Title: What's more important – physical activity levels as determined by self-report or objective-assessment in women with breast cancer?

Manuscript type: Original research.

Authors: Ben Singh[1], Rosalind R. Spence[2,3], Megan L. Steele[4] & Sandra C. Hayes[2,5].

Affiliations:

[1] University of Jean Monnet, Inter-university Laboratory of Human Movement Biology, A 7424, F-42023, Saint-Etienne, France.

[2] School of Public Health and Social Work, Queensland University of Technology, Victoria Park Road, Kelvin Grove, Queensland, Australia.

[3] Institute of Health and Biomedical Innovation, Queensland University of Technology, Musk Avenue, Kelvin Grove, Queensland, Australia.

[4] School of Clinical Medicine, University of Queensland, St. Lucia, Queensland, Australia.

[5] Menzies Health Institute Queensland, Griffith University, Queensland, Australia.

Corresponding author:

Dr. Ben SINGH

Laboratoire Interuniversitaire de Biologie de la Motricité

Bâtiment IRMIS

10 rue de la Marandière

42270 Saint Priest en Jarez

Email: benjamin.singh@connect.qut.edu.au

ABSTRACT

Background: To help women with breast cancer (BC) become and stay sufficiently active, accurate assessment of physical activity (PA) is important. This study compared self-reported with objectively-assessed PA in women with stage II+ BC.

Methods: Moderate-to-vigorous-intensity physical activity (MVPA) was assessed objectively using accelerometery (Actigraph® GT3X+) and self-reported via the Active Australia Survey and reported in weekly metabolic equivalent minutes (MET.min/wk). Associations, difference and agreement between self-reported and objectively-assessed MVPA were evaluated using Spearman's correlation, Wilcoxon signed-rank test and Bland-Altman analyses. Women were also categorised as being insufficiently ($\leq$450 MET.min/wk) or sufficiently active (>450 MET.min/wk) and compared using Cohen's Kappa.

Results: Participants (n=50) were 51±9 years, with a mean body mass index of 29±6 kg/m^2. Self-reported and objectively-assessed MVPA were moderately correlated ($r=0.46$, $p<0.01$). Median MVPA was similar across methods (self-reported: median=1085.1 [Interquartile range, IQR=1032.2] MET.min/wk; objectively-assessed: median=888.4 [IQR=1218.5] MET.min/wk; $p=0.74$), although limits of agreement were wide (±2588.6 MET.min/wk).

Conclusion: For most who self-reported PA levels consistent with national guidelines, their objectively-assessed PA levels confirmed this to be true. It seems plausible that self-report methods of PA could be used to identify women who need encouragement to stay active versus those need more specific and targeted PA advice.

Trial registration: Prospectively registered on the Australian and New Zealand Clinical Trials Registry (ANZCTR, Trial registration number: ACTRN12616000954426).

Keywords: breast cancer; neoplasm; physical activity; exercise; accelerometry.

Introduction

Consistent evidence supports that exercise and physical activity interventions lead to improvements in physiological and functional outcomes including improved physical and psychosocial health, as well as higher overall quality of life during and following treatment for breast cancer.[1–4] Exploratory analyses from randomized trials also suggests that following a breast cancer diagnosis, higher physical activity levels are associated with reduced risk of cancer recurrence and improved survival.[5,6] Overall, the evidence supporting the importance of physical activity following a breast cancer diagnosis is compelling.

In helping women to become or stay sufficiently physically active, it is important to accurately measure levels of physical activity. Methods of assessing physical activity widely used in breast cancer research include completion of self-reported questionnaires and objective assessment using accelerometers.[7,8] Self-reported methods using validated questionnaires, such as the Active Australia survey[9], International Physical Activity Questionnaires[10] and Women's Health Initiative Brief Physical Activity Questionnaire[11], are considered low-cost and easy to administer. This method of assessment also provides information about type, duration and intensity of physical activity undertaken.[7,8,12] However, data collected via this method is subject to recall bias, typically in the direction of over-reporting.[13–15] In contrast, the use of accelerometers provides an objective measure of the frequency, intensity and duration of physical activity[14,16], and can overcome the recall bias issues associated with self-reported methods. Nonetheless, accelerometers bring higher measurement costs (financial and participant burden), and are subject to missing data issues introduced through non-compliance.[15,17] Further, there is lack of consensus on data processing, analysis and reporting procedures, which limits comparability between studies.[14]

The Active Australia survey[9] has been used previously for population-based physical activity assessment in studies involving healthy[18–20] and clinical[21,22] Australian samples. The survey is designed to assess leisure-time physical activity and evaluates frequency (sessions) and duration (minutes) of walking, moderate and vigorous activities, and household and gardening activities for the past seven days.[9] The survey has been shown to have good test-retest reliability (Kappa=0.52)[23] and has been demonstrated to have good reliability (Intraclass Correlation Coefficient=0.64), criterion validity (r=0.61) and is responsive to intervention change.[24] The survey has also been validated against the use of accelerometers among Australian men and women[25–28] and US women[29], with findings supporting positive associations between the two methods (Active Australia and accelerometery) for weekly minutes of moderate-intensity activity (including walking, as this cannot be distinguished from moderate-intensity activity as recorded by an accelerometer; r=0.50) and moderate-to-vigorous activity (MVPA) (r=0.61).[28] However, comparisons have only been made using data collected from healthy adult samples.

