Medical Science

To Cite:
Zwierzchowska M, Banaśkiewicz JK, Wagner-Bieleń NK, Dąbrowska GH, Antoniak A, Jocz AM, Centkowska A, Żyta AM, Żmijewska MA, Ziółkowski J, Lazitskaya D. The Joint Impact of Physical Activity and Sedentary Behaviour on Mortality and Health-Related Outcomes in Cancer Survivors: A Literature Review. *Medical Science* 2025; 29: e205ms3659
doi:

Authors' Affiliation:
[1]Independent Public Clinical Hospital of Prof. W. Orlowski CMKP, ul. Czerniakowska 231, 00-416 Warsaw, Poland
[2]Independent Public Health Care Complex - Hospital in Iłża, ul. Bodzentyńska 17, 27-100 Iłża, Poland
[3]Military Institute of Medicine - National Research Institute, ul. Szaserów 128, 04-141 Warsaw, Poland
[4]The Infant Jesus Teaching Hospital, ul. Williama Heerleina Lindleya 4, 02-005 Warsaw, Poland
[5]Praski Hospital of the Transfiguration of the Lord, al. "Solidarności" 67, 03-401 Warsaw, Poland, Poland
[6]Specialist Provincial Hospital in Ciechanów, Powstańców Wielkopolskich 2, 06-400 Ciechanów, Poland
[7]Wolski Hospital of Dr. Anna Gostyńska, ul. Marcina Kasprzaka 17, 01-211 Warsaw, Poland
[8]Faculty of Medicine, Medical University of Warsaw, ul. Żwirki i Wigury 61, 02-091 Warsaw, Poland
[9]Międzyleski Specialist Hospital in Warsaw, Bursztynowa 2, 04-749 Warsaw, Poland

***Corresponding author:**
Martyna Zwierzchowska,
Independent Public Clinical Hospital of Prof. W. Orlowski CMKP, ul. Czerniakowska 231, 00-416 Warsaw, Poland
E-mail: martyna.zwierzchowska@gmail.com.
ORCID: 0000-0002-0723-8404

Peer-Review History
Received: 07 July 2025
Reviewed & Revised: 21/July/2025 to 23/September/2025
Accepted: 05 October 2025
Published: 11 October 2025

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

DISCOVERY SCIENTIFIC SOCIETY

The Joint Impact of Physical Activity and Sedentary Behaviour on Mortality and Health-Related Outcomes in Cancer Survivors: A Literature Review

Martyna Zwierzchowska[1*], Joanna Karina Banaśkiewicz[2], Natalia Katarzyna Wagner-Bieleń[3], Gabriela Helena Dąbrowska[4], Agata Antoniak[5], Anna Maria Jocz[6], Anna Centkowska[7], Aleksandra Maria Żyta[1], Maria Anna Żmijewska[8], Jakub Ziółkowski[1], Darya Lazitskaya[9]

ABSTRACT

With the growing number of cancer survivors worldwide, it has become increasingly important to create non-pharmacological approaches that support long-term health and promote better survival outcomes. While physical activity (PA) is widely recognised for its health benefits, and sedentary behaviour (SB) is known for its detrimental effects in the general population, evidence on their independent and especially joint associations with health-related quality of life (HRQoL) and survival outcomes in cancer survivors has been limited. This literature review examines findings from recent prospective cohort studies and systematic reviews, drawing on a nationally representative sample of US cancer survivors, as well as specific populations by cancer type. The review highlights that both prolonged sitting and lack of leisure-time physical activity (LTPA) independently increase mortality risks among cancer survivors. Their combined occurrence is linked to the greatest risk of both overall and cancer-specific mortality. At the same time, engaging in regular physical activity—even at modest levels—has been shown to improve HRQoL, reduce cancer-related fatigue, and enhance physical fitness in various groups of cancer survivors. The findings highlight the importance of promoting LTPA and reducing SB as key elements of cancer survivorship care, with meaningful implications for clinical practice and public health guidelines.

Keywords: leisure-time physical activity, physical exercise, sedentary behaviour, cancer, survivorship

1. INTRODUCTION

Around the world, rising cancer rates have created an ever-expanding group of survivors (Cao et al., 2022; Ha et al., 2021). In the United States, nearly 18.6 million

adults are living with the disease today. This number is expected to grow steadily, with some estimates predicting it will exceed 22 million by 2035. Improved survival rates are largely linked to progress in diagnostic timeliness and the development of more effective therapeutic interventions. Despite these advances, the vast majority of patients continue to experience chronic health problems attributable to the primary disease or its treatment, frequently persisting well beyond the conclusion of therapeutic care (Li et al., 2022). They include increased mortality and morbidity, impaired cardiorespiratory fitness (CRF), neuropathy, frailty, cancer-induced fatigue, reduced psychological well-being, as well as various psychosocial deficits (Ha et al., 2021; Lavery et al., 2024; Cao et al., 2023; Cannioto et al., 2021; Spei et al., 2019; Jung et al., 2019). Consequently, there is an urgent need to find practical strategies for enhancing the long-term health of this vulnerable population.

