Original paper

Physical activity of women treated for breast cancer in the context of sociodemographic factors

Aktywność fizyczna kobiet leczonych z powodu raka piersi w zakresie czynników socjodemograficznych

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Słowa kluczowe: rak piersi, aktywność fizyczna, czynniki socjodemograficzne, akcelerometr.

Abstract

Introduction: Physical activity (PA) is recommended for all cancer survivors to enhance their health and quality of life.
Aim of the research: To evaluate the influence of sociodemographic factors on the levels of PA of women undergoing treatment for breast cancer.
Material and methods: In a study conducted at Holycross Cancer Center, Kielce, Poland, we included 135 women who were receiving treatment for breast cancer. The objective measurement of PA was performed using the ActiGraph GT3X-BT accelerometer in conjunction with ActiLife 6 software. Additionally, we administered a questionnaire to assess sociodemographic factors (age, area of residence, marital, educational, and occupational status) and medical records (comorbidities, the side of mastectomy, lymphadenectomy, and the use of radiation therapy or chemotherapy).
Results: We observed significant differences in both the number of steps and the duration of moderate to vigorous physical activity (MVPA) based on comorbidity status. Age was notably related to the number of steps, light physical activity and MVPA. Furthermore, the area of residence was significantly related to light PA, and comorbidity status was associated with both the number of steps and MVPA.
Conclusions: We identified several sociodemographic factors – older age, number of comorbidities, and area of residence – that were significantly related to lower level of PA among women undergoing treatment for breast cancer. These findings should be taken into account when developing organized PA guidelines and promoting an active lifestyle among this patient group.

Streszczenie

Wprowadzenie: Aktywność fizyczna (PA) jest zalecana osobom, które przeżyły raka, aby poprawić zdrowie i jakość ich życia.
Cel pracy: Ocena wpływu czynników socjodemograficznych na poziom aktywności fizycznej kobiet leczonych z powodu raka piersi.
Materiał i metody: Do badania przeprowadzonego w Świętokrzyskim Centrum Onkologii w Kielcach włączono 135 kobiet leczonych z powodu raka piersi. Obiektywny pomiar aktywności fizycznej przeprowadzono za pomocą akcelerometru ActiGraph GT3X-BT w połączeniu z oprogramowaniem ActiLife 6. Dodatkowo przeprowadzono kwestionariusz ankiety oceniający czynniki socjodemograficzne (wiek, miejsce zamieszkania, stan cywilny, wykształcenie i status zawodowy) oraz dane medyczne (choroby współistniejące, strona mastektomii, limfadenektomia, stosowanie radioterapii lub chemioterapii).
Wyniki: Stwierdzono istotne różnice zarówno w liczbie kroków, jak i w czasie trwania umiarkowanej do intensywnej aktywności fizycznej (MVPA) w zależności od chorób współistniejących. Wiek wykazywał istotny związek z liczbą kroków, lekką aktywnością fizyczną (LPA) oraz MVPA. Miejsce zamieszkania było istotnie związane z lekką aktywnością fizyczną, natomiast liczba chorób współistniejących z liczbą kroków i MVPA.
Wnioski: Zidentyfikowano czynniki demograficzne – starszy wiek, liczba chorób towarzyszących oraz miejsce zamieszkania – jako istotnie związane z niższym poziomem aktywności fizycznej wśród kobiet leczonych z powodu raka piersi. Powyższe informacje powinny być uwzględniane przy tworzeniu programów zorganizowanej aktywności fizycznej i promocji aktywnego stylu życia w powyższej grupie kobiet.

Introduction

Engaging in regular physical activity (PA) is widely recommended for all cancer survivors due to its potential to improve health outcomes and quality of life. Consistent participation in PA is linked to reduction in cancer recurrence rates, increased survival, and improved health-related quality of life [1–10].