Few studies have compared self-reported physical activity with objectively-assessed physical activity levels among women with breast cancer. Four previous studies[11,30–32] involving sample sizes between 63 and 161 have compared five different self-reported physical activity assessment methods with accelerometer-assessed data. Three[30–32] of these four studies reported a lack of agreement between self-reported and objective measures, with self-report overestimating physical activity by up to 247%[32] when compared with objectively-assessed physical activity. However, these findings were derived from North American and Swedish samples, and did not involve the use of the Active Australia survey. It is unclear how generalisable these findings are to Australian women with breast cancer, using an Australian physical activity survey. Therefore, the purpose of this study was to compare physical activity assessed using the Active Australia survey with objectively-assessed physical activity using accelerometery in a sample of Australian women with stage II+ breast cancer. It was also an objective to assess the relationships between self-reported and objectively-assessed physical activity with other health-related outcomes, including aerobic fitness, upper-body strength, lower-body strength, exercise self-efficacy and quality of life.

Methods

Study overview and sample

This is a cross-sectional study involving a convenience sample of women with stage II+ breast cancer, who had recently completed a 12-week physical activity trial.[33] Ethical approval for this trial was obtained from the Human Research Ethics Committee at the Queensland University of Technology (approval number: HREC 16000 00631).

Outcome of interest – physical activity

Objectively-assessed physical activity was collected using a tri-axial accelerometer (Actigraph® GT3X+). Participants were asked to wear the accelerometer on their hip at all times, excluding sleep and water-based activities, for a 7-day wear-period. Data were then downloaded using the Actigraph® software (ActiLife®, version 6.10.2) and screened for completeness and irregularities. A minimum of 10 hours per day was used as the cut-off for a valid day of measurement and a minimum of 4 valid days of data were required per participant (participants not meeting this threshold of valid wear-time were excluded from the analysis) .[34–36] Bouts of ≥ 90 minutes of zero counts per minute were coded as non-wear time.[34,36] The accelerometer recorded the maximum activity count in 60 second epochs at a sampling rate of 80 Hz, providing data on time spent in light, moderate, and vigorous physical activity, as well as steps. Standard calibration thresholds were used to aggregate data into minutes per week of moderate and vigorous activity using the Freedson cut-points (sedentary: <100 counts/minute;

light: 101 to 1951 counts/minute; moderate: 1952 to 5724; or vigorous: >5725 counts/minute).[34,36] All minutes with ≥1952 counts per minute were classified as MVPA and were summed for each day and averaged across valid days, then multiplied by seven to compute a weekly value.[34,36]

Self-reported physical activity was assessed using the Active Australia Survey[9] administered at the end of the 7-day wear period of the accelerometer. The questionnaire assesses weekly minutes of walking, moderate and vigorous activities, and household and gardening activities (in the past 7 days). Outcomes obtained using the Active Australia questionnaire included minutes per week of moderate-intensity activity, vigorous-intensity activity and total MVPA, with vigorous activity weighted according to manual instructions.[9] For consistency in comparing the two methods, vigorous intensity activity assessed using the accelerometer was also weighted by two. Walking and moderate intensity activities are similar in intensity and cannot be distinguished by accelerometer data.[23] Therefore, minutes of walking was included as moderate intensity activity.[23]

This present study used data collected as part of a 12-week physical activity intervention that also assessed aerobic fitness, upper- and lower-body strength, quality of life and exercise self-efficacy using the 6-minute walk test[37], YMCA bench press test[38] (modified to use a reduced weight of 10 kg instead of 16 kg) and 30-second sit-to-stand test[39], the Functional Assessment of Cancer Therapy-Breast[40] questionnaire and the Barrier self-efficacy scale[41], respectively. Aerobic fitness, upper- and lower-body strength, quality of life, exercise self-efficacy and self-reported physical activity were assessed at baseline (i.e., 0 weeks) and at 12 weeks follow-up. Objectively-assessed physical activity was only assessed at the 12-week follow-up. Personal, demographic, clinical and health history information were also obtained using a participant-completed questionnaire at baseline. The Physical Activity Compendium was used to convert physical activity data (minutes per week) into metabolic equivalent minutes per week (MET.min/wk) by assigning a weighting to walking, moderate intensity activity and vigorous intensity activity of 3.3, 4 and 8 METS, respectively.[42]

Statistical analyses

Patient characteristics were described using means and standard deviations (SD) and frequencies and percentages (%) for continuous and categorical data, respectively. The average minutes per week of self-reported and objectively-assessed moderate-intensity, vigorous-intensity and MVPA were assessed for normality and reported at group level as medians (interquartile range) due to non-normal distribution. Associations between self-reported and objectively-assessed physical activity data were evaluated using Spearman's correlation coefficients. Differences between the self-reported and objectively-assessed physical activity levels were compared using a Wilcoxon signed-rank test. Bland-Altman analyses were undertaken to evaluate agreement between the two methods of assessment following previously described methods.[43] Bland-Altman plots for moderate-intensity, vigorous-intensity and MVPA were created for the mean difference between MET.min/wk of the two methods and limits of agreement (LOA; mean difference and 95% CI of the mean differences) were calculated. The association between the mean and the mean difference in moderate intensity, vigorous intensity and MVPA MET.min/wk was assessed using Spearman's correlations to evaluate whether the two methods agree equally through the range of measurements.[44] The proportion of participants classified as sedentary (performing <60 MET.min/wk of MVPA), insufficiently physically active (performing 60-450 MET.min/wk of MVPA) or sufficiently physically active (performing >450 MET.min/wk of MVPA) based on self-reported physical activity and objectively-assessed physical activity were compared using the Cohen's Kappa.[23] Associations between self-reported and objectively-assessed MVPA and aerobic fitness, upper-body strength, lower-body strength, quality of life and exercise self-efficacy were evaluated using Spearman's correlations. All data analyses were undertaken using SPSS version 22.0

(Chicago, Illinois, USA) and a two-tailed P-value of ≤0.05 was considered statistically significant.

Results

This study involved a convenience sample of 50 participants (Table 1). Mean age of the sample was 51 years (SD= 9 years) and mean body mass index was 29 kg/m^2 (SD= 6 kg/m^2).

