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The influence of objectively measured physical activity and sedentary time on the fitness of elderly female breast cancer survivors – pilot study

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Abstract

Introduction and Objective. Treatment for breast cancer is associated with numerous adverse effects that may impair functional fitness. The aim of the study is to assess physical fitness levels and examine the influence of objectively measured physical activity and sedentary time on functional fitness among independently functioning breast cancer survivors (BCS) over the age of 60. The influence was assessed of the overall distribution of adiposity and adipose tissue on the level of fitness and physical activity.

Materials and Method. 88 breast cancer survivors with an average age of 69 years were included in the study. Physical activity was measured using ActiGraph GT3X triaxial accelerometer. Senior Fitness Test (SFT) was used to assess functional fitness.

Results. Time spent in moderate-to-vigorous physical activity was positively correlated with performance in SFT3, SFT4, SFT5 and SFT6 trials. Sitting time showed a negative correlation with SFT1, SFT3, SFT5 and SFT6 trial results. Objective measurements of PA indicated that participants primarily engaged in LPA, with an average of approximately 290 minutes per day. Average daily sitting time was 765 minutes.

Conclusions. Breast cancer survivors often fail to meet the recommendations regarding physical fitness. The flexibility of the upper extremity, agility and balance were the most impaired components. Patients older than 60 years do not undertake vigorous physical activity. Improvements in functional fitness were seen in older patients who engaged in more physical activity or spent less time sitting.

Key words

breast cancer, physical activity, accelerometer

INTRODUCTION

Breast cancer (BC) is the most common malignancy among women globally, accounting for 11.7% of all cancer cases and 6.9% of cancer-related deaths. Treatment for breast cancer is often associated with a range of adverse effects that can negatively impact functional fitness, reduce patient independence, and significantly reduce the overall quality of life. These challenges are particularly pronounced with advancing age, making it increasingly difficult for older female breast cancer survivors (BCS) to meet recommended levels of physical fitness. To define and promote health-enhancing levels of physical activity (PA), the World Health Organization (WHO) published the *Global Recommendations on Physical Activity for Health* [1], guidelines which recommend that adults engage in at least 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous-intensity aerobic activity, or an equivalent combination of moderate-to-vigorous physical activity (MVPA) per week, accumulated in series of at least 10 minutes each. For instance, this can be achieved by performing 30 minutes of MVPA on 5 days per week, or approximately 21.4 minutes daily across 7 days [1]. Accelerometers are devices for objectively measuring participants' overall PA and sedentary behaviour throughout 24 hour periods, recording data on the duration, intensity, and frequency of activity, while minimizing error and variability commonly associated with self-reported measures [2]. The relationship between PA levels, sedentary behaviour and physical fitness among elderly BCS, is assessed by utilizing objective measurement methods, of which one of the standard measurement tools for adults of age 60 or older is the Senior Fitness Test (SFT), introduced by Rikli and Jones in 1999 [3].

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Obesity is a significant risk factor that limits physical fitness and the level of physical activity in older adults, including women who have survived breast cancer. It is important to note that obesity often coexists with chronic diseases such as respiratory disorders (e.g., asthma, chronic obstructive pulmonary disease), cardiovascular conditions (e.g., heart failure, myocardial infarction), and neurological diseases (e.g., ischemic stroke, Parkinson's disease, Alzheimer's disease). The presence of these comorbidities may further restrict the ability of older adults to engage in physical activity, negatively affecting their functional fitness and quality of life.

Despite the growing body of evidence on the benefits of physical activity (PA) for breast cancer survivors (BCS), there remains a significant gap in understanding how objectively measured PA and sedentary behaviour influence functional fitness in elderly BCS, particularly in Central and Eastern Europe. Previous systematic reviews and meta-analyses, such as the work by Spei et al. (2019), have demonstrated that increased PA is associated with improved overall and breast cancer-specific survival among survivors. However, most studies rely on self-reported PA and rarely address the combined impact of obesity and chronic comorbidities on physical function.