The American Cancer Society (ACS) has developed physical activity guidelines for cancer survivors, advocating for at least 150 min of exercise weekly [6, 11]. However, only approximately 37% of breast cancer survivors adhere to these guidelines [12, 13]. Data from the Behavioral Risk Factor Surveillance System (BRFSS) indicate that 31.5% of cancer survivors did not participate in PA during their leisure time [7].

The literature identifies numerous barriers to engagement in PA. Factors related to health, e.g. fatigue and joint stiffness, and emotional and cognitive challenges, as well as environmental factors, e.g. lack of facilities or inclement weather, all play a role [7, 14]. Notably, specific cancer-related impediments, including pain, fatigue and sociodemographic factors, hinder the ability to engage in PA.

The benefits of PA are indisputable. One of the most precise methods of its measurement is accelerometry, which captures 24-hour data on both PA and sedentary behaviors of study participants [15]. Duration, intensity, and frequency are recorded, at the same time limiting errors and inherent deviations often associated with subjective measurement methods [15, 16]. Precise assessment of PA and sedentary lifestyle using accelerometry enhances our understanding of those exposures and their impact on the health of patients undergoing cancer treatment. Such insights are invaluable for developing interventions aiming at modifying these behaviors. However, the quality of data recorded with an accelerometer is influenced by several decisions made during the recording and processing phases. Those critical decisions include type and location of the device, wear time protocols, epoch length, filtering techniques, and criteria for non-use and valid wear time. Another challenge is effectively processing the data to receive metrics such as total sitting time, light physical activity, and moderate to vigorous physical activity (MVPA) [15, 17, 18].

To facilitate effective and targeted interventions aimed at improving PA among BCS, our research focuses on sociodemographic characteristics influencing objectively assessed PA in this group.

Aim of the research

This research aims to evaluate the impact of sociodemographic factors on the physical activity levels of women undergoing breast cancer treatment.

Material and methods

Study population

In total, 135 women who underwent treatment for breast cancer in Holycross Cancer Center in Kielce, Poland were included in the study. The study was approved by the Ethics Committee in Kielce on May 19th, 2017 (approval no. 19/2017). A conversation was carried out informing the participants about the examination method, concluded by signing a consent form. The study was carried out in the Department of Rehabilitation, Holycross Cancer Center.

Demographics and cancer treatment variables

A questionnaire involving sociodemographic factors (age, area of residence, marital, educational, and occupational status) and medical data (comorbidities, the side of mastectomy, lymphadenectomy, and the use of radiation therapy or chemotherapy) was used in the study.

Sedentary behavior and physical activity assessment

Physical activity (PA) was objectively assessed using the triaxial ActiGraph GT3X-BT accelerometer (Pensacola, Florida, USA) paired with ActiLife 6 software (Pensacola, Florida, USA). This well-validated device measures the frequency, duration, and intensity of sedentary behavior, light PA (LPA), and MVPA. It incorporates an inclinometer that registers the wearer's orientation in three dimensions, which enables differentiation between sitting and standing positions. Participants were instructed to wear the accelerometer at waist level continuously for a week. After this duration, they returned the devices and were provided a comprehensive activity measurement summary.

Data were analyzed using ActiLife 6 software with a low-frequency extension and were aggregated into 60-second epochs. Every minute of device wear was categorized by intensity (counts per minute, cpm), employing Freedson cut points: < 100 cpm, sedentary lifestyle; 100–1.951 cpm, LPA; 1.952–5.724 cpm, MVPA ≥ 5.725 cpm [19, 20].

Wear time was determined using ActiLife 6 software, based on the Troiano 2007 algorithm. The minimum wear time criterion was set at 3 days. Non-wear time was defined as periods of at least 60 consecutive minutes with 0 counts, though interruptions of up to 2 min registering fewer than 100 CPM were permissible within this duration [21].