Association between self-reported and objectively-assessed minutes per week of physical activity. Significant positive correlations between the two methods were observed for MET.min/wk of moderate-intensity physical activity (r=0.69, p<0.01)) and MVPA (r=0.46, p<0.01), but not for vigorous-intensity physical activity (r=0.05, p=0.73; Table 2).

Average self-reported moderate-intensity physical activity (median=845.5 MET.min/wk [IQR=691.1]) was higher (p<0.01) compared with the objectively-assessed data (median moderate-intensity=274.4 [IQR=365.0] MET.min/wk, Table 3). In contrast, vigorous-intensity physical activity was higher (p<0.01) according to objectively-assessed data compared with self-reported data (median=524.6 [IQR=974.7] MET.min/wk and 0 [IQR=480.4] MET.min/wk, respectively, Table 3). Total MVPA was similar between methods (self-reported: median=1085.1 [IQR=1032.2] MET.min/wk; objectively-assessed: 888.4 [IQR=1218.5] MET.min/wk, p=0.74, Table 3).

The mean difference and LOA between the two methods was 530.4 (95% CI=396.4, 664.6; LOA: ±924.9) MET.min/wk for moderate-intensity physical activity (Figure 1), -415.1 (95% CI= -786.7, -43.4; LOA: ±2590.3) MET.min/wk per week for vigorous-intensity activity (Figure 2) and 116.1 (95% CI: -259.2, 491.4; LOA: ±2588.6) MET.min/wk for MVPA (Figure 3). A significant positive association was found between the mean and the difference between the two methods for moderate-intensity physical activity (r=0.73, p<0.01) and MVPA (r=0.42, p=0.03), indicating that differences between the two methods increased as MET.min/wk increased (Table 4).

The proportions of participants classified according to self-report versus objective-assessment as sedentary (4% vs. 0%), insufficiently active (14% vs. 24%) and sufficiently active (82% vs. 76%; κ = 0.12 [95% CI= -0.12, 0.37], p=0.31) were similar. The majority (80.5%) who self-reported being active were also sufficiently active according to objective-assessment (Supplementary Content 1).

Higher self-reported MVPA at baseline or at 12-weeks follow up was associated (p<0.01, Table 7) with higher baseline aerobic fitness (r=0.43), upper-body strength (r=0.79) and lower-body strength (r=0.37-0.54). Higher objectively-assessed MVPA at 12 weeks was associated (p<0.05, Table 7) with higher lower-body strength (r=0.65), and exercise self-efficacy (r=0.29).

Discussion

Findings from this study showed that self-reported MVPA using the Active Australia survey is comparable with objectively-assessed physical activity. However, compared with objective assessment, the Active Australia survey overestimates moderate-intensity physical activity and underestimates vigorous-intensity activity. Irrespective, for the majority of those who self-report physical activity levels consistent with levels recommended in national guidelines, their objectively-assessed physical activity levels confirms this to be true.

We observed a wide LOA between the two methods, ranging between ±924.9 to ±2590.3 MET.min/wk, suggesting that the Active Australia survey and accelerometer cannot be used interchangeably for most individuals. Most of the activity that participants self-reported was of moderate intensity, with the median self-reported MVPA approximately 570 MET.min/wk higher when compared with objectively-assessed MVPA. Our findings are consistent with previous studies that have reported an over-estimation of self-reported physical activity when compared to accelerometry data among cancer populations.[31,45] This includes a study of colon cancer survivors (n=176), which showed self-reported MVPA was more than double that of accelerometer-assessed MVPA (26 min/day vs. 12 min/day, respectively, $p<0.01$; equivalent to approximately 1092 MET.min/wk vs. 504 MET.min/wk)[45], and a study of breast cancer patients (n=65) whose self-reported moderate intensity activity was higher compared with accelerometery (55 min/day vs. 41 min/day respectively, $p<0.01$; equivalent to approximately 1504 MET.min/wk vs. 1148 MET.min/wk).[31] Further, we observed that differences between the two methods increased as the average minutes of moderate-intensity and MVPA increased, suggesting that the days the participants were the most physically active were also the days when the level of agreement between the two methods was weakest. This is also consistent with previous findings involving women with breast cancer (n=65), whereby differences between physical activity levels self-reported via logbook and those recorded via accelerometry increased as the average of moderate ($r = 0.3$, $P < 0.01$) and vigorous ($r = 0.5$, $P < 0.01$) intensity physical activity increased.[31] Collectively, findings from this present study and previous studies[31,45] consistently demonstrate an overestimation of self-reported physical activity compared with objectively-assessed activity. As such, if measuring physical activity levels is about determining minimum thresholds for degree of health or survival benefits, then it could be argued that objective assessment is vital for ensuring accuracy of physical activity data collected.

Understanding physical activity levels on an individual basis at any given point in time allows for identifying individuals not meeting national physical activity level recommendations, as well as determining potential for change that may come through physical activity intervention (both in levels of physical activity, as well as potential for benefits in health outcomes). While there was lack of agreement in moderate, vigorous and MVPA levels between our two methods of assessment, similar proportions of participants were classified as sedentary, insufficiently active or physically active based on self-reported and objectively-assessed data. Further, 80% who self-reported being sufficiently active were classified similarly according to objective measurement. In contrast, less than half (44%) of whom self-reported being sedentary or insufficiently active were also grouped as sedentary or insufficiently active based on objective measure. These results suggests that when a woman says she’s sufficiently active, she usually is; when she reports being insufficiently active or sedentary, she may be correct but either way improvements in physical activity levels (whether observed via self-report or objective assessment) will likely lead to benefit in at least fitness and strength.