OBJECTIVES

The study had several aims: objective assessment of the relationship between PA, sedentary time, obesity, chronic diseases, and physical fitness in a cohort of independently functioning elderly female BCS [4]; assessment of the levels of physical fitness and influence of objectively assessed PA, as well as sedentary behaviour on the physical fitness in a group of independently functioning BCS over the age of 60; assessment of the influence of the overall adiposity index and adipose tissue distribution on levels of fitness and PA.

MATERIALS AND METHOD

Study population. The epidemiological clinical study involved a cohort of 88 female breast cancer survivors recruited from the Holy Cross Cancer Centre in Kielce, Poland. The research was conducted in 2022 within the Centre's Rehabilitation Department. Recruitment was open to all patients attending the rehabilitation Outpatient Clinic, with inclusion limited to those who voluntarily consented to participate. The study protocol received ethical approval from the Ethics Committee in Kielce (Approval No. 19/2017, dated 19 May 2017).

Inclusion criteria included female gender only, histopathological confirmation of breast cancer, aged over 60 years at examination, the completion of surgical intervention – either unilateral or bilateral mastectomy – as well as completion of radiotherapy (RTH) and/or chemotherapy (CHTH). Patients were required to collect at least 3 full days of accelerometer data and had performed all of the SFT trials. Exclusion criteria – male sex and being hospitalized on the day of assessment.

Demographics and cancer treatment variables. The study utilized a questionnaire to collect demographic data, including age, educational background, marital status, and place of residence, as well as medical information: such as treatment history, mastectomy laterality, lymphadenectomy status, and presence of comorbidities. Anthropometric assessments included measurements of body mass and waist and hip circumferences, conducted by the personnel. Participant height was self-reported.

General adiposity assessment. BMI values were categorized in accordance with the World Health Organization (WHO) classification: underweight: <18.50 kg/m², normal weight: 18.50–24.99 kg/m², overweight: 25.00–29.99 kg/m², and obesity: ≥30.00 kg/m² [5, 6, 7, 8].

Adipose tissue distribution measurement. A waist circumference (WC) of less than 88 cm was considered normal, whereas a WC of 88 cm or more was classified as central (abdominal) obesity, in accordance with the WHO criteria for women. The waist-to-hip ratio (WHR) was calculated by dividing waist circumference by hip circumference, and categorized as either normal (WHR < 0.85) or abdominal obesity (WHR ≥ 0.85), following WHO recommendations. Additionally, the waist-to-height ratio (WHtR) was computed by dividing waist circumference by height, with values < 0.5 indicating a normal distribution of adipose tissue and values ≥ 0.5 reflecting increased cardiometabolic risk. [9].

Sedentary behaviour and physical activity assessment. A well-validated, triaxial ActiGraph GT3X-BT accelerometer (ActiGraph LLC, Pensacola, FL, USA) was employed to obtain objective measurements of PA. The device recorded the frequency, duration, and intensity of sedentary behaviour, light-intensity PA (LPA), and MVPA. The accelerometer is equipped with a built-in inclinometer that records body position across 3 dimensions, enabling the distinction between sitting and standing postures.

Wearing the accelerometer at waist level for 24 hours per day for 7 consecutive days, was recommended to the participants. A minimum of 3 days of valid wear time was required for data inclusion. Following the monitoring period, participants returned the devices and received personalized feedback along with a printout of their activity data. All complete and valid data were processed using ActiLife 6 software, employing the low-frequency extension setting and aggregated into 60-second epochs. Each minute of recorded data was classified by intensity level – sedentary, LPA, or MVPA – based on counts per minute (cpm), using the Freedson cutpoints (≥5.725 cpm) [2]. Wear time was determined according to the Troiano (2007) algorithm, as implemented in ActiLife 6. Non-wear time was defined as any sequence of at least 60 consecutive minutes of zero counts, allowing for up to 2 minutes of activity with counts under 100 cpm within that interval [10]. For each valid day of wear, the number of minutes spent in sedentary behaviour, LPA, and MVPA was extracted as an estimate of daily time allocation to each activity type. The daily values were averaged across all valid days for each participant at each measurement time point, providing individual-level estimates of average daily activity. To account for variations in wear time, the number of minutes in each activity category was normalized by dividing by total daily wear time, yielding the percentage of the day spent in each behavioural category [10].