For each valid accelerometer wear day, minutes spent in sedentary lifestyle, LPA, and MVPA were tabulated. These daily estimates were then averaged across all valid days for each participant at every time point to determine the daily average minutes spent on each activity type. The number of minutes in each category was normalized by the total wear time to determine the percentage of the day allocated to each behavior. Furthermore, we assessed the daily steps using the accelerometer [21, 22].

Statistical analysis

Baseline statistics are presented as either mean (standard deviation), median (interquartile range), range (minimum-maximum) or number and proportion, depending on the nature of the specific variable. Statistical differences in PA based on the analyzed sociodemographic attributes were assessed using the Wilcoxon signed-rank test. Effect sizes are presented using Cohen's *d*. Relationships between PA and sociodemographic features were analyzed using robust regression models. Univariate and multivariate models were fitted. Sociodemographic features that demonstrated significance in prior analyses were incorporated into the multivariate models. *P*-values of < 0.05 were considered statistically significant. All analyses were executed using R software (version 3.6.3).

Results

A total of 135 women who underwent treatment for breast cancer were included in the study. Their average age was 63.2 ±10.0 years. All participants had undergone breast surgery. Regarding the methods of cancer treatment, 29.6% (n = 40) were treated using one method, 35.6% (n = 48) with two methods, and 34.8% (n = 47) with three methods, as outlined in Table 1. In terms of demographics, more than half of the women (63%) resided in urban areas, two-thirds were in a relationship, and 85% had university degrees. 70% of the patients were not currently engaged in professional activities. Approximately 70% of the women reported having comorbidities.

Table 2 presents the characteristics of PA intensities, segmented by sociodemographic variables. We observed significant differences in the number of steps and MVPA across diverse age categories. Using Cohen's *d* to assess the effect size, we found the observed differences to be of medium magnitude (Table 3). Moreover, significant differences based on the comorbidity status were noted both in the number of steps and MVPA, with the effect sizes also falling into the medium range, with Cohen's *d* values ranging between > 0.3 and < 0.8.

In the univariate regression models, presented in Table 4, negative values of regression coefficients signify a relative reduction in PA, while positive values denote a relative increase. A significant correlation was observed between age and the number of steps, LPA, and MVPA. Additionally, the area of residence was significantly linked to LPA, while the comorbidity status correlated with both the number of steps and MVPA.

Table 1. Basic characteristic of study group (n = 135; 100%)

Characteristic	*N* (%)
Age [years]:	
65 or older	68 (50.4)
Less than 65	67 (49.6)
Mastectomy side:	
Left side	70 (51.9)
Right side	48 (35.6)
Both side	17 (12.6)
Lymphadenectomy:	
No	82 (60.7)
Yes	53 (39.3)
Radiotherapy:	
No	66 (48.9)
Yes	69 (51.1)
Chemotherapy:	
No	62 (45.9)
Yes	73 (54.1)
Area of residence:	
Rural	50 (37.0)
Urban	85 (63.0)
Marital status:	
In a relationship	90 (66.7)
Single	45 (33.3)
Education:	
Higher level	115 (85.2)
Lower level	20 (14.8)
Occupational status:	
Professionally active	40 (29.6)
Professionally inactive	95 (70.4)
Comorbidities:	
No	38 (28.2)
Yes	97 (71.9)

Age, area of residence, occupational status, education, and comorbidities were included in the multivariate analyses. Their inclusion, however, differed based on the application of specific models. In multivariate regression models (Table 5), age and comorbidity status displayed a significant relationship with the number of steps. Interestingly, among the socioeconomical variables evaluated, only age was consistently related to MVPA in all subsequent multivariate models.