Engagement in physical activity (PA) has been proposed to improve oncological outcomes through diverse biological and clinical mechanisms. Included among these are regulation of tumor proliferation and dissemination, reduction of adverse sequelae from therapy, increased adherence to treatment regimens, and augmentation of treatment effectiveness (Li et al., 2022; Siegel et al., 2021; Miller et al., 2019). The recommendation of sustained physical activity (PA) for health promotion by institutions such as the World Health Organization (WHO) and the American College of Sports Medicine (ACSM) explicitly encompasses populations with chronic conditions, including cancer (Bull et al., 2020; Piercy et al., 2018; Patel et al., 2019; Ekelund et al., 2016; Yang et al., 2021).

The recommendations of the ACSM specify that cancer survivors should engage in moderate-intensity aerobic activity on at least three occasions per week, lasting approximately 30 minutes per session. The ACSM recommends that cancer survivors perform moderate aerobic exercise for at least 150 minutes per week, spread over a minimum of three sessions. In addition, survivors are encouraged to complete resistance training twice weekly, performing each exercise for 8–15 repetitions at about 60% of their one-repetition maximum (1RM) (Lavery et al., 2024; Thorsen et al., 2023; Rock et al., 2022).

Despite these recognised benefits, levels of PA remain critically low among cancer survivors. SB, defined as any waking behaviour with an energy expenditure of 1.5 metabolic equivalent of task (MET) or less in a sitting, reclining, or lying posture, has become increasingly prevalent in modern times (Li et al., 2022; Stamatakis et al., 2019). Prolonged sitting has been associated with a range of adverse health outcomes, which include an elevated risk of cardiovascular disease, diabetes, cancer, and all-cause mortality, particularly among individuals with low levels of PA (Li et al., 2022; Lavery et al., 2024; Thorsen et al., 2023; Friedenreich et al., 2020).

Evidence on the independent roles of PA and SB continues to accumulate; however, research addressing their joint influence on health outcomes among cancer survivors is still limited (Li et al., 2022; Ficarra et al., 2022; Cao et al., 2023) A 2019 roundtable report from the ACSM identified the lack of epidemiological data connecting SB with cancer survival outcomes as a critical area requiring further research (Cao et al., 2022). This suggests a need for more research to inform specific SB guidelines from ACSM for this population. Cancer survivors are often more sedentary than the cancer-free population due to comorbidities or deconditioning associated with their disease and treatment (Li et al., 2022). Gaining insight into the relationship between PA and SB is key to developing quantitative recommendations and interventions that support survival and quality of life in this growing population. This review explores these critical topics through an analysis of findings from recent large-scale research.

2. REVIEW METHODS

This review examines what is currently known about how PA and SB together influence mortality and other health outcomes in cancer survivors. The goal was to summarize existing evidence, highlight areas where research is lacking, and suggest directions for future studies. To gather relevant information, we conducted a thorough search of the PubMed and Google Scholar databases (Figure 1).

Inclusion criteria:

Sources considered for this work comprised randomized controlled trials, intervention-based clinical research, meta-analytical studies, and review literature published from Jan 2005 to Apr 2025, with most evidence published between Jan 2015 and Apr 2025. Relevant search terms included the following keywords: “leisure-time physical activity“, “physical exercise“, “sedentary behaviour“, “cancer“, and “survivorship“, among others.

Exclusion criteria:

Studies with various methodological weaknesses, such as insufficient sample sizes, the absence of control groups, and unsatisfactory statistical analysis, were excluded. We also excluded articles published in languages other than English.

Every study included in this review followed established ethical guidelines, with research involving patients approved by the relevant institutional review boards.