Table 1. Senior Fitness Test (SFT): descrpitions and normative values for the subsequent trials

SFT Trial	Assessed Domain	Description	Reference Values by Age Group (min–max)
SFT1	Lower body strength	30-second Chair Stand Test: Number of full stands from a seated position completed in 30 seconds.	60–64: 13–19 65–69: 12–18 70– 74: 12–17 75–79: 11–17 80–84: 10–16 85–89: 10–15
SFT2	Upper body strength	30-second Arm Curl Test: Number of forearm curls with a dumbbell completed in 30 seconds.	60–64: 12–17 65–69: 11–16 70– 74: 10–15 75–79: 10–15 80–84: 9–14 85–89: 8–13
SFT3	Aerobic endurance	2-minute Step Test: Number of knee raises to mid-thigh height performed in place.	60–64: 75–107 65–69: 73–107 70–74: 68–101 75–79: 68–100 80–84: 60–90 85–89: 55–85
SFT4	Lower body flexibility	Chair Sit-and-Reach Test: Distance [cm] between fingertips and toes when bending forward with one leg extended while seated. '+' = beyond toes; '–'= short of toes.	60–64: –0.5 to +5.0 65–69: –0.5 to +4.5 70–74: –1.0 to +4.0 75–79: – 1.5 to +3.5 80–84: –2.0 to +3.0 85–89: –2.5 to +2.5
SFT5	Upper body flexibility	Back Scratch Test: Distance [cm] between middle fingers when reaching over the shoulder and behind the back. '+' = overlap; '–'= gap.	60–64: –3.0 to +1.5 65–69: –3.5 to +1.5 70–74: –4.0 to +1.0 75–79: – 5.0 to +0.5 80–84: –5.5 to +0.0 85–89: –7.0 to –1.0
SFT6	Agility & dynamic balance	8-Foot Up-and-Go Test: Time [s] to rise from a chair, walk 2.44 m, turn, and return to the seated position.	60–64: 4.4–6.0 65–69: 4.8–6.4 70–74: 4.9–7.1 75–79: 5.2–7.4 80–84: 5.7–8.7 85–89: 6.2–9.6

Physical fitness assessment (SFA). The SFA was used to assess the physical fitness. This is the only test battery recommended for older adults by the International Council of Sport Science and Physical Education. Normal values for healthy elderly individuals were developed based on the authors' research [11].

Senior fitness test (SFT). Comprises a series of assessments designed to evaluate key components of physical fitness in older adults, including aerobic capacity, neuromotor function, musculoskeletal strength, and overall health-related fitness, reflecting intrinsic capacity [11]. The trials included in the test are presented in Table 1.

Statistical analysis. NCSS 20 software was used to perform the statistical analyses. Spearman rank correlation coefficients were estimated between SFT and PA results. Differences in the analyzed scales based on area of residence, marital status, education level, professional activity, presence of comorbidities, BMI, WC, WHR, WHtR and MVPA, were evaluated using the Mann–Whitney U test. The relationships between the analyzed scales and BMI, WC, WHR, and WHtR were further assessed using Spearman rank correlation coefficients.

RESULTS

The study sample consisted of 88 female BCS (100%), with a mean age of 69.2 ± 5.9 years. For each main outcome, both the statistical significance and the effect size are reported. For example: 'A weak negative correlation was observed between SFT1 performance and total sitting time (Spearman's rho = -0.23, $p < 0.05$), indicating a small effect size.' This approach is applied consistently across all reported associations.