Table 2. Basic characteristics of the analyzed intensities of PA according to the category of socio-demographic features

Characteristic	Steps number	LPA [min/day]	MVPA [min/day]	Sedentary behaviors [min/day]
Age [years]:				
65 or older				
Mean (SD)	5544.84 (2200.33)	286.02 (74.38)	18.49 (17.59)	776.30 (204.19)
Median (IQR)	5390.50 (2734.00)	288.35 (73.75)	16.90 (20.85)	761.00 (357.60)
Min.–max.	920.00–13911.00	93.40–465.40	0.30–95.30	443.40 (1466.80)
Less than 65				
Mean (SD)	6820.07 (2169.47)	313.49 (76.01)	28.79 (18.76)	785.41 (166.49)
Median (IQR)	6965.00 (2673.00)	319.60 (109.20)	26.00 (23.80)	833.70 (227.10)
Min.–max.	1999.00–11878.00	126.50–477.40	0.10–73.50	260.00 (1067.00)
Area of residence:				
Rural				
Mean (SD)	6227.86 (2141.26)	320.84 (75.29)	23.39 (17.91)	803.01 (151.76)
Median (IQR)	6543.00 (3595.00)	325.20 (86.20)	18.35 (24.20)	848.60 (169.20)
Min.–max.	1999.00–10177.00	126.50–477.40	0.10–72.00	445.30–1067.00
Urban				
Mean (SD)	6148.25 (2352.90)	287.19 (74.33)	23.73 (19.47)	767.77 (202.89)
Median (IQR)	6073.00 (2841.00)	281.60 (98.90)	20.10 (23.80)	767.00 (343.60)
Min.–max.	920.00–13911.00	93.40–465.40	0.30–95.30	260.00–1466.80
Marital status:				
In a relationship				
Mean (SD)	6274.54 (2224.67)	305.72 (74.56)	23.26 (17.85)	783.77 (168.87)
Median (IQR)	6155.00 (2974.00)	308.10 (88.00)	19.85 (21.70)	832.85 (286.60)
Min.–max.	1776.00–13911.00	112.00–477.40	0.10–95.30	260.00–1067.00
Single				
Mean (SD)	5984.11 (2368.79)	287.51 (78.74)	24.30 (20.88)	774.92 (217.70)
Median (IQR)	5903.00 (3035.00)	284.90 (99.90)	19.60 (26.10)	725.10 (349.70)
Min.–max.	920.00–11878.00	93.40–445.10	0.30–73.50	442.40–1466.80
Education:				
Higher				
Mean (SD)	6138.02 (2338.30)	295.69 (75.13)	22.82 (18.69)	778.44 (190.66)
Median (IQR)	6075.00 (3158.00)	298.00 (89.90)	19.20 (21.80)	810.00 (327.50)
Min.–max.	920.00–13911.00	93.40–474.30	0.10–95.30	260.00–1466.80
Lower				
Mean (SD)	6406.10 (1854.71)	322.44 (80.11)	28.12 (19.52)	794.54 (158.47)
Median (IQR)	6910.50 (2653.50)	329.65 (131.55)	29.40 (24.35)	832.00 (224.60)
Min.–max.	3233.00–9099.00	191.20–477.40	1.00–72.00	506.50–1014.60
Occupational status:				
Professionally active				
Mean (SD)	6749.08 (2290.90)	305.52 (70.71)	27.12 (17.84)	804.86 (164.69)
Median (IQR)	6941.00 (3366.00)	317.60 (117.55)	26.30 (25.95)	844.20 (174.45)
Min.–max.	2015.00–11878.00	165.00–451.40	0.60–73.50	260.00–1067.00

Table 2. Cont.

