; WAI, work ability index; MSD, musculoskeletal disorders (number of anatomical regions with declared pain); Kruskal-Wallis test.

Table 3 Work Ability Among Women Who Met And Did Not Meet The Physical Activity (PA) Recommendations

Variables			Physical Activity Recommendations				p-value
			Not Meet		Meet		
			Mean	SD	Mean	SD	
Age	30–49 years	Subjective work ability	7.76	1.62	8.19	1.61	0.162
		Work ability in relation to demands	4.03	0.77	4.28	0.73	0.063
		Work ability in relation to demands	4.34	0.68	4.37	0.62	0.906
		Number of diseases	5.72	1.54	6.33	1.06	0.033
		Work impairments	5.37	0.98	5.65	0.57	0.198
		Sick leave in past year	4.59	0.92	4.86	0.41	0.132
		Prognosis of work ability	5.84	1.64	6.16	1.51	0.245
		Mental resources	3.37	0.75	3.53	0.88	0.417
		WAI score	41.01	5.85	43.37	4.25	0.042
	50–64 years	Subjective work ability	6.35	1.99	7.55	1.85	0.002
		Work ability in relation to demands	3.64	0.97	4.00	0.76	0.047
		Work ability in relation to demands	3.91	0.87	4.13	0.85	0.141
		Number of diseases	4.78	1.75	5.21	1.71	0.092
		Work impairments	4.36	1.44	4.92	1.25	0.033
		Sick leave in past year	2.38	1.86	3.15	1.96	0.031
		Prognosis of work ability	4.55	1.92	4.90	1.39	0.382
		Mental resources	3.07	0.77	3.18	0.70	0.495
		WAI score	33.75	7.53	36.28	6.05	0.036
	65–75 years	Subjective work ability	6.19	2.12	6.74	1.90	0.127
		Work ability in relation to demands	3.39	0.83	3.82	0.77	0.003
		Work ability in relation to demands	3.63	0.88	3.86	0.73	0.107
		Number of diseases	4.84	1.33	4.96	1.60	0.187
		Work impairments	3.80	1.84	4.05	1.83	0.418
		Sick leave in past year	1.37	1.17	1.51	1.43	0.615
		Prognosis of work ability	4.00	1.75	4.12	1.72	0.752
		Mental resources	2.61	0.79	2.80	0.80	0.186
		WAI score	29.36	7.88	31.81	6.41	0.059

Note: Bold values indicate statistical significance.

Abbreviations: WAI, work ability index; Mann Whitney U-test.

in the past year and last week (Table 5). Similar to our previous results, the only significant differences were found in women aged 50–65 years. Both the total MSD in the last year and the pain intensity in the last week were significantly higher in women who did not perform the recommended amount of physical activity.

Discussion

The main purpose of this study was to evaluate whether adherence to health-related physical activity recommendations is related to perceived work ability and musculoskeletal disorders among women of various ages. In this study, we only included women who declared mentally demanding occupations and sedentary type of job during the majority of their professional activity. This was

because we monitored total weekly physical activity. Meanwhile, some studies have shown that occupational physical activity is not beneficial for health.^{40,41} Therefore, the majority of physical activity of our participants was performed during their leisure-time.

Our study did not show any significant differences between the level of moderate physical activity among various age groups. However, the intensity of weekly physical activity decreased with increasing age. These results support the data previously demonstrated by Ayabe et al.⁴²

In our study, work ability level decreased with increasing age. Similar tendencies have been highlighted in previous studies.^{43,44} However, the number of reported musculoskeletal disorders in the last year did not differ

Table 4 Percentages Of Musculoskeletal Disorders Among Women Who Met And Did Not Meet The Physical Activity (PA) Recommendations

Region	Pain In The Last Year	Age									
		30–49 Years			p-value	50–64 Years		p-value	65–75 Years		p-value
		PA Recommendations		Did Not Meet		Met	PA Recommendations		Did Not Meet	Met	
		Did Not Meet	Met		Did Not Meet		Met	Did Not Meet			Met
Neck	No Yes	29.9 70.1	36.6 63.4	0.468	29.6 70.4	42.4 57.6	0.159	38.9 61.1	49.2 50.8	0.258	
Shoulders	No Yes	64.2 35.8	65.9 34.1	0.860	35.2 64.8	61 39	0.006	57.4 42.6	52.3 47.7	0.578	
Upper back	No Yes	53.7 46.3	51.2 48.8	0.800	48.1 51.9	66.1 33.9	0.054	63 37	61.5 38.5	0.873	
Elbows	No Yes	91 9	82.9 17.1	0.208	77.8 22.2	88.1 11.9	0.141	83.3 16.7	86.2 13.8	0.669	
Wrists/ Hands	No Yes	78.8 21.2	78 22	0.928	59.3 40.7	67.8 32.2	0.346	59.3 40.7	53.8 46.2	0.553	
Lower back	No Yes	17.9 82.1	31.7 68.3	0.099	22.2 77.8	35.6 64.4	0.118	38.9 61.1	35.4 64.6	0.707	
Hips/ Thighs	No Yes	80.6 19.4	85.4 14.6	0.528	61.1 38.9	59.3 40.7	0.846	64.8 35.2	64.6 35.4	0.982	
Knees	No Yes	71.6 28.4	63.4 36.6	0.372	50 50	59.3 40.7	0.320	42.6 57.4	52.3 47.7	0.291	
Ankles/ Feet	No Yes	79.1 20.9	75.6 24.4	0.672	59.3 40.7	79.7 20.3	0.018	66.7 33.3	61.5 38.5	0.562	

Note: Bold values indicate statistical significance.