Limitations to this research need to be considered. First, lower levels of physical activity as assessed by the accelerometer, compared with self-report, may have been attributed to limitations related to accelerometery, such as inability to capture water-based physical activity, time spent cycling (stationary or road) and participation in resistance exercise. This is particularly relevant in the context of this study as these represent activities self-reported by the sample (in particular, resistance exercise twice per week), and suggest that differences reported between self-report and objectively-assessed physical activity levels may have been overstated. Additional factors such as missing data may also have contributed to differences measured. Further, while all participants were instructed to complete the Active Australia on the final day of collection of accelerometry data, we were unable to quantify the full extent to which this occurred. It is also possible that recall bias or social desirability bias may have influenced self-reporting of physical activity, possibly contributing to over-reporting of physical activity (both at baseline and follow-up). However, we expected this to be less of an issue in the context of this study as participants had previously been participants of the SAFE trial, which involved receiving physical activity counselling and education.

Conclusion

The health and survival benefits associated with physical activity highlight the importance of accurately identifying those who require assistance in meeting national physical activity guidelines. Findings from this work suggest that when women are educated as to what constitutes moderate- and vigorous-intensity activity, those who self-report to be meeting guidelines, generally are meeting guidelines (based on objective assessment) and can be encouraged to maintain those levels of activity. All others could likely benefit from receipt of behavioural counselling that seeks to gradually increase and then maintain their physical activity levels over time. Overall, use of an accelerometer or other objective measure of physical activity in conjunction with education and behavioural counselling, appears useful in helping women with breast cancer to increase and then maintain their physical activity levels over time.

List of abbreviations:

IQR: Interquartile range.

LOA: Limits of agreement

MET.min/wk: metabolic equivalent minutes per week.

MVPA: Moderate-to-vigorous-intensity physical activity.

SD: standard deviation.

Declarations

Ethics approval and consent to participate: Ethical approval for this trial was obtained from the Human Research Ethics Committee at the Queensland University of Technology (approval number: HREC 16000 00631). All participants provided written informed consent prior to participation.

Consent for publication: Not applicable.

Availability of data and materials: Available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: The authors received no specific funding for this work.

Authors' contributions: BS, RS and SH undertook study implementation and data collection. BS, MS, RS and SH contributed to data analysis and manuscript preparation.

Acknowledgements: Nil.

References

1. Speck RM, Courneya KS, Mâsse LC, Duval S, Schmitz KH. An update of controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. J Cancer Surviv. 2010;4(2):87–100.

2. Duijts SF, Faber MM, Oldenburg HS, van Beurden M, Aaronson NK. Effectiveness of behavioral techniques and physical exercise on psychosocial functioning and health-related quality of life in breast cancer patients and survivors--a meta-analysis. Psychooncology. 2011;20(2):115–26.

3. Soares Falcetta F, de Araujo Vianna Trasel H, de Almeida FK, Rangel Ribeiro Falcetta M, Falavigna M, Dornelles Rosa D. Effects of physical exercise after treatment of early breast cancer: systematic review and meta-analysis. Breast Cancer Res Treat. 2018;170(3):455-476

4. Singh B, Spence RR, Steele ML, Sandler CX, Peake JM, Hayes SC. A Systematic Review and Meta-Analysis of the Safety, Feasibility, and Effect of Exercise in Women With Stage II+ Breast Cancer. Arch Phys Med Rehabil. 2018;99(12):2621–36.

5. Courneya KS, Segal RJ, McKenzie DC, Dong H, Gelmon K, Friedenreich CM, et al. Effects of exercise during adjuvant chemotherapy on breast cancer outcomes. Med Sci Sport Exerc. 2014;46(9):1744–51.

6. Hayes SC, Steele ML, Spence RR, Gordon L, Battistutta D, Bashford J, et al. Exercise following breast cancer: exploratory survival analyses of two randomised, controlled trials. Breast Cancer Res Treat. 2018;167(2):505–14.

7. Ainsworth B, Cahalin L, Buman M, Ross R. The current state of physical activity assessment tools. Prog Cardiovasc Dis. 2015;57(4):387–95.

8. Broderick JM, Ryan J, O'Donnell DM, Hussey J. A guide to assessing physical activity using accelerometry in cancer patients. Support Care Cancer. 2014;22(4):1121–30.

9. Australian Institute of Health and Welfare. The Active Australia Survey: a guide and manual for implementation, analysis and reporting. Canberra: AIHW; 2004.

10. Hagstromer M, Oja P, Sjostrom M. The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. Public Health Nutr. 2006;9(6):755–62.

11. Johnson-Kozlow M, L Rock C, A Gilpin E, Hollenbach K, Pierce J. Validation of the WHI Brief Physical Activity Questionnaire among Women Diagnosed with Breast Cancer. Am J Health Behav. 2007;31:193–202.

12. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. Int J Behav Nutr Phys Act. 2008;5:56.

13. Ainsworth B, Cahalin L, Buman M, Ross R. The current state of physical activity assessment tools. Prog Cardiovasc Dis. 2015;57(4):387–95.

14. Broderick JM, Ryan J, O'Donnell DM, Hussey J. A guide to assessing physical activity using accelerometry in cancer patients. Support Care Cancer. 2014;22(4):1121–30.

15. Prince SA, Adamo KB, Hamel ME, Hardt J, Connor Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. Int J Behav Nutr Phys Act. 2008;5:56.

16. Chomistek AK, Yuan C, Matthews CE, Troiano RP, Bowles HR, Rood J, et al. Physical Activity Assessment with the ActiGraph GT3X and Doubly Labeled Water. Med Sci Sports Exerc. 2017;49(9):1935–44.

17. Bassett DR, Troiano RP, McClain JJ, Wolff DL. Accelerometer-based physical activity: total volume per day and standardized measures. Med Sci Sport Exerc. 2015;47(4):833–8.