Characteristic	Steps number	LPA [min/day]	MVPA [min/day]	Sedentary behaviors [min/day]
Professionally inactive				
Mean (SD)	5937.17 (2228.11)	297.18 (78.59)	22.13 (19.14)	770.70 (193.92)
Median (IQR)	5910.00 (2836.00)	296.00 (92.10)	18.80 (23.50)	776.80 (346.50)
Min.–max.	920.00–13911.00	93.40–477.40	0.10–95.30	442.40–1466.80
Comorbidities:				
No				
Mean (SD)	7179.82 (2205.51)	319.19 (76.93)	28.96 (18.61)	803.28 (183.88)
Median (IQR)	7157.50 (2813.00)	325.05 (115.70)	26.25 (22.10)	786.60 (225.10)
Min.–max.	2608.00–11878.00	165.00–477.40	1.00–73.50	474.40–1466.80
Yes				
Mean (SD)	5785.16 (2181.39)	292.00 (74.89)	21.51 (18.60)	772.02 (186.74)
Median (IQR)	5897.00 (2880.00)	294.50 (86.50)	17.80 (23.60)	838.10 (345.90)
Min.–max.	920.00–13911.00	93.40–474.30	0.10–95.30	260.00–1059.00

PA – physical activity, MVPA – moderate to vigorous physical activity, min/day – minutes per day, SD – standard deviation, IQR – interquartile range, min.–max. – minimum–maximum.

Discussion

Approximately two-thirds of cancer survivors do not adhere to ACS physical exercise guidelines. Various factors – including sociodemographic, economic, health-related, and cancer-related elements – are perceived as obstacles to engagement in regular PA [7, 23].

In our study, we assessed which sociodemographic factors influence objectively measured physical activity. A relationship was identified between the number of steps taken, age, and area of residence. The average number of steps among women older than 65 years undergoing treatment for breast cancer was 5,544 steps, compared to an average of 6,820 steps for women younger than 65 years.

WHO guidelines indicate that a minimum of 10,000 steps daily is required for preservation of good health. The studied population exhibited low activity, ranging from 5000 to 7499 steps/day. Therefore, on average, the women in our study did not adhere to the guidelines. Number of steps is classified as follows: 1) sedentary lifestyle (< 5000 steps/day); 2) low activity (5000–7500 steps/day); 3) somewhat active (7500–9999 steps/day); 4) active (≥ 10,000 steps/day); 5) highly active (12500 steps/day) [24].

Achieving 10,000 steps per day has emerged as a universal benchmark for physical fitness [25]. This target equates to an energy expenditure of approximately 300–400 kcal, contingent upon walking pace and body mass. The weekly energy expenditure associated with achieving 10,000 steps on more than 3 days is comparable to 30 min of moderate PA performed on most weekdays. This level of activity mirrors the energy expenditure (pegged at 1,000 kcal/week) tied to a marked reduction in mortality from cardiovascular disorders. According to growing body of scientific evidence, in order to preserve and improve cardiovascular fitness, as well as to maximize health benefits overall, it is recommended to engage in MVPA. Assessing PA according to number of steps is considered the correct approach to increase health-related PA. However, controversies persist regarding the exact number of steps needed to preserve health and physical fitness [24, 26, 27].

Our findings align with existing literature, in which age has consistently been identified as an important barrier to engagement in PA [7, 28, 29]. Presence of comorbidities and higher BMI were also associated with decreased PA [28]. Other authors point to demographic factors, including older age and lower education levels, as contributors to lower PA among breast cancer survivors [29].

Our research did not demonstrate a relationship between PA and education level in women treated for breast cancer. Nevertheless, other studies indicate that a lower education level is associated with decreased PA following a diagnosis [30]. Compared to participants with higher or vocational education, those with only secondary education or those who did not complete high school were 2.4 and 5.9 times more likely to remain professionally inactive after diagnosis. Patients with higher education perceived PA as a method to decrease fatigue and improve the quality of life. Interestingly, 9% of participants stated that "uncertainty about what they are allowed to do" served as a barrier to engaging in PA. Less-educated patients reported this limitation more frequently [30].