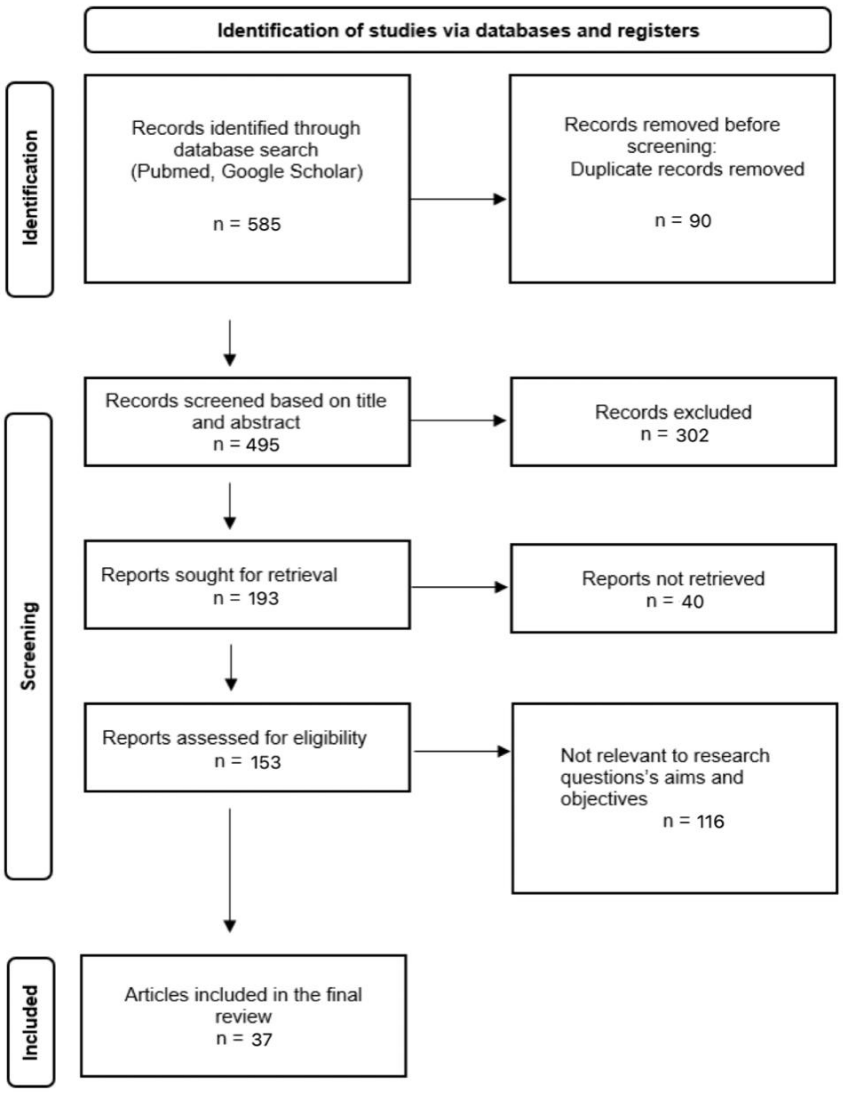

Figure 1: Prisma consort chart.

3. RESULTS

Prevalence of Inactivity and Sedentary Behaviour

High levels of PA and prolonged SB are widely observed among cancer survivor populations, presenting a substantial public health challenge (Cao et al., 2022; Bull et al., 2020) (Table 1). In a prospective cohort investigation conducted by Cao et al., (2022), more than half (56.8%) of a nationally representative sample of U.S. cancer survivors (n = 1535) were identified as physically inactive, reporting no engagement in LTPA over the course of a week. Only a minority (27.6%) were categorised as sufficiently active, engaging in 150 minutes or more of LTPA per week, while 15.6% were insufficiently active (LTPA less than 150 minutes per week but more than 0). Regarding SB, most cancer survivors (60.3%) reported sitting for more than 6 hours per day (h/d). Among the participants, 35.4% reported sitting for 6 to 8 hours per day, while 24.9% reported sitting for more than 8 hours per day. Alarmingly, 35.8% of these cancer survivors engaged in no LTPA and also reported sitting for over 6 hours per day. High levels of SB combined with minimal PA have been reported as "highly prevalent," indicating that overall activity among cancer survivors remains "critically low" (Cao et al., 2022) (Table 1). In a 2021 cross-sectional study, Ha et al., (2021) examined 614 US lung cancer survivors and found that just over half (51.5%)

engaged in LTPA, leaving nearly half (48.5%) without any LTPA in the preceding 30 days. The authors observed that this proportion of inactivity in lung cancer survivors was "higher than those reported in previous studies".

In the study by Jiménez et al., (2022) high percentages, specifically between 50% and 80%, of inactivity or low activity were reported among ovarian cancer survivors. Interestingly, despite most not achieving WHO-recommended activity levels, there was a high expressed interest in PA programmes in this group (Table 1). In the study by Cao et al., (2023) among a nationally representative sample of US skin cancer survivors aged 50 years or older, nearly half (46.3%) reported no LTPA (inactive). Over half of this group reported sitting for more than 6 h/d, with 38.1% sitting 6-8 h/d and 22.1% sitting over 8 h/d. The combination of no LTPA and sitting for more than 6 h/d was reported by 29.6% of skin cancer survivors. The patterns of LTPA and sitting time in skin cancer survivors were noted to be similar to those in non-cancer adults (Cao et al., 2023).

Table 1: Prevalence of Physical Activity (PA) and Sedentary Behaviour (SB) in Cancer Survivors.