Objective measurements of PA indicated that participants primarily engaged in LPA, averaging approximately 290 minutes per day. No instances of vigorous PA were recorded among the study group. Average daily sitting time – 765 minutes. Performance on all components of the SFT fell below recommended normative values. The most pronounced limitations were observed in the SFT5 and SFT6 trials (Tab. 2).

Significant associations were observed between physical fitness outcomes and physical activity parameters (Tab. 3). A statistically significant ($p < 0.05$) weak negative correlation was found between SFT1 performance and total sitting time across all days. A highly significant ($p < 0.01$) weak positive correlation was noted between SFT3 and the number of days with moderate physical activity, as well as with MVPA frequency. Additionally, SFT3 showed a highly significant ($p < 0.01$) weak negative correlation with total sitting time. SFT4 was positively correlated at a low level with both average moderate PA days and MVPA ($p < 0.05$).

A highly significant ($p < 0.01$) weak negative correlation was identified between SFT5 (right arm) and average sitting time. Similarly, SFT5 (left arm) was also negatively correlated with average sitting time ($p < 0.01$) and demonstrated highly significant ($p < 0.01$) weak positive correlations with the number of days involving light, moderate, and MVPA. SFT6 exhibited a statistically significant moderate positive correlation with sitting time and statistically significant negative correlations with light, moderate, and MVPA days – of which the correlation with LPA was highly significant ($p < 0.01$), while the remaining correlations reached significance at the $p < 0.05$ level.

For the SFT5 right arm (SFT5P) and left arm (SFT5L) trials, significant differences were observed across BMI categories, with higher scores recorded in the 'Normal Weight' group. Highly significant differences were observed in SFT4, SFT5 right arm (SFT5P), SFT5 left arm (SFT5L), and SFT6 performance based on WC classification. For SFT4, SFT5P, and SFT5L, higher scores were recorded in the 'Normal' WC group, whereas for SFT6, higher scores were observed in the 'Abdominal Obesity' group. No significant associations were found between WHR and PA parameters (SittingTime/AllDays, MVPA/Days) or any of the SFT outcomes. Significant differences ($p < 0.05$) were identified in SFT1, SFT2, SFT4, and SFT5L scores based on waist-to-height ratio (WHtR), categorized as 'Normal' versus 'Obesity', with higher scores consistently found in the 'Normal' group. For SFT5R, the difference was highly significant ($p < 0.01$), also favouring the 'Normal' group (Tab. 4).

Table 2. Baseline characteristics of the studied group (n=88; 100%)

Characteristic	n (%)
Age (year)	
Mean (SD)	69.2 (5.9)
Median (IQR)	68.0 (8.0)
Min-Max	60.0–85.0
Age group	
60–64 years	20 (22.7)
65–69 years	35 (39.8)
70–74 years	14 (15.9)
75 or older	19 (21.6)
Mastectomy side	
Both sides (bilateral)	11 (12.5)
Left side	47 (53.4)
Right side	30 (34.1)
Lymphadenectomy	
No	56 (63.6)
Yes	32 (36.4)
Underwent radiation therapy	
No	46 (52.3)
Yes	42 (47.7)
Underwent chemotherapy	
No	44 (50.0)
Yes	44 (50.0)
Place of residence	
Rural	22 (25.0)
Urban	66 (75.0)
Marital status	
In a relationship	51 (58.0)
Single	37 (42.1)
Education	
Higher	72 (81.8)
Lower	16 (18.2)
Occupational status	
Professionally active	4 (4.6)
Professionally inactive	84 (95.5)
Comorbidities	
No	12 (13.6)
Yes	76 (86.4)
BMI category	
Normal	22 (25.0)
Overweight or Obesity	66 (75.0)
WC category	
Normal	23 (26.1)
Abdominal obesity	65 (73.9)
WHR category	
Normal	5 (5.7)
Abdominal obesity	83 (94.3)
WHtR category	
Normal	7 (7.9)
Obesity	81 (92.1)
Time from diagnosis to study enrollment (years)	
Mean (SD)	9.2 (7.9)
Median (IQR)	7.0 (11.0)
Min-Max	1.0–41.0