Table 3. Differences in PA by category of sociodemographic features with estimated effect sizes

Characteristic	*T*	d*f*	Cohen's *d*	95% CI		*P*-value
				Lower	Upper	
Age:						
Steps [number]	–3.39	133.00	–0.58	–0.93	–0.24	< 0.0001
LPA [min/day]	–1.25	133.00	–0.22	–0.55	0.12	0.2154
MVPA [min/day]	–3.29	133.00	–0.57	–0.91	–0.22	0.0013
Sedentary behavior [min/day]	–0.28	133.00	–0.049	–0.39	0.29	0.7769
Area of residence:						
Steps [number]	0.20	110.74	0.04	–0.31	0.38	0.8410
LPA [min/day]	1.84	100.79	0.33	–0.02	0.68	0.0682
MVPA [min/day]	–0.10	109.81	–0.02	–0.37	0.33	0.9179
Sedentary behavior [min/day]	1.15	125.36	0.20	–0.15	0.55	0.2539
Marital status:						
Steps [number]	0.69	83.35	0.13	–0.23	0.48	0.4951
LPA [min/day]	0.91	91.78	0.16	–0.19	0.52	0.3669
MVPA [min/day]	–0.29	76.95	–0.05	–0.41	0.30	0.7742
Sedentary behavior [min/day]	0.24	71.27	0.05	–0.31	0.40	0.8116
Education:						
Steps [number]	–0.57	30.57	–0.13	–0.60	0.35	0.5714
LPA [min/day]	–1.25	24.70	–0.31	–0.79	0.17	0.2220
MVPA [min/day]	–1.13	25.44	–0.28	–0.76	0.21	0.2699
Sedentary behaviors [min/day]	–0.41	29.46	–0.09	–0.57	0.38	0.6876
Occupational status:						
Steps [number]	1.90	71.54	0.36	–0.02	0.73	0.0621
LPA [min/day]	0.14	76.82	0.03	–0.34	0.39	0.8924
MVPA [min/day]	1.45	78.34	0.27	–0.10	0.64	0.1506
Sedentary behavior [min/day]	1.04	85.71	0.19	–0.18	0.56	0.3001
Comorbidities:						
Steps [number]	3.31	67.00	0.64	0.24	1.02	0.0015
LPA [min/day]	1.36	67.41	0.26	–0.12	0.64	0.1773
MVPA [min/day]	2.09	67.66	0.40	0.02	0.78	0.0401
Sedentary behavior [min/day]	0.88	68.62	0.17	–0.21	0.54	0.3796

PA – physical activity, MVPA – moderate to vigorous physical activity, min/day – minutes per day, T – t-statistic, df – degrees of freedom, Cohen's d – Cohen's delta, 95% CI – 95% confidence interval.

In the Life and Longevity After Cancer (LILAC) study conducted by the Women's Health Initiative (WHI), women (n = 3710) possessing higher education levels, better self-esteem, improved physical fitness, and robust support systems, were more likely to engage in any type of physical activity [31].

In line with our study, other authors have also failed to find a significant relationship between PA and marital status [7, 27]. Nevertheless, we did observe a relationship between PA (both the number of steps and MVPA) and the presence of comorbidities. With an increase of number of comorbidities, PA correspondingly decreased.

Various epidemiological studies have explored the connection between PA and comorbidities of cancer survivors. For instance, a cross-sectional study involving women found that while total PA was not related to multimorbidity, the time spent walking

Table 4. Associations of sociodemographic features with PA according to the examined intensities based on univariate regression models

