Physical Activity, Walking, and Quality of Life in Women with Depressive Symptoms

Kristiann C. Heesch, DrPH, Yolanda R. van Gellecum, MSocSci, Nicola W. Burton, PhD, Jannique G.Z. van Uffelen, PhD, Wendy J. Brown, PhD

Background: Physical activity (PA) has a positive association with health-related quality of life (HRQL) in the general population. The association between PA and HRQL in those with poor mental health is less clear.

Purpose: To examine the concurrent and prospective dose–response relationships between total PA (TPA) and walking only with HRQL in women aged 50–55 years with depressive symptoms in 2001.

Methods: Participants were 1,904 women born in 1946–1951 who completed mailed surveys for the Australian Longitudinal Study on Women's Health in 2001, 2004, 2007, and 2010, and reported depressive symptoms in 2001. At each time point, they reported their weekly minutes of walking, moderate PA, and vigorous PA. A summary TPA score was created that accounted for differences in energy expenditure among the three PA types. Mixed models were used to examine associations between TPA and HRQL (short form-36 [SF-36] component and subscale scores) and between walking and HRQL, for women who reported walking as their only PA. Analyses were conducted in 2013–2014.

Results: Concurrently, higher levels of TPA and walking were associated with better HRQL ($p < 0.05$). The strongest associations were found for physical functioning, vitality, and social functioning subscales. In prospective models, associations were attenuated, yet compared with women doing no TPA or walking, women doing "sufficient" TPA or walking had significantly better HRQL over time for most SF-36 scales.

Conclusions: This study extends previous work by demonstrating trends between both TPA and walking and HRQL in women reporting depressive symptoms.
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Introduction

Depression is projected to be the second-leading cause of disease burden worldwide by 2030 and the leading cause in high-income countries.[1] Given the high prevalence[2] and associated burden of disease,[1,3] there is an urgent need to identify modifiable factors to improve the health-related quality of life (HRQL) of those with depression. There is good evidence from both cross-sectional[4–12] and prospective[13–19] studies that physical activity (PA) can improve HRQL in the general population,[20] but the association between PA and HRQL has been less frequently examined in people with poor mental health, including those with depression. Cross-sectional data have indicated a positive association for people with bipolar disorder[21] and those with affective, anxiety, or substance-dependence disorders,[22] although no association has been found for inpatients with a serious mental illness, including schizophrenia and psychosis.[23] More work is needed to examine the relationship between PA and HRQL in people with depression.

Research is particularly needed to understand the dose–response relationship between PA and HRQL in depressed people. Cross-sectional studies in general adult

From Queensland University of Technology, Institute of Health & Biomedical Innovation and the School of Public Health and Social Work (Heesch), and The University of Queensland, School of Human Movement Studies and Centre for Research on Exercise, Physical Activity and Health Brisbane (Heesch, van Gellecum, Burton, van Uffelen, Brown), QLD, Australia; and Victoria University, Institute of Sport, Exercise and Active Living (van Uffelen), Melbourne, VIC, Australia

Address correspondence to: Kristiann C. Heesch, DrPH, School of Public Health and Social Work, Queensland University of Technology, Victoria Park Road, Herston QLD 4059, Australia. E-mail: k.heesch@qut.edu.au.

populations have suggested a curvilinear relationship,[11] a linear trend,[8,24,25] stronger associations for lower or higher than intermediate PA levels,[26] and an association for intermediate levels of PA only.[27] A prospective study with older adults demonstrated a linear trend,[28] whereas another with young to middle-aged adults found a positive association for higher levels of PA only.[16] Understanding the beneficial levels of PA for HRQL in people with depression could have important management implications, as there may be thresholds below which PA offers no benefits, or above which PA provides no additional benefits for HRQL.[20]