18. Armstrong T, Bauman A & Davies J 2000. Physical activity patterns of Australian adults. Results of the 1999 National Physical Activity Survey. Canberra: Australian Institute of Health and Welfare.

19. Bauman A, Ford I & Armstrong T (2001). Trends in population levels of reported physical activity in Australia, 1997, 1999 and 2000. Canberra: Australian Sports Commission. Accessed 20 Feb 2019.

20. Chau J., Smith, B., Chey T., Merom D., Bauman A., (2007). Trends in population levels of sufficient physical activity in NSW, 1998 to 2005: Full report. Report No. CPAH06-001c. Accessed 20 Feb 2019.

21. Hawkes AL, Atherton J, Taylor CB, Scuffham P, Eadie K, Miller NH, et al. Randomised controlled trial of a secondary prevention program for myocardial infarction patients ('ProActive Heart'): study protocol. Secondary prevention program for myocardial infarction patients. BMC Cardiovasc Disord. 2009;9:16.

22. Eakin E, Reeves M, Lawler S, Graves N, Oldenburg B, Del Mar C, et al. Telephone counseling for physical activity and diet in primary care patients. Am J Prev Med. 2009;36(2):142–9.

23. Brown WJ, Trost SG, Bauman A, Mummery K, Owen N. Test-retest reliability of four physical activity measures used in population surveys. J Sci Med Sport. 2004;7(2):205–15.

24. Reeves MM, Marshall AL, Owen N, Winkler EAH, Eakin EG. Measuring Physical Activity Change in Broad-Reach Intervention Trials. J Phys Act Heal. 2010;7(2):194–202.

25. Brown WJ, Burton NW, Marshall AL, Miller YD. Reliability and validity of a modified self-administered version of the Active Australia physical activity survey in a sample of mid-age women. Aust NZ J Public Heal. 2008;32(6):535–41.

26. Timperio A, Salmon J, Crawford D. Validity and reliability of a physical activity recall instrument among overweight and non-overweight men and women. J Sci Med Sport. 2003;6(4):477–91.

27. Timperio A, Salmon J, Rosenberg M, Bull FC. Do logbooks influence recall of physical activity in validation studies? Med Sci Sport Exerc. 2004;36(7):1181–6.

28. Fjeldsoe BS, Winkler EA, Marshall AL, Eakin EG, Reeves MM. Active adults recall their physical activity differently to less active adults: test-retest reliability and validity of a physical activity survey. Heal Promot J Austr. 2013;24(1):26–31.

29. Pettee Gabriel K, McClain JJ, Lee CD, Swan PD, Alvar BA, Mitros MR, et al. Evaluation of physical activity measures used in middle-aged women. Med Sci Sport Exerc. 2009;41(7):1403–12.

30. Wagoner CW, Choi SK, Deal AM, Lee JT, Wood WA, Muss HB, et al. Establishing physical activity in breast cancer: self-report versus activity tracker. Breast Cancer Res Treat. 2019;176(2):395-400.

31. Mazzoni A-S, Nordin K, Berntsen S, Demmelmaier I, Igelström H. Comparison between logbook-reported and objectively-assessed physical activity and sedentary time in breast cancer patients: an agreement study. BMC Sports Sci Med Rehabil. 2017;9(1):8.

32. Johnson-Kozlow M, Sallis JF, Gilpin EA, Rock CL, Pierce JP. Comparative validation of the IPAQ and the 7-Day PAR among women diagnosed with breast cancer. Int J Behav Nutr Phys Act. 2006;3(1):7.

33. Singh B, Spence RR, Sandler CX, Tanner J, Hayes SC. Feasibility and effect of a physical activity counselling session with or without provision of an activity tracker on maintenance of physical activity in women with breast cancer – A randomised controlled trial. J Sci Med Sport. 2019; doi: https://doi.org/10.1016/j.jsams.2019.09.019.

34. Cain, Kelli L. (2014) Accelerometer Scoring Protocol for the IPEN-Adult Study. University California San Diego, CA. http://www.ipenproject.org/protocols/accelerometer. Accessed 20 Feb 2019.

35. Reeves MM, Terranova CO, Erickson JM, Job JR, Brookes DS, McCarthy N, et al. Living well after breast cancer randomized controlled trial protocol: evaluating a telephone-delivered weight loss intervention versus usual care in women following treatment for breast cancer. BMC Cancer. 2016;16(1):830.

36. Hartman SJ, Nelson SH, Myers E, Natarajan L, Sears DD, Palmer BW, et al. Randomized controlled trial of increasing physical activity on objectively measured and self-reported cognitive functioning among breast cancer survivors: The memory & motion study. Cancer. 2017;124(1):192-202.

37. American Thoracic Society. ATS Statement. Am J Respir Crit Care Med. 2002;166(1):111–7.

38. Kim SP, Mayhew LJ, Peterson FD. A Modified YMCA Bench Press Test as a Predictor of 1 Repetition Maximum Bench Press Strength. J Strength Cond Res. 2002;16(3):440–5.

39. Jones J, Rikli R, C. Beam W. A 30-s Chair-Stand Test as a Measure of Lower Body Strength in Community-Residing Older Adults. 1999;70:113–9.

40. Cella DF, Tulsky DS, Gray G, Sarafian B, Linn E, Bonomi A, et al. The Functional Assessment of Cancer Therapy scale: development and validation of the general measure. J Clin Oncol. 1993;11(3):570–9.

41. Buchan J, Janda M, Box R, Rogers L, Hayes S. Exercise barriers self-efficacy: development and validation of a subcale for individuals with cancer-related lymphedema. Health Qual Life Outcomes. 2015;13:37.

42. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DRJ, Tudor-Locke C,

et al. 2011 Compendium of Physical Activities: a second update of codes and MET values. Med Sci Sports Exerc. 2011;43(8):1575–81.