Characteristic	Steps number		LPA [min/day]		MVPA [min/day]		Sedentary behaviors [min/day]	
	Estimate (95% CI)	*P*-value	Estimate (95% CI)	*P*-value	Estimate (95% CI)	*P*-value	Estimate (95% CI)	*P*-value
Age [years]:								
Less than 65 vs. 65 or older	1275.24 (531.34, 2019.13)	0.0009	27.48 (1.87, 53.08)	0.0357	10.30 (4.10, 16.49)	0.0013	9.11 (–54.27, 72.49)	0.7766
Area of residence:								
Urban vs. rural	–79.61 (–862.92, 703.70)	0.8410	–33.65 (–60.07, –7.24)	0.0129	0.34 (–6.18, 6.86)	0.9179	–35.24 (–96.04, 25.57)	0.2537
Marital status:								
Single vs. in a relationship	–290.43 (–1128.87, 548.01)	0.4944	–18.21 (–46.15, 9.73)	0.1996	1.05 (–6.15, 8.24)	0.7739	–8.85 (–82.07, 64.36)	0.8113
Education:								
Lower vs. higher	268.08 (–658.70, 1194.87)	0.5700	26.75 (–11.29, 64.79)	0.1666	5.30 (–4.00, 14.60)	0.2614	16.10 (–62.32, 94.51)	0.6854
Occupational status:								
Professionally active vs professionally inactive	–811.91 (–1659.12, 35.31)	0.0600	–8.33 (–35.60, 18.93)	0.5466	–4.99 (–11.79, 1.81)	0.1490	–34.16 (–98.98, 30.66)	0.2991
Comorbidities:								
Yes vs no	–1394.65 (–2226.96, –562.35)	0.0012	–27.19 (–56.09, 1.71)	0.0650	–7.45 (–14.50, –0.41)	0.0382	–31.25 (–101.17, 38.66)	0.3782

PA – physical activity, MVPA – moderate to vigorous physical activity, min/day – minutes per day, 95% CI – 95% confidence interval.

was inversely proportional to the number of comorbidities [32]. However, this study was limited due to the small size of its cohort.

A retrospective cohort study involving 1526 cancer survivors revealed that moderate to high levels of physical activity were correlated with a 35% to 45% decrease in the presence of cardiovascular risk factors, including diabetes or hypertension [33]. Other comorbidity groups were not studied. Additionally, a prospective cohort study of 1,696 breast cancer survivors demonstrated that moderate PA, such as 30 min of daily walking, led to a 31% decrease in the incidence of metabolic syndrome [34]. Notably, other comorbidities were not studied. Altogether, the results of these studies demonstrate an inverse relationship between PA and several comorbidities, such as diabetes and hypertension, in cancer survivors. These studies were limited in terms of range of studied comorbidities and types of PA. Dong-Woo *et al.* further expanded on this, investigating the associations between various comorbidities based on type of exercise (aerobic vs. strength training) and doses (completely inactive vs. insufficiently active vs. following PA guidelines). Elevated blood glucose concentrations are related to worse prognosis in cancer patients, but this association varies depending on the location of cancer [35, 36].

Jeon *et al.* found that diabetic patients who survived colon cancer had 20% shorter disease-free survival compared to non-diabetic patients [37]. A similar trend was observed in breast cancer, prostate cancer, and bladder cancer patients [35]. Research by Dong-Woo *et al.* reported an inverse relationship between frequency of aerobic PA and fasting glycemia. Physically inactive cancer survivors were found to have higher average glucose concentrations (102.6 ±1.3 mg/dl), indicative of prediabetes. Conversely, those who adhered to PA guidelines had normal glycemia, at 95.8 ±1.7 mg/dl. Patients who adhered to aerobic PA guidelines had approximately a 35% reduced risk of diabetes compared to patients who did not exercise. This is consistent with well-documented evidence on the positive influence of PA on diabetes management

Table 5. Associations of sociodemographic features with PA according to the examined intensities based on multivariate regression models