HRQL is a multidimensional construct, and the dose–response relationship with PA in depressed people may differ between physical and psychological aspects. In general populations, higher PA levels are associated more consistently with higher physical functioning and vitality than other aspects of HRQL.[20] Some cross-sectional data for women, however, indicate certain dimensions of PA (i.e., moderate-intensity PA,[27] leisure-time PA,[29] and sports participation[26]) are more strongly associated with psychological HRQL than physical HRQL. Prospective studies suggest change in PA over time is predominantly associated with improvement in psychological HRQL,[13,16,24] although a study in women showed greater improvements in physical HRQL.[19] In another study, the association between PA and HRQL was mainly for physical HRQL in cross-sectional analyses, and predominantly for psychological and social HRQL in prospective analyses.[24] A review of five exercise training studies for people with depression indicated statistically significant changes in physical HRQL for four studies, but no changes in psychological HRQL.[30] There is, therefore, a need to examine in more detail the associations between PA and the different components of HRQL, both cross-sectionally and over time.

The primary aim of this study was to examine concurrent and 9-year prospective associations between total PA (TPA) and HRQL, and between walking only and HRQL, in community-dwelling healthy women who reported depressive symptoms (Center for Epidemiologic Studies Short Depression Scale [CESD] 10 score ≥10)[31] in 2001, when they were aged 50–55 years. The secondary aim was to describe the nature of these dose–response relationships.

Methods

The Australian Longitudinal Study on Women's Health (ALSWH) is a prospective study of the health and well-being of Australian women born in 1973–1978, 1946–1951, and 1921–1926. Sampling and recruitment details have been reported elsewhere.[32] Surveys were first posted in 1996 and subsequently on a 3-year rolling basis. The study was approved by the Ethics Committees of The University of Queensland and the University of Newcastle.

Informed consent was received from all respondents. Further study details are available on the ALSHW website at www.alswh.org.au/.

Participants

The analytic sample included women born in 1946–1951 who completed surveys in 2001, 2004, 2007, and 2010. These surveys were chosen because PA was measured the same way in each year. The first survey in 1996 was completed by 14,100 women, who were broadly representative of the general population of middle-aged women, although Australian-born, employed, and university-educated women were over-represented.[32] After loss to follow-up between 1996 and 2001, the baseline for these analyses, data from 11,219 women were available for analysis. Women lost to follow-up after 1996 were more likely to report poorer health, less education, and being born in a non–English-speaking country than those who continued in ALSWH.[33] Of these, 2,323 met the inclusion criteria of reporting depressive symptoms in 2001 (CESD10 score ≥10),[31] 207 of these were excluded because they reported at one or more surveys that they were unable to walk 100 meters. Another 212 were excluded because they had missing data for a predictor or outcome variable for two or more surveys (<3% of any variable except 6% for BMI). Among women who reported depressive symptoms at baseline (n=2,323), notable differences were found between those included (n=1,904) and those excluded (n=405) from analysis. Excluded women were more likely to have not completed high school, to find managing their income impossible/difficult, and be more unhealthy (p<0.05; Appendix Table 1, available online).

Measures

The well-validated Medical Outcomes Study's Health Status Survey short-form 36 (SF-36) was used to measure HRQL.[34] Four subscales (21 items) assess physical HRQL: bodily pain, physical functioning, general health perception, and role limitations from physical problems. The remaining four subscales (14 items) measure psychological HRQL: vitality, social functioning, mental health, and role limitations from emotional problems. Each subscale was treated as a separate outcome variable. In addition, Physical and Mental HRQL Component Summary scales (PCS and MCS, respectively), with factor structures validated using the baseline ALSWH surveys,[35] served as summary measures of self-reported general physical and psychological HRQL. HRQL scores were standardized to range from 0 to 100, with the population mean of each cohort set at 50.[35] Higher scores indicated better HRQL.