43. Brown W, Bauman A, Chey T, Trost S, Mummery K. Comparison of surveys used to measure physical activity. Aust N Z J Public Heal. 2004;28(2):128–34.

44. Mazzoni A-S, Nordin K, Berntsen S, Demmelmaier I, Igelström H. Comparison between logbook-reported and objectively-assessed physical activity and sedentary time in breast cancer patients: an agreement study. BMC Sports Sci Med Rehabil. 2017;9(1):8.

45. Boyle T, Lynch B, S Courneya K, K Vallance J. Agreement between accelerometer-assessed and self-reported physical activity and sedentary time in colon cancer survivors. Support Care Cancer. 2014;23:23(4):1121-6.

Table 1. Characteristics of the study participants (n=50)

Characteristic	n=50
Age (years), mean (SD)	51.1 (9.1)
Body mass index (kg/m^2), mean (SD)	28.6 (5.6)
Current smoker, (yes)	0 (0%)
Marital status, n (%)	
Married, defacto or living together	34 (68%)
Highest level of education, n (%)	
Trade, certificate or diploma, Bachelor's degree or higher degree	33 (66%)
Employment status, n (%)	
Full-time, part-time or casual	24 (48%)
Number of work hours in paid employment per week, mean (SD)	11.1 (13.5)
Has Private Health Cover, n (%)	40 (80%)
Disease stage, n (%)	
II	23 (46%)
III, IV or missing	27 (54%)
Mastectomy/MRM, n (%)	33 (66%)
Chemotherapy (yes, current or previously), n (%)	45 (90%)
Previous/completed	43 (86%)
Current	2 (4%)
Radiotherapy (yes, current or previously), n (%)	42 (84%)
Previous/completed	40 (80%)
Current	2 (4%)
Hormone therapy (yes, current or previously), n (%)	40 (80%)
Other treatment, n (%)	
Herceptin	4 (8%)
Herceptin and immunotherapy	1 (2%)
Time since diagnosis (months), median (minimum, maximum)	40 (5, 82)
Time since treatment completion (months), median (minimum, maximum)	19 (0, 54)
Total number of treatment-related adverse effects[1]	
Mean (SD)	3 (1.7)
Median (minimum, maximum)	3 (0, 8)
Number of comorbidities[3]	
0	16 (23%)
1 to 3	30 (60%)
>3	4 (8%)
Intervention completed in SAFE	
20 supervised exercise sessions	26 (52%)
5 supervised sessions	24 (48%)
Meeting physical activity guidelines (yes)[4]	39 (78%)

[1] Treatment-related side effects included pain, fatigue, nausea, hair loss, sleep problems/insomnia, peripheral neuropathy, arthralgia (joint pain), hot flushes, lymphoedema, skin changes, upper-body morbidity (loss of strength, impaired mobility), numbness or tingling in hands and feet, seroma formation, weight gain, mood swings, cognitive issues, anxiety, depression, loss of finger or toes nails.
[2] Severity ranged from 0 (symptom not present) to 3 (severe).
[3] Comorbidities included cardiovascular disease, hypertension, high cholesterol, high blood glucose, diabetes, heart attack, stroke, emphysema, chronic bronchitis, arthritis, thyroid condition, peripheral vascular disease, osteoporosis, inflammatory condition or asthma.
[4] Defined as performing at least 150 minutes per week of moderate intensity physical activity.
SD: standard deviation; MRM: modified radical mastectomy.

Table 2. Spearman's correlation coefficients (Pearson's r) between MET minutes per week of self-reported and objectively-assessed physical activity based on MET minutes groupings of 90 minute increments

	Objectively-measured physical activity		
	Moderate-intensity *r* (p-value)	Vigorous-intensity *r* (p-value)	MVPA *r* (p-value)
Self-report			
Moderate-intensity (n=50)[1]	0.69 (p<0.01)	-	-
Vigorous -intensity (n=50)	-	0.05 (p=0.73)	-
MVPA (n=50)[1]	-	-	0.46 (p<0.01)

[1] Includes minutes per week of walking.
MVPA: Moderate-to-vigorous physical activity.

Table 3. Comparison of self-reported and objectively-assessed moderate-, vigorous- and moderate-to-vigorous intensity physical activity, presented as medians and interquartile ranges (p-values represent results of Wilcoxon signed-rank test).

	MET minutes per week		
Activity intensity	Self-reported, Median (IQR)	Objectively-measured, Median (IQR)	p-value
Moderate-intensity (n=50)[1]	845.5 (691.1)	274.4 (365.0)	<0.01
Vigorous-intensity (n=50)	0.0 (480.4)	524.6 (974.7)	<0.01
MVPA (n=50)	1085.1 (1032.2)	888.4 (1218.5)	0.74

[1] Includes minutes per week of walking.
IQR: Interquartile range.
MVPA: Moderate-to-vigorous physical activity.

Table 4. Correlations (Pearson's r) between the mean and the difference between self-reported and objectively-assessed physical activity.

	Mean of self-reported and objectively-measured physical activity		
	Moderate-intensity *r* (p-value)	Vigorous-intensity *r* (p-value)	MVPA *r* (p-value)
Difference between self-report and objectively-measured physical activity (self-reported – objective)			
Moderate-intensity (n=50)[1]	0.73 (p<0.01)	-	-
Vigorous-intensity (n=50)	-	-0.41 (p=0.03)	-
MVPA (n=50)[1]	-	-	0.42 (p=0.03)

[1] Includes minutes per week of walking.
MVPA: Moderate-to-vigorous physical activity.

Table 5. Comparison of the proportion of participants classified as sedentary, insufficiently physically active or physically active based on self-reported physical activity and objectively-assessed physical activity.