Domain	Findings	Key Metrics / Statistics	Source(s)
Inactivity	High prevalence of inactivity	56.8% inactive; 27.6% ≥ 150 min/wk; 15.6% insufficient	Cao et al., 2022
	Lung cancer survivors: nearly half inactive	48.5% no LTPA	Ha et al., 2021
	Ovarian cancer survivors: 50-80% low activity	High interest in PA programs	Jiménez et al., 2022
	Skin cancer survivors: nearly half inactive	46.3% inactive; 29.6% inactive + sit >6 h/d	Cao et al., 2023
Sedentary Behaviour (SB)	Prolonged sitting common	60.3% sit >6 h/d; 35.8% inactive + sit >6 h/d	Cao et al., 2022
	Skin cancer survivors	38.1% sit 6-8h/d; 22.1% sit >8 h/d	Cao et al., 2023

Independent Associations of Physical Activity with Mortality

Participating in PA was consistently associated with a reduced risk of mortality across various cancer survivor populations. For US cancer survivors generally, being physically active (≥150 min/wk LTPA) was linked to a significantly lower risk of all-cause mortality (Hazard Ratio [HR], 0.34; 95% Confidence Interval [CI], 0.20-0.60) and cancer-specific mortality (HR, 0.32; 95% CI, 0.15-0.70) compared with being inactive (Cao et al., 2022) (Table 2). Non-cancer mortality also showed a reduction (HR, 0.36; 95% CI, 0.19-0.68). In a large, nationally representative prospective cohort of US adult cancer survivors, engagement in LTPA was associated with a lower risk of all-cause mortality (Li et al., 2022). Relative to inactive individuals, survivors who participated in increasing levels of PA experienced progressively greater reductions in mortality risk. Specifically, hazard ratios (HR) and 95% confidence intervals (CI) were as follows: 10 minutes to 1 hour per week, HR = 0.75 (95% CI, 0.67–0.85); 1–2.5 hours per week, HR = 0.72 (95% CI, 0.67–0.78); 2.5–5 hours per week, HR = 0.66 (95% CI, 0.60–0.72); 5–7.5 hours per week, HR = 0.63 (95% CI, 0.56–0.70); 7.5–13.3 hours per week, HR = 0.53 (95% CI, 0.47–0.61); and 13.3–24 hours per week, HR = 0.57 (95% CI, 0.49–0.66), demonstrating a clear dose-response relationship between PA and survival (Li et al., 2022) (Table 2). These inverse associations with increasing PA were also observed for cancer and cardiovascular disease (CVD) mortalities. This study also indicated a nonlinear association with a threshold effect at 1 hour/week; increasing PA by 1 hour/week demonstrated a 30% decrease (HR = 0.70; 95% CI, 0.66–0.75) in all-cause mortality for those performing less than 1 hour/week, with a smaller 2% decrease for those above this threshold. With each one-hour increase in PA the risk of all-cause mortality was reduced by 5% in fully adjusted models (Li et al., 2022) (Table 2).

Among long-term testicular cancer survivors, regular and maintained PA was associated with a significant reduction in overall mortality risk of at least 50% (Thorsen et al., 2023). About 20 years after treatment, survivors classified as Low-Active (2–6 MET-h/week), Active, or High-Active (≥20 MET-h/week) had at least a 60% lower mortality risk than Inactive. Active participants (10–18

MET-h/week) showed a 51% reduction in overall mortality (HR 0.49, 95% CI: 0.29–0.84). Participants who took part in PA at ≥10 MET-h/week at both Survey 1 and Survey 2 experienced a 51% lower risk of mortality compared with those who remained inactive (<10 MET-h/week at both time points) (HR 0.49, 95% CI: 0.30–0.82) (Thorsen et al., 2023) (Table 2).

A meta-analysis of breast cancer survivors found that women engaging in the highest levels of recreational PA after diagnosis had a 42% lower risk of death from any cause (HR=0.58, 95% CI: 0.45–0.75) and a 40% lower risk of breast cancer–specific death (HR=0.60, 95% CI: 0.36–0.99) compared with those reporting the lowest activity levels (Spei et al., 2019). Among high-risk breast cancer patients, recurrence risk was lower but did not reach statistical significance (HR = 0.79; 95% CI, 0.60–1.05). Compliance with the Physical Activity Guidelines for Americans (PAGAs) both prior to diagnosis and one year post-diagnosis was associated with significant reductions in recurrence (HR = 0.59) and mortality (HR = 0.51). These associations were even stronger at 2-year follow-up (recurrence HR=0.45, mortality HR=0.32) (Spei et al., 2019) (Table 2).

Table 2: Associations of Physical Activity (PA) and Sedentary Behavior (SB) with Mortality.

Domain	Findings	Key Metrics / Statistics	Source(s)
Physical Activity (PA) & Mortality	Higher PA reduces all-cause & cancer-specific mortality	≥ 150 min/wk LTPA: HR all-cause = 0.34; cancer-specific = 0.32	Cao et al., 2022
	Dose-response relationship	HR decreases progressively with more PA; threshold at 1 h/wk	Li et al., 2022
	Testicular cancer survivors	Active (10-18 MET-h/wk): HR = 0.49; Low-Active ≥60% lower mortality than inactive	Thorsen et al., 2023
	Breast cancer survivors	HR all-cause = 0.58; HR breast cancer 0.60	Spei et al., 2019
Sedentary Behaviour (SB) & Mortality	Prolonged sitting increases mortality	Sit ~8 h/d: HR all-cause = 1.81; cancer 2.27; +7-9% per extra hour	Cao et al., 2022
	Skin cancer survivors	Sit ~8 h/d: HR all-cause = 1.72; non-cancer 1.76; +8% per extra hour	Cao et al., 2023
Joint PA & SB Effects	Inactivity + prolonged sitting = highest mortality risk	Sit >8h/d + inactive: HR all-cause = 5.38; HR cancer 4.71	Cao et al., 2022; Cao et al., 2023
	Female skin cancer survivors	No LTPA + sit >6 h/d: 4-fold increase in all-cause mortality	Cao et al., 2023
Dose-Respone & Activity Levels	Greatest benefit at lower PA; plateau at high PA	10 min-1 h/wk reduces all-cause mortality by ~25%	Li et al., 2022; Albrecht & Taylor 2012