Abbreviation: Chi-square test.

significantly between age groups. It could have been due to the fact that various musculoskeletal problems were very common in all tested women. Though, it should be noted that researchers and reports emphasize that the prevalence of musculoskeletal problems increases with aging.^{28,45} It could be caused by typical aging changes in musculoskeletal system, such as progressive loss of muscle mass and muscle strength (sarcopenia), and a decreased regenerative capacity. These changes are associated with impaired muscle metabolism, including mitochondrial dysfunction. However, a healthy lifestyle is a well-established countermeasure against muscle aging.^{46–48}

Our results show that adherence to physical activity recommendations was related to better work ability among women, regardless of age. Similar results were observed

among male workers.⁴⁹ The beneficial relation between various parameters of physical activity and work ability has been recognized in many previous studies.^{30,31,50,51} Also, some studies have shown that physical exercise can reduce musculoskeletal problems and pain among both adults^{25,52} and older people.^{24,53} In our study, similar results were observed in women aged 50–64 years. Both the prevalence of musculoskeletal problems reported in the past year, and intensity of musculoskeletal pain during last the week were significantly lower in women who met physical activity recommendations. These data confirm that physical activity has a positive influence on musculoskeletal aging. According to other studies, exercise has the potential to reverse and enhance the impaired mitochondrial function observed with aging. Exercise can attenuate age-related decreases in muscle mass, strength,

Table 5 Musculoskeletal Disorders And Pain In All Anatomical Regions Among Women Who Met And Did Not Meet Physical Activity (PA) Recommendations

Musculoskeletal Pain In All Anatomical Regions			PA Recommendations				p-value
			Did Not Meet		Met		
			Mean	SD	Mean	SD	
Age	30–49 years	Total MSD (last year)	3.39	2.19	3.29	1.86	0.941
		Total MSD (last week)	–	–	–	–	–
		Pain intensity (last week)	–	–	–	–	–
	50–64 years	Total MSD (last year)	4.57	2.43	3.41	1.89	0.009
		Total MSD (last week)	1.58	2.37	1.28	1.50	0.610
		Pain intensity (last week)	2.21	1.57	1.18	0.85	0.008
	65–75 years	Total MSD (last year)	3.91	2.70	3.83	2.62	0.904
		Total MSD (last week)	2.53	2.53	2.62	2.68	0.953
		Pain intensity (last week)	2.61	1.68	2.72	2.45	0.579

Note: Bold values indicate statistical significance.

Abbreviations: Total MSD, total musculoskeletal disorder (sum of the musculoskeletal disorders from all anatomic regions); Mann Whitney U-test.

and prevent impairments in muscle metabolism.^{46–48} Therefore, physical activity should be promoted as part of a healthy lifestyle essential to prevent musculoskeletal disorders during aging.

Strengths And Limitations

The main strength of this study is the objective measurement of weekly physical activity using the tri-axial accelerometer. This guarantees more accuracy of physical activity assessment in comparison to self-assessment using questionnaires. It has been confirmed in many studies that self-reported physical activity is often overestimated.^{54,55}

Furthermore, including in the research, three various age groups give a better and more versatile view of the level and changes of assessed parameters during aging.

The main limitation of this study is the cross-sectional design with a convenience sample which does not allow assessment of the cause-effect relationship. In future studies, the evaluation of the influence of implemented physical activity programs on work ability and musculoskeletal disorders will be very valuable and needed. Another limitation is the fact that in the group aged 65–75 years, the majority of women were not professionally active. Therefore, the comparison of this group to the others does not reflect accurately the real state in the aspect of full-time employment. However, we included this age group to verify the potential of physical activity in increasing perceived ability to work, which is very important especially in the context of policy to encourage greater labor market participation at an older age.

Conclusion

Adherence to Global Recommendations on Physical Activity for Health disseminated by WHO is related to better perceived work ability among adults (30–49 years) and middle-aged (50–64 years) women. There is also a relationship between recommended physical activity and prevalence and intensity of musculoskeletal pain among middle-aged women.

Study Implications

Observed relationships between levels of physical activity in all studied groups and their ability to work suggest that the creation and implementation of health-enhancing physical activity programs (based on WHO recommendations) in order to maintain the ability to work and high quality of life in an aging population should be mandatory. Further studies of assessment of the relationship between physical activity and the ability to work and musculoskeletal disorders should be performed among employed older people, including specifically work-related musculoskeletal disorders.

Disclosure

The authors report no conflicts of interest in this work.

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