	Self-reported MVPA only (n=50)	Objectively-assessed MVPA only (n=50)	κ (95% CI)	P-value
Physical activity level				
Sedentary or insufficiently active[1]	9 (18%)	12 (24%)		
Physically active[2]	41 (82%)	38 (76%)	0.12 (-0.12, 0.37)	0.31

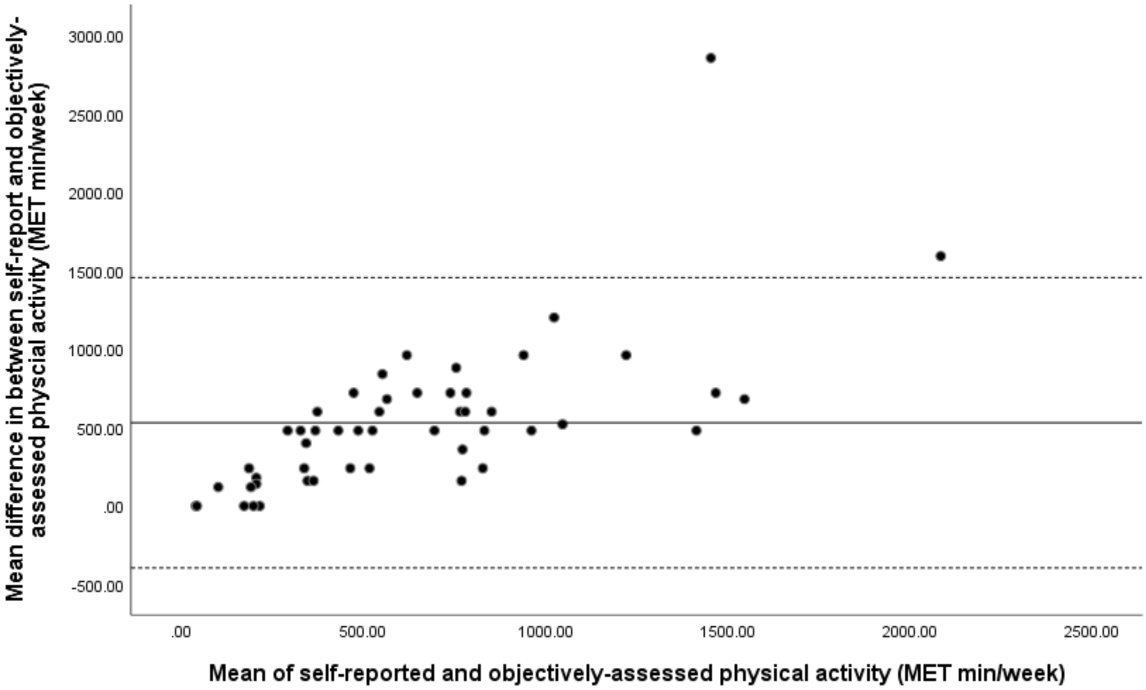
[1] Defined as performing 0 to 450 MET mins per week.
[2] Defined as performing ≥450 MET mins per week.

Table 7. Associations (Pearson's correlation coefficients) between self-reported and objectively-assessed physical activity and quality of life, aerobic fitness, upper- and lower-body strength, n=50.

	Self-reported MVPA at baseline *r* (p-value)	Self-reported MVPA at 12 weeks *r* (p-value)	Objectively-assessed MVPA 12 weeks *r* (p-value)
Aerobic fitness[1]			
Baseline[2]	0.13 (p=0.34)	0.43 (p<0.01*)	0.25 (p=0.08)
Upper-body strength[3]			
Baseline[2]	0.79 (p<0.01*)	0.09 (p=0.50)	0.27 (p=0.05)
Lower-body strength[4]			
Baseline[2]	0.54 (p<0.01*)	0.37 (p<0.01*)	0.65 (p<0.01*)
Overall quality of life[5]			
Baseline	0.01 (p=0.97)	0.07 (p=0.62)	0.11 (p=0.40)
12 weeks	-0.59 (p=0.68)	0.08 (p=0.54)	0.27 (p=0.05)
Exercise self-efficacy			
Baseline	0.05 (p=0.68)	0.17 (p=0.23)	0.21 (p=0.13)
12 weeks	-0.11 (p=0.43)	0.04 (p=0.78)	0.29 (p=0.03*)

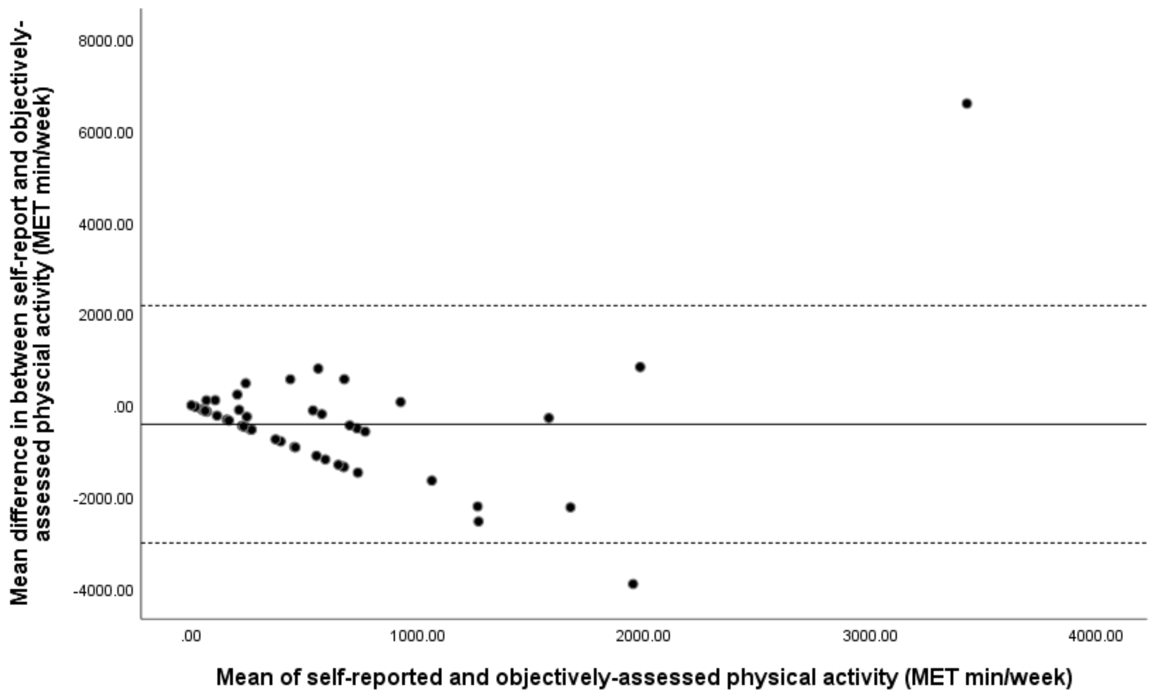
[1] Aerobic fitness assessed using the 6-minute walk test.
[2] Assessed at baseline only.
[3] Upper-body strength assessed using the YMCA bench press test.
[4] Lower-body strength assessed using the 30-second sit-to-stand test.
[5] Overall quality of life assessed using the Functional Assessment of Cancer Therapy-Breast (FACT-B) questionnaire.
* Statistically significant (p<0.05)