Independent Associations of Sedentary Behaviour with Mortality

Prolonged sitting was found to be independently associated with higher mortality risk. Among cancer survivors in the United States, those who spent more than 8 hours per day sitting had greater risks of both overall mortality (HR=1.81; 95% CI: 1.05–3.14) and cancer-specific mortality (HR=2.27; 95% CI: 1.08–4.79) compared with individuals who sat fewer than 4 hours daily (Cao et al., 2022) (Table 2). Each additional hour of daily sitting was associated with a 7% higher risk of death from any cause, a 9% higher risk of cancer-related death, and a 5% higher risk of non-cancer-related death (Cao et al., 2022) (Table 2). Skin cancer survivors who reported sitting for about 8 hours per day faced notably higher overall (HR = 1.72; 95% CI: 1.11–2.67) and non-cancer mortality (HR = 1.76; 95% CI: 1.07–2.92)

compared with those who sat for under 6 hours per day. A dose–response pattern was also observed: each additional hour of sitting raised the risk of both all-cause and non-cancer mortality by 8%. In contrast, sitting time did not appear to be linked with cancer-specific mortality in this group (Cao et al., 2023).

Joint Associations and Synergistic Impact of PA and SB

The combination of extended sitting and insufficient PA was common and associated with the highest risk of all-cause mortality (Cao et al., 2022) (Table 2). Crucially, the excess risk linked to SB was largely confined to cancer survivors who did not engage in adequate levels of activity (Cao et al., 2022). The highest overall and cancer-specific mortality risks were observed in inactive and insufficiently active survivors who reported sitting more than 8 h/d. Specifically, these individuals had the highest overall mortality risk (HR, 5.38; 95% CI, 2.99-9.67) and cancer-specific mortality risk (HR, 4.71; 95% CI, 1.60-13.9). These risks were compared to active survivors who sat for less than 6 hours per day. For individuals who were insufficiently active or inactive, spending more time sitting was related to higher risks of all-cause (HR per 1-h increase, 1.08) and cancer (HR per 1-h increase, 1.09) mortality in a dose-response manner (Table 2). Cancer survivors who were insufficiently active or inactive and sat for more than 8 hours per day faced up to a fivefold higher risk of death from all causes, including both cancer and non-cancer. Cancer survivors who were least active—sitting 8 hours or more per day and engaging in less than 150 minutes of LTPA per week—faced about a 5.5-fold higher risk of death compared with those who were most active, sitting less than 4 hours per day and achieving at least 150 minutes of LTPA per week (Table 2).

Among cancer survivors who were sufficiently active, longer sitting times were not associated with higher mortality. Inactive skin cancer survivors sitting more than 8 h/d had the highest mortality risks from all-cause (HR=2.26; 95% CI: 1.28 to 4.00) and non-cancer (HR=2.11; 95% CI, 1.10 to 4.17) mortality. This combined behaviour led to a two-fold increase in all-cause mortality risk. The association of the combination of lack of LTPA and prolonged sitting with elevated mortality was more noticeable in female skin cancer survivors. Female skin cancer survivors with no LTPA and sitting >6 h/d had as much as a four-fold increase in the risk of all-cause mortality compared to those with any LTPA and sitting <6h/d. The associations of LTPA and sitting time with all-cause and cause-specific mortality did not significantly differ between skin cancer survivors and non-cancer adults (Cao et al., 2023), (Table 2).

4. DISCUSSION

Evidence indicates that PA and SB are strongly associated with health outcomes in cancer survivors (Cao et al., 2022; Ha et al., 2021; Li et al., 2022; Cannioto et al., 2021; Jiménez et al., 2022; Siegel et al., 2021). Across multiple studies, more than 50% of survivors did not engage in LTPA. Almost two-thirds engaged in SB for over six hours per day (Li et al., 2022). High SB combined with low PA was linked to the largest increases in all-cause and cancer-specific mortality, highlighting their combined impact on survivor health (Cao et al., 2022; Ha et al., 2021).