Physical activity, measured by the accelerometer	
xEnergyExpenditDays	
Mean (SD)	279.77
Median (IQR)	255.95
Min-Max	62.00–771.10
xLightPADays	
Mean (SD)	292.53
Median (IQR)	292.85
Min-Max	93.40–477.40
xModeratePADays	
Mean (SD)	18.82
Median (IQR)	17.25
Min-Max	0.10–95.30
xVigorousPADays	
Mean (SD)	0.05
Median (IQR)	0.00
Min-Max	0.00–2.30
xSittingTimeAllDays	
Mean (SD)	765.09
Median (IQR)	756.70
Min-Max	260.00–1466.80
xMVPADays	
Mean (SD)	19.78
Median (IQR)	17.25
Min-Max	0.10–95.30
Physical fitness (SFT)	
SFT1	
Mean (SD)	11.8
Median (IQR)	12.0
Min-Max	1.0–20.0
SFT2	
Mean (SD)	15.8
Median (IQR)	15.5
Min-Max	3.0–46.0
SFT3	
Mean (SD)	79.9
Median (IQR)	76.5
Min-Max	26.0–133.0
SFT4	
Mean (SD)	-8.5
Median (IQR)	-6.5
Min-Max	-64.0 – 23.0
SFT5 right	
Mean (SD)	-13.8
Median (IQR)	-12.0
Min-Max	-39.0 – 40.0
SFT5 left	
Mean (SD)	-13.8
Median (IQR)	-12.0
Min-Max	-39.0 – 40.0
SFT6	
Mean (SD)	9.8
Median (IQR)	9.0
Min-Max	5.0–25.0

Data presented as number (percentage), unless otherwise stated. **-?-** hormone therapy; CHTH – chemotherapy; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; WHtR – waist-to-height ratio; SD – standard deviations; IQR, interquartile range; Min-Max, minimum-maximum. PA, physical activity; SFT, Senior Fitness Test; MVPA – moderate vigorous physical activity

DISCUSSION

Physical fitness refers to physical attributes required to perform daily activities safely, independently, and without over-exertion. This concept is particularly relevant in the context of the elderly oncology patients, whose functioning may be compromised due to the disease- and treatment-related factors. The present study aimed to assess the level of physical fitness and to examine the relationship between objectively measured PA, sitting time, and physical fitness in independently functioning BCS aged over 60 years. Additionally, the influence of social determinants and

Table 3. Spearman rank correlations coefficients

SFT		xLightPADays	xModeratePADays	xVigorousPADays	xSittingTimeAllDays	xMVPADays
SFT1	R	0.0004	0.1871	0.1329	**-0.2139**	0.2006
	P	0.9972	0.0809	0.2171	0.0454	0.0610
SFT2	R	0.1438	0.1332	0.0859	-0.1967	0.1482
	P	0.1813	0.2162	0.4263	0.0662	0.1681
SFT3	R	0.1267	**0.2737**	0.0855	**-0.3568**	**0.2875**
	P	0.2394	0.0099	0.4284	0.0006	0.0066
SFT4	R	0.1999	**0.2450**	0.1052	-0.2015	**0.2458**
	P	0.0619	0.0214	0.3292	0.0598	0.0210
SFT5Right	R	0.1359	0.1210	0.1444	**-0.2625**	0.1136
	P	0.2068	0.2614	0.1795	0.0135	0.2921
SFT5Left	R	**0.2526**	**0.3101**	0.1762	**-0.2947**	**0.3031**
	P	0.0176	0.0033	0.1006	0.0053	0.0041
SFT 6	R	**-0.3451**	**-0.2395**	-0.1755	**0.4084**	**-0.2341**
	P	0.0010	0.0246	0.1020	0.0001	0.0282

PA – physical activity; MVPA – moderate-to-vigorous physical activity; SFT – Senior Fitness Test

adiposity indices, including overall adiposity and adipose tissue distribution on physical fitness outcomes were investigated.