Physical activity	Model	Estimate (95% CI)	*P*-value
Number of steps	Age – less than 65 years vs. 65 or older	1093.86 (207.27, 1980.45)	0.0160
	Occupational status – professionally inactive vs. professionally inactive	268.53 (–636.07, 1173.14)	0.5581
	Comorbidities – yes vs. no	–1084.19 (–1932.35, –236.02)	0.0126
LPA [min/day]	Age – less than 65 years vs. 65 or older	20.10 (–10.38, 50.57)	0.1943
	Area of residence – urban	–21.72 (–49.81, 6.36)	0.1284
	Occupational status – professionally inactive vs. professionally inactive	16.48 (–16.22, 49.18)	0.3207
	Education – lower level	17.68 (–21.28, 56.64)	0.3710
	Comorbidities – yes vs. no	–23.54 (–50.69, 3.62)	0.0887
MVPA [min/day]	Age – less than 65 years vs. 65 or older	10.32 (2.33, 18.32)	0.0118
	Education – lower level	5.24 (–3.18, 13.67)	0.2204
	Occupational status – professionally inactive vs. professionally inactive	2.83 (–5.29, 10.96)	0.4915
	Comorbidities – yes vs. no	–4.94 (–12.15, 2.26)	0.1770
Sedentary behavior [min/day]	Area of residence – urban	–29.14 (–92.26, 33.99)	0.3629
	Occupational status – professionally inactive vs. professionally inactive	–26.72 (–93.93, 40.48)	0.4329

PA – physical activity, MVPA – moderate to vigorous physical activity, min/day – minutes per day, 95% CI – 95% confidence interval.

and glycemic control [38]. The physiological mechanisms behind the relationship between PA and cancer prognosis remain elusive. However, PA may contribute to the systemic regulation of blood glucose and insulin concentrations, subsequently restricting glucose uptake and growth in cancer cells. It could also play a role in anti-proliferative processes, through inhibition of the direct and indirect mechanisms associated with glucose and insulin intake, and cancer growth [36, 39, 40].

Elevated blood pressure or hypertension often coexists with diabetes in cancer patients [41]. While the association between hypertension and cancer patients' prognosis is not universal, maintaining normal blood pressure decreases the risk of death due to cardiovascular disease [42–44]. Prior usage of angiogenesis inhibitors in cancer survivors also increases the risk of both hypertension onset and cardiovascular disease-related deaths [36, 45].

The results of our research imply that area of residence is associated with LPA frequency. Individuals living in rural areas showed a higher likelihood of engaging in PA. Lynch *et al.* found, consistent with our study, that colon cancer survivors in Australia residing in urban areas were less likely to adopt or maintain a healthy lifestyle after diagnosis when compared to those in rural settings [46]. In contrast, Weaver *et al.* reported that cancer survivors from rural areas were less likely to engage in PA compared to urban residents [47]. Such divergent findings could arise from variations in the classification of residence areas, contextual differences, as well as regional or societal factors [28].

Our research holds significance for patients after the diagnosis of breast cancer, for whom PA should be an integral part of lifestyle. The indicated socioeconomic factors point to specific patient demographics that would benefit from more frequent fitness-oriented interventions.

Strengths and weaknesses of the study

This study has several limitations. First, the accelerometer cannot differentiate specific subtypes of physical activity, such as cycling or swimming, and may misclassify actions that are not truly PA. For instance, driving a car could be recorded as movement rather than sedentary behavior. While the Freedson cut points are broadly acknowledged in assessment of PA of cancer survivors, they originate from studies on healthy adults with an average age of 24 years. Consequently, the accelerometer might not detect the optimal MVPA in older populations, including cancer survivors. The studied groups are often characterized by multiple comorbidities and lingering side effects of cancer treatment, which compromises their functional fitness. Therefore, the cut points derived from a younger population might not always be pertinent for cancer survivors.

However, there are multiple notable strengths to this study. Primarily, robust measurement methods were employed. Employing accelerometers to monitor sitting duration is less susceptible to errors associated with self-assessment, such as recall biases. Furthermore, accelerometers outperform self-assessment tools in registering LPA and sedentary behavior. Ability to accurately assess LPA is particularly important in this population, because, as the data indicate, it tends to engage more in LPA than in MVPA.

Conclusions

We identified demographic factors – older age, number of comorbidities, and area of residence – as significantly related to lower activity levels of women undergoing treatment for breast cancer. This information should be taken into consideration when encouraging organized PA and a healthy lifestyle for this group of patients.

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Conflict of interest

The authors declare no conflict of interest.

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