Independent Associations: In cancer survivors, regular PA is clearly linked to meaningful health benefits, while prolonged SB tends to correspond with worse outcomes (Cannioto et al., 2021; Holmes et al., 2005; Swain et al., 2020; D'Silva et al., 2018; Dunstan et al., 2021). Even low volumes of PA are linked to meaningful reductions in both all-cause and cancer-specific mortality. Notably, engaging in as little as 10 minutes to 1 hour of PA per week can lower all-cause mortality risk by approximately 25% (Cannioto et al., 2021). The findings emphasize the need to limit inactivity and promote the highest achievable levels of PA, since even modest participation is associated with meaningful improvements in survival and overall health among this population (Cannioto et al., 2021). For instance, physically active cancer survivors benefit from a significantly lower risk of death in comparison to inactive individuals, with reductions up to 66% in some cancer types (Li et al., 2022; Albrecht & Taylor, 2012). Engagement in prolonged sitting independently contributes to higher risks of death, including those from non-cancer as well as all causes. Each successive hour of sitting accumulated per day has been shown to raise the likelihood of mortality in a dose–response fashion (Li et al., 2022; Spei et al., 2019). This association remains when differences in activity levels are accounted for, indicating that SB produces unique adverse health effects (Li et al., 2022).

Joint Associations: Perhaps the most crucial insight from the reviewed literature is the detrimental joint association of prolonged sitting with a lack of PA. Studies consistently show that cancer survivors who are both inactive or insufficiently active and spend extensive time sitting (e.g., >8 hours/day) are associated with the highest risks of cancer-specific and all-cause mortality. Perhaps the most crucial insight from the reviewed literature is that cancer survivors who engage in little or no PA and spend extended periods of time sitting face significantly higher mortality risks, which are many times greater than those observed in individuals who remain active and minimise SB (Li et al., 2022; Cao et al., 2023; Spei et al., 2019). Cancer survivors who are able to meet the recommended levels

of PA benefit from a reduction in the increased mortality associated with prolonged SB (Cao et al., 2022; Li et al., 2022; Cao et al., 2023; Lavery et al., 2024). These results support interventions that both encourage PA and limit SB.

Dose-Response and Activity Levels: The studied evidence points to a nonlinear dose–response relationship between PA and health outcomes (Cao et al., 2022; Li et al., 2022; Cao et al., 2023; Cannioto et al., 2021; Swain et al., 2020), although guidelines generally recommend at least 150 minutes of moderate-intensity PA per week (Bull et al., 2020; Piercy et al., 2018; Patel et al., 2019; Ekelund et al., 2016; Campbell et al., 2019). The greatest benefits are observed in individuals with low levels of physical activity. Incremental benefits diminish or plateau as activity increases (Swain et al., 2020; Albrecht & Taylor, 2012). For example, in testicular cancer survivors, engaging in moderate levels of PA was associated with a significant reduction in mortality, while very high activity levels did not provide further decreases beyond those seen at moderate intensities (Albrecht & Taylor, 2012). For cancer survivors, understanding this trend is key to setting realistic PA goals, as many are limited by comorbidities or the side effects of treatment (Li et al., 2022; Jung et al., 2019).

Specific Cancer Types: Across multiple cancer populations—including breast, lung, testicular, and skin malignancies—health-promoting behaviors have been linked to improved survival, with patterns generally mirroring those observed in adults without cancer (Cao et al., 2022; Li et al., 2022; Cao et al., 2023; Spei et al., 2019; Schmid & Leitzmann, 2014; Holmes et al., 2005). In populations of skin cancer survivors, declines in mortality are chiefly associated with non-cancer causes, emphasizing the critical public health importance of addressing lifestyle-related chronic conditions, which have a greater impact on survival than the primary cancer. In certain cohorts, the relationship between LTPA and mortality benefits was more pronounced in females. This suggests that individualised approaches may be necessary (Cao et al., 2023; Spei et al., 2019).

Limitations of Current Research

Since PA and SB are often assessed via self-report, there is a potential for recall bias and overestimation compared to objective methods, such as accelerometry. This limitation suggests that the actual prevalence of SB among cancer survivors could potentially be even higher than the reported figures. Future studies using objective, device-based measures are needed. Many studies assess PA and SB at a single time-point, which may not reflect changes in behaviour during long follow-up periods. Longitudinal studies using repeated measurements are critical. Finally, the potential for reverse causation—where reduced activity results from poorer health or more advanced disease rather than causing adverse outcomes—cannot be completely excluded, although sensitivity analyses are frequently used to address this issue.

5. CONCLUSION

Elevated all-cause and cancer-specific mortality in survivors is independently linked to low PA and prolonged SB, with the greatest risk when both are present. Even modest PA offsets these effects, improving survival, HRQoL, fatigue, and cardiovascular health. Integrating dual recommendations—promoting PA and reducing SB—into survivorship care remains essential, while further work should refine dose–response estimates through rigorous designs.

Acknowledgments

The authors have no acknowledgments to disclose.