In the study group, the participants spent a significant amount time sitting, averaging 765 minutes per day. Time spent in LPA was 292 minutes per day, while time in MVPA was limited to 20 minutes per day – comprising 19 minutes of moderate PA and only 0.05 minutes of vigorous PA. These findings are consistent with prior research, for example, Weiner et al. [9] reported that BCS averaged 534.3 minutes of sitting, 288.9 minutes of LPA, and 14.4 minutes of MVPA per day. Similarly, Romero et al. [12], in a study involving 84 BCS, found average MVPA to be 275 minutes per week, with only 7.7 minutes per week spent in vigorous PA, and approximately 55 hours per week (3292 minutes) spent sitting.

The results obtained in the current study further confirm that BCS tend to avoid high-intensity activities. This may be due to concerns over upper extremity straining, particularly in post-lymphadenectomy patients, or overall fatigue from cancer treatments. Despite scientific evidence confirming that high-intensity activity can be safely performed by cancer survivors and may confer additional benefits beyond those of moderate-intensity programmes [13], patients often remain reluctant to engage in such exercise. Cancer-related fatigue and pain, particularly in individuals with advanced disease, may also deter participation in vigorous activity [14].

Correlation analyses from the current study indicate that a higher frequency of MVPA is associated with improvements in several components of physical fitness, notably aerobic endurance, lower and upper body flexibility, and dynamic balance. On the other hand, prolonged sedentary time was negatively associated with lower body strength, aerobic capacity, upper body flexibility, agility and balance.

These relationships are also supported by existing literature [15, 16]. Studies by Honda et al. [16] and Spartano et al. [17] have confirmed that MVPA is positively correlated with aerobic endurance, muscular strength, agility, and dynamic balance in older adults. Park [18], in a study of older Japanese adults, demonstrated that time spent in MVPA was positively associated with walking speed and balance, and noted that increasing MVPA by just 10 minutes per day could improve overall physical fitness by 1.4% – 2.7%. Several authors, including Tomas and Izawa [19, 20], have noted that even low intensity PA can positively affect functional endurance, underscoring its potential value in promoting physical function. In the current study, a positive correlation was found between LPA and performance in the SFT5 and SFT6 trials.

Sitting time and SFT results. When discussing PA, it is essential to address the issue of sedentary behaviour. The objective accelerometer measurements obtained in the present study revealed that the participants spent an average of 765 minutes per day sitting. The findings demonstrate negative correlations between sedentary time and physical fitness levels. These results are consistent with previous studies by van de Velde, Spartano, and Santos, among others [16, 17]. The findings have important implications for public health because reduced physical fitness is associated with physical frailty, increased morbidity, and other adverse health outcomes which, in turn, contribute to significantly higher

Table 4. Results of analyzed trials correlated with BMI, WC, WHR, WHtR indices

Characteristic		SittingTime All Days	MVPA Days	SFT1	SFT2	SFT3	SFT4	SFT5Right	SFT5Left	SFT6
BMI	p-value	0.8208	0.3625	0.3670	0.3977	0.3399	0.3221	0.0296	0.0331	0.4045
Over-weight or Obesity	Median	751.8	18.0	12.0	15.5	78.0	-3.0	-9.0	-14.5	9.0
Normal weight	Median	794.4	14.2	13.0	15.5	73.5	0.0	0.0	-6.5	8.5
WC	p-value	0.4389	0.805	0.063	0.1183	0.6484	0.0073	0.0018	0.0048	0.0055
Abdominal obesity	Median	767.00	17.80	12.00	15.00	76.00	-4.00	-9.00	-15.00	9.00
Normal	Median	723.80	15.10	13.00	16.00	78.00	0.00	2.00	-6.00	8.00
WHR	p-value	0.5520	0.8782	0.0987	0.0910	0.4329	0.2800	0.0899	0.1940	0.1126
Abdominal obesity	Median	767.0	17.0	12.0	15.0	76.0	-2.0	-7.0	-13.0	9.0
Normal	Median	703.8	18.8	13.0	21.0	84.0	0.0	4.0	-7.0	8.0
WHtR	p-value	0.1652	0.5122	0.0079	0.0133	0.0609	0.0388	0.0034	0.0133	0.2239
Obesity	Median	785.3	17.0	12.0	15.0	76.0	-3.0	-9.0	-13.0	9.0
Normal	Median	703.8	18.1	15.0	21.0	102.0	0.0	4.0	-4.0	8.0