Figure 1. Bland-Altman plot of the difference between self-reported and objectively-assessed moderate-intensity physical activity (MET mins/week) plotted against the mean with 95% limits of agreement.



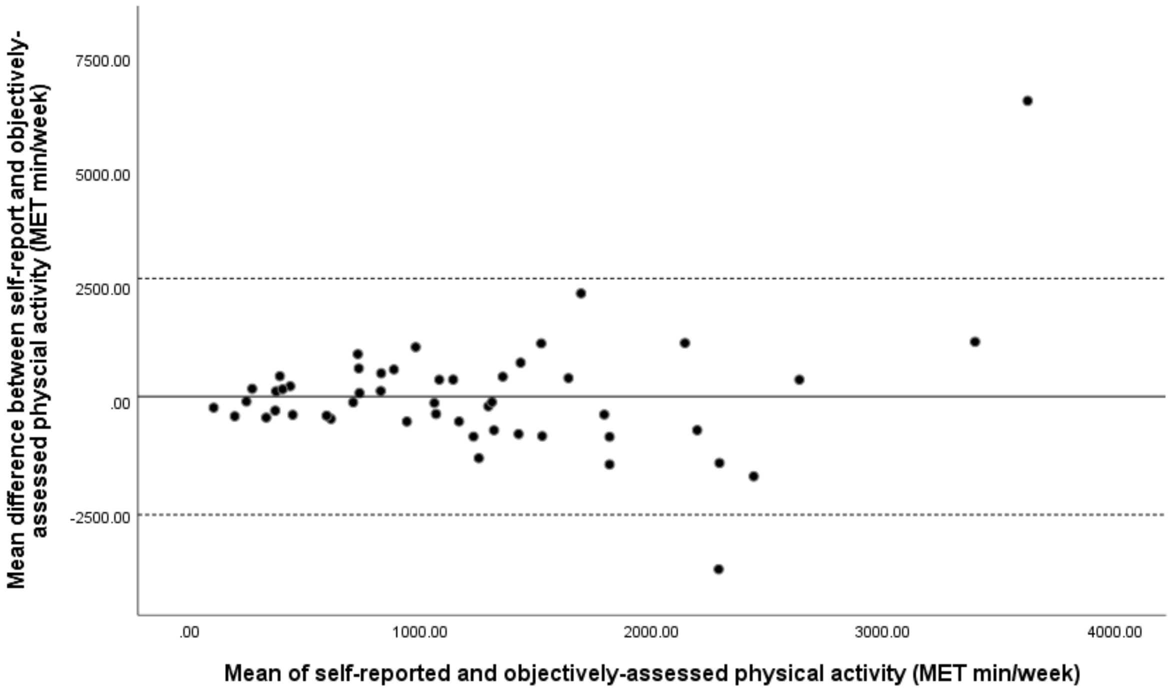
Note: Each point represents a pair of measurements (self-reported and objectively-assessed) obtained from each participant. The solid line indicates the mean difference and the two dotted lines indicate the limits of agreement (SD=1.96).

Figure 2. Bland-Altman plot of the difference between self-reported and objectively-assessed vigorous-intensity physical activity (MET mins/week) plotted against the mean with 95% limits of agreement.



Note: Each point represents a pair of measurements (self-reported and objectively-assessed) obtained from each participant. The solid line indicates the mean difference and the two dotted lines indicate the limits of agreement (SD=1.96).

Figure 3. Bland-Altman plot of the difference between self-reported and objectively-assessed moderate-to-vigorous intensity physical activity (MET mins/week) plotted against the mean with 95% limits of agreement.



Note: Each point represents a pair of measurements (self-reported and objectively-assessed) obtained from each participant. The solid line indicates the mean difference and the two dotted lines indicate the limits of agreement (SD=1.96).

Supplementary Content 1. Proportions of participants classed as sedentary, insufficiently physically active or physically active based on self-reported physical activity and objectively-assessed physical activity.

	Self-reported MVPA		
	Insufficiently active[2]	Physically active[3]	Total
Objectively-assessed MVPA			
Sedentary or Insufficiently active[1]	4 (44.4%)	8 (19.5%)	12 (24%)
Physically active[2]	5 (55.6%)	33 (80.5%)	38 (76%)
Total	9 (100%)	41 (100%)	50 (100%)

[1] Defined as performing 0 to 450 MET mins per week.
[2]Defined as performing ≥450 MET mins per week.