Author contributions

Conceptualization: Martyna Zwierzchowska
Methodology: Martyna Zwierzchowska, Natalia Katarzyna Wagner-Bieleń, Joanna Karina Banaśkiewicz, Aleksandra Maria Żyta
Formal analysis: Agata Antoniak, Anna Maria Jocz, Anna Centkowska
Investigation: Natalia Katarzyna Wagner-Bieleń, Joanna Karina Banaśkiewicz, Gabriela Helena Dąbrowska, Agata Antoniak
Writing-rough preparation: Martyna Zwierzchowska, Gabriela Helena Dąbrowska, Anna Maria Jocz
Writing-review and editing: Anna Centkowska, Jakub Ziółkowski, Darya Lazitskaya
Supervision: Aleksandra Maria Żyta, Maria Anna Żmijewska, Jakub Ziółkowski
All authors have read and agreed with the published version of the manuscript.

Informed consent

Not applicable.

Ethical approval

Not applicable. This article does not contain any studies with human participants or animals performed by any of the authors.

Funding

This research did not receive any external funding like specific grant from funding agencies in the public, commercial, or nonprofit sectors.

Conflict of interest

The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have influenced the work reported in this paper.

Data and materials availability

All data associated with this study will be available based on the reasonable request to corresponding author.

REFERENCES

1. Albrecht TA, Taylor AG. Physical activity in patients with advanced-stage cancer: A systematic review of the literature. Clin J Oncol Nurs 2012;16(3):293–300. doi:10.1188/12.cjon.293-300.
2. Cao C, Friedenreich CM, Yang L. Association of daily sitting time and leisure-time physical activity with survival among US cancer survivors. JAMA Oncol 2022;8(3):395–403. doi:10.1001/jamaoncol.2021.6590.
3. Ha DM, Prochazka AV, Bekelman DB, Stevens-Lapsley JE, Chan ED, Keith RL. Association of leisure-time physical activity with health-related quality of life among US lung cancer survivors. JNCI Cancer Spectr 2021;5(1):kaa118. doi:10.1093/jncics/pkaa118.
4. Li Q, Pan X, Li X, Huang W. Association of physical activity intensity with all-cause mortality in cancer survivors: A national prospective cohort study. Cancers (Basel) 2022;14(23):5760. doi:10.3390/cancers14235760.
5. Lavery JA, Boutros PC, Knight D, Tammela T, Moskowitz CS, Jones LW. Association of exercise with pan-cancer incidence and overall survival. Cancer Cell 2024;42(2):169–71. doi:10.1016/j.ccell.2023.12.007.
6. Thorsen L, Courneya KS, Steene-Johannessen J, Gran JM, Haugnes HS, Negaard HFS, Kiserud CE, Fosså SD. Association of physical activity with overall mortality among long-term testicular cancer survivors: A longitudinal study. Int J Cancer 2023;153(8):1512–9. doi:10.1002/ijc.34625.
7. Ficarra S, Thomas E, Bianco A, Gentile A, Thaller P, Grassadonio F, Papakonstantinou S, Schulz T, Olson N, Martin A, Wagner C, Nordström A, Hofmann H. Impact of exercise interventions on physical fitness in breast cancer patients and survivors: a systematic review. Breast Cancer 2022;29(3):402–18. doi:10.1007/s12282-022-01347-z.
8. Cao C, Wang N, Liu R, Patel AV, Friedenreich CM, Yang L. Leisure-time physical activity, daily sitting time, and mortality among US skin cancer survivors. Support Care Cancer 2023;31(12):718. doi:10.1007/s00520-023-08192-6.
9. Cannioto RA, Hutson A, Dighe S, McCann W, McCann SE, Zirpoli GR, Barlow W, Kelly KM, DeNysschen CA, Hershman DL, Unger JM, Moore HCF, Stewart JA, Isaacs C, Hobday TJ, Salim M, Hortobagyi GN, Gralow JR, Albain, KS, Budd GT, Ambrosone CB. Physical activity before, during, and after chemotherapy for high-risk breast cancer: Relationships with survival. J Natl Cancer Inst 2021;113(1):54–63. doi:10.1093/jnci/djaa046.
10. Spei ME, Samoli E, Bravi F, La Vecchia C, Bamia C, Benetou V. Physical activity in breast cancer survivors: A systematic review and meta-analysis on overall and breast cancer survival. Breast 2019;44:144–52. doi:10.1016/j.breast.2019.02.001.
11. Jung AY, Behrens S, Schmidt M, Thoene K, Obi N, Hüsing A, Benner A, Steindorf K, Chang-Claude J. Pre- to postdiagnosis leisure-time physical activity and prognosis in postmenopausal breast cancer survivors. Breast Cancer Res 2019;21(1):117. doi:10.1186/s13058-019-1206-0.
12. Jiménez S, Vinolo-Gil MJ, Carmona-Barrientos I, Martin-Vega FJ, García-Muñoz C, Guillén Vargas AR, Gonzalez-Medina G. The influence of therapeutic exercise on survival and the quality of life in survivorship of women with ovarian cancer. Int J Environ Res Public Health 2022;19(23):16196. doi:10.3390/ijerph192316196.

13. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2021. CA Cancer J Clin 2021;71(1):7–33.doi:10.3322/caac.21654.
14. Miller KD, Nogueira L, Mariotto AB, Rowland JH, Yabroff KR, Alfano CM, Jemal A, Kramer JL, Siegel RL. Cancer treatment and survivorship statistics, 2019. CA Cancer J Clin 2019;69(5):363–85. doi:10.3322/caac.21565.
15. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, Carty C, Chaput JP, Chastin S, Chou R, Dempsey PC, DiPietro L, Ekelund U, Firth J, Friedenreich CM, Garcia L, Gichu M, Jago R, Katzmarzyk PT, Lambert E, Willumsen JF. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med 2020;54(24):1451–62. doi:10.1136/bjsports-2020-102955.
16. Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, George SM, Olson RD. The Physical Activity Guidelines for Americans. JAMA 2018;320(19):2020–8. doi:10.1001/jama.2018.14854.
17. Patel AV, Friedenreich CM, Moore SC, Hayes SC, Silver JK, Campbell KL, Winters-Stone K, Gerber LH, George SM, Fulton JE, Denlinger C, Morris GS, Hue T, Schmitz KH, Matthews CE. American College of Sports Medicine Roundtable report on physical activity, sedentary behavior, and cancer prevention and control. Med Sci Sports Exerc 2019;51(11):2391–402. doi:10.1249/MSS.0000000000002117.
18. Ekelund U, Steene-Johannessen J, Brown WJ, Fagerland MW, Owen N, Powell KE, Bauman A, Lee IM. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. Lancet 2016;388(10051):1302–10. doi:10.1016/S0140-6736(16)30370-1.
19. Stamatakis E, Gale J, Bauman A, Ekelund U, Hamer M, Ding D. Sitting time, physical activity, and risk of mortality in adults. J Am Coll Cardiol 2019;73(16):2062–72. doi:10.1016/j.jacc.2019.02.031.
20. Friedenreich CM, Stone CR, Cheung WY, Hayes SC. Physical activity and mortality in cancer survivors: A systematic review and meta-analysis. JNCI Cancer Spectr 2020;4(1):kz080. doi:10.1093/jncics/pkz080.
21. Schmid D, Leitzmann MF. Association between physical activity and mortality among breast cancer and colorectal cancer survivors: a systematic review and meta-analysis. Ann Oncol 2014;25(7):1293–311. doi:10.1093/annonc/mdu012.
22. Holmes MD, Chen WY, Feskanich D, Kroenke CH, Colditz GA. Physical activity and survival after breast cancer diagnosis. JAMA 2005;293(20):2479–86. doi:10.1001/jama.293.20.2479.
23. Swain CTV, Nguyen NH, Eagles T, Vallance JK, Boyle T, Lahart IM, Lynch BM. Postdiagnosis sedentary behavior and health outcomes in cancer survivors: A systematic review and meta-analysis. Cancer 2020;126(4):861–9. doi:10.1002/cncr.32578.
24. D'Silva A, Gardiner PA, Boyle T, Bebb DG, Johnson ST, Vallance JK. Associations of objectively assessed physical activity and sedentary time with health-related quality of life among lung cancer survivors: A quantile regression approach. Lung Cancer 2018;119:78–84. doi:10.1016/j.lungcan.2018.03.010.
25. Campbell KL, Winters-Stone KM, Wiskemann J, May AM, Schwartz AL, Courneya KS, Zucker DS, Matthews CE, Ligibel JA, Gerber LH, Morris GS, Patel A, Hue TF, Perna FM, Schmitz KH. Exercise guidelines for cancer survivors: Consensus statement from international multidisciplinary Roundtable. Med Sci Sports Exerc 2019;51(11):2375–90. doi:10.1249/MSS.0000000000002116.
26. Rock CL, Thomson CA, Sullivan KR, Howe CL, Kushi LH, Caan BJ, Neuhouser ML, Bandera EV, Wang Y, Robien K, Basen-Engquist, KM, Brown JC, Courneya KS, Crane TE, Garcia DO, Grant BL, Hamilton KK, Hartman SJ, Kenfield SA, Martinez ME, McCullough ML. American Cancer Society nutrition and physical activity guideline for cancer survivors. CA Cancer J Clin 2022;72(3):230–62. doi:10.3322/caac.21719.
27. Dunstan DW, Dogra S, Carter SE, Owen N. Sit less and move more for cardiovascular health: emerging insights and opportunities. Nat Rev Cardiol 2021;18(9):637–48. doi:10.1038/s41569-021-00547-y.
28. Yang L, Morielli AR, Heer E, Kirkham AA, Cheung WY, Usmani N, Friedenreich CM, Courneya KS. Effects of exercise on cancer treatment efficacy: A systematic review of preclinical and clinical studies. Cancer Res 2021;81(19):4889–95. doi:10.1158/0008-5472.CAN-21-1258.