PA – physical activity; MVPA – moderate-to-vigorous physical activity; SFT – Senior Fitness Test; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; WHtR – waist-to-height ratio healthcare costs [20]. Variability in findings across studies may be attributed, in part, to differences in participants' health status. Inclusion of individuals with chronic illnesses, those considered vulnerable, or residents of long-term care facilities, could all lead to significant variability of results. Additionally, discrepancies in methodologies used to assess PA and fitness (self-reporting vs. objective measures) may also help to explain these inconsistencies [16].

Obesity and physical activity. The current study also evaluated the impact of general adiposity and adipose tissue distribution indices on physical fitness and levels of activity. Significant differences were observed in selected fitness test outcomes across the BMI, WC, and WHtR categories. As adiposity indices increased, physical fitness – as measured using the SFT – tended to decrease. Previous studies [21, 22] have consistently demonstrated an inverse relationship between body mass and physical fitness, indicating that increased body weight is associated with lowered functional capacity. In comparison to younger adults, the elderly typically exhibit a higher proportion of adipose tissue alongside reductions in both skeletal muscle mass and bone mineral density [22]. The high prevalence of obesity in the study group (approximately 70%) may be one of the main factors limiting physical fitness among participants. Obesity, especially when combined with chronic diseases, leads to further deterioration of physical capacity, increases the risk of complications, and reduces independence. The presence of chronic conditions, such as respiratory, cardiovascular, or neurological diseases, can significantly affect the level of physical activity and the outcomes of fitness tests. Future research should analyze the impact of these comorbidities on physical activity and fitness in detail to better tailor rehabilitation interventions to the needs of this population.

Limitations of the study. This study has several limitations: 1) potential confounding variables were not controlled for, which may have influenced the observed associations; 2) participant height was self-reported, introducing possible measurement bias; 3) accelerometers may misclassify certain activities (e.g., cycling, swimming, or passive sitting in vehicles); 4) the single-centre recruitment limited the generalizability of the findings to broader populations; 5) the cross-sectional design precluded causal inference; observed correlations did not imply causation. Future studies should consider longitudinal or interventional designs to clarify these relationships.

All participants were women residing in Poland, which may have limited the generalizability of the findings, particularly given that PA levels were evaluated using normative values developed for a US population.

Additional methodological limitations should also be considered. Although accelerometers provide objective and reliable measurements of PA, they are unable to capture certain types of activity, such as cycling or swimming. Moreover, these devices may fail to correctly classify some behaviour, for instance, passive activities – sitting in a moving vehicle can be incorrectly registered as physical movement rather than sedentary behaviour. Even though the Freedson cut points are commonly applied in studies involving cancer survivors, it is important to note that they were originally developed based on a cohort of healthy young adults with a mean age of 24 years [23].

Strengths of the study. Despite its limitations, this study also offers several notable strengths. It was carefully designed and implemented in a well-defined cohort of patients from a specific geographic region, ensuring contextual relevance. The use of the Senior Fitness Test (SFT) represents a significant methodological advantage, as it is a validated and reliable tool for assessing functional fitness in older adults [24].

The use of accelerometry to assess sitting time represents a significant advantage, because it is far less susceptible to recall and response biases compared to self-reporting. Moreover, accelerometers are far more accurate in capturing LPA and sedentary behaviour – both of which are particularly relevant in the examined population.

Another strength of this study was the use of interviewer-administered questionnaires. In accordance with international guidelines, surveys may be completed either in person or through telephone interviews. Unlike self-administered questionnaires, interviewer-led data collection helps reduce over-reporting of both the type and duration of PA [25].

Regarding mechanisms, it is plausible that obesity and chronic diseases reduce physical capacity through increased inflammation, reduced cardiorespiratory fitness, and musculoskeletal limitations. However, further research is needed to elucidate these pathways.

CONCLUSIONS

The physical fitness of older breast cancer survivors was found to fall below recommended normative values. The most pronounced limitations were observed in upper extremity flexibility, as well as in agility and dynamic balance.

BCS over the age of 60 did not engage in vigorous PA. One of the primary constituting factors to these limitations appears to be the high prevalence of overweight and obesity in the study group, seen in approximately 70% of all participants. An increase in daily sedentary time was associated with decreased physical performance, particularly in lower body strength, aerobic endurance, upper body flexibility and agility, as well as dynamic balance. Conversely, higher levels of MVPA were positively associated with better outcomes in aerobic endurance, lower and upper body flexibility, as well as agility and dynamic balance. Time spent engaging in LPA and moderate PA was also linked to improved performance in SFT trials evaluating aerobic capacity, flexibility of both lower and upper limbs, and agility with balance. Furthermore, increased indicators of adiposity were consistently associated with lower physical fitness levels as measured by the SFT.

In conclusion, older adults who engage in higher levels of PA and spend less time in sedentary behaviours demonstrated better functional fitness outcomes, regardless of other influencing factors. These findings underscore the importance of promoting both the reduction of sedentary time and the increase of MVPA in this population as key strategies for preserving or enhancing physical function in later life. These findings should be considered in the development of structured PA guidelines and in efforts to promote an active lifestyle among BCS. Tailored interventions to address the specific needs and limitations of this population may help improve functional fitness and overall quality of life.

Obesity and the presence of chronic diseases are important factors limiting physical fitness in older women who have survived breast cancer. Increased body weight and co-existing chronic conditions may lead to reduced physical activity, poorer fitness test results, and a higher risk of losing independence. Preventive and interventional strategies should focus not only on increasing physical activity, but also on weight management and the treatment and monitoring of chronic diseases to effectively improve fitness and quality of life in this group of patients. Future research should employ longitudinal or interventional designs to better understand the causal relationships between physical activity, sedentary behaviour, obesity, chronic diseases, and functional fitness in elderly breast cancer survivors.

Implications for practice. The data presented in this study reveal several practical implications. The finding that physical fitness levels among older BCS fall below recommended PA standards should encourage healthcare professionals and physiotherapists working in oncology settings to place greater emphasis on PA education. Women should be encouraged to join support groups, such as the Amazon Clubs, offering regular and varied forms of PA. Additionally, patients should be motivated to reduce sedentary behaviours, such as frequent use of transportation, lifts, or prolonged sitting, and be encouraged to walk more often, use stairs, and engage in regular daily PA while minimizing sitting time.

On the other hand, the clinical and research experience in oncology care by the authors suggests that, despite numerous educational initiatives, access to diverse PA programs, and comprehensive multidisciplinary support (including physicians, physiotherapists, dietitians, psychologists, and occupational therapists), the patient's habits play a significant role in determining PA levels. Future assessments of PA and fitness should incorporate a detailed questionnaire evaluating the individual's PA history over recent years.

Importantly, even LPA positively impacts physical fitness, indicating that simple recommendations, such as daily walking, can yield significant health benefits. Finally, patient education should also emphasize the importance of maintaining a healthy body weight as part of a comprehensive approach to long-term health and functional independence.

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