TPA and (only) walking were measured with the validated Active Australia survey.[36,37] The survey assesses time in the previous week (in ≥10-minute periods) spent walking briskly (*for recreation or exercise or to get from place to place*), in moderate-intensity PA (*like golf, social tennis, moderate exercise classes, recreational swimming, line dancing*), and in vigorous-intensity PA (*that makes you breathe harder or puff and pant, like aerobics, competitive sport, vigorous cycling, running, swimming*). A TPA MET.min/week score was computed by multiplying minutes in each activity type by an assigned MET (walking=3.0 METs, moderate-intensity PA=4.0 METs, vigorous-intensity PA=7.5 METs) and summing.[38] Scores were categorized as: none (<40); very low (40–299); intermediate (300–599); and sufficient

($\geq$600).[39] Participants in the sufficient category were considered to meet national PA guidelines[40] because the lower cutoff for this category is equivalent to 150 min/week of moderate-intensity PA. For women whose only PA was walking, a walking (only) score (MET.min/week) was additionally computed by multiplying walking minutes by 3.0 (METs) and using the same categorizations as for TPA.

Sociodemographic and health-related variables indicated by previous work to be confounders in women without depressive symptoms[18] were included as potential confounders here. These included demographic variables: country of birth (proxy for ethnicity), area of residence (derived from postal codes), educational attainment, and ability to manage on one's income (proxy for income status). Assessed social variables were marital status, the number of stressful life events in the past 12 months (e.g., death of partner), provision of care for children, provision of care for adults (e.g., with a long-term illness, disability, or frailty), and social support (measured with the Medical Outcomes Study Social Support Index[41]). Health-related variables included BMI (kg/m^2 computed from self-reported height and weight), menopausal status, number of doctor-diagnosed chronic conditions in the previous 3 years (from a list that included diabetes, cancer, and heart disease), and medical diagnoses or treatment for anxiety or other psychiatric condition in the previous 3 years. Assessed health behaviors were smoking status and alcohol consumption. Further details are provided in Table 1 and Appendix Table 1 (available online).

Statistical Analyses

Associations between TPA and (only) walking with HRQL scores were examined using random intercept multivariable mixed models in Stata, version 13.0. Separate models were computed for each HRQL variable. Logistic models (the XTLOGIT function) were used for the role limitations from physical problems subscale and the role limitations from emotional problems subscale, as these scales exhibited bimodal distributions. For all other HRQL scales, linear models (the XTREG function) were used. Individuals served as random effects. Survey year served as a covariate to account for changes in the outcome as the women aged, and area of residence at baseline served as a covariate to account for oversampling of rural and remote areas. Bootstrap corrections were applied to skewed outcome variables (physical functioning and social functioning scales). All predictor variables were treated as categorical except social support, which was continuous.

To examine sequential cross-sectional (concurrent) relationships between TPA and each HRQL outcome, TPA and confounders measured in 2001, 2004, 2007, and 2010 served as fixed effects in models without a time lag, with HRQL at the same survey periods serving as outcome variables. These models have a longitudinal element, as they account for repeated observations from the same woman, and the overall estimates account for within-subject correlations. To examine prospective associations between TPA and each HRQL outcome, TPA and confounders measured in 2001, 2004, and 2007 served as fixed effects in prospective models with time lag, with HRQL in 2004, 2007, and 2010, respectively, serving as outcome variables. Among the subgroup of women who reported no moderate or vigorous PA in 2001, 2004, and 2007 (walking was their only PA), the same models were used, except walking replaced TPA.

Results

Select characteristics of participants are presented in Table 1. Additional characteristics are reported in Appendix Table 1 (available online).

Women's activity and HRQL scores at each survey are listed in Table 2. The percentage of participants who reported sufficient PA increased during the study's first 6 years, but decreased slightly for the 9-year survey. Mean SF-36 scores were fairly consistent across surveys, although the percentage of women scoring >50.0 for role limitations from physical and from emotional problems increased substantially from the first to last survey. Significant trends for HRQL were observed across PA categories (Appendix Table 2, available online), with improvements in HRQL with greater PA levels.

The associations between both TPA and (only) walking with HRQL variables are shown in Tables 3 and 4. The dose–response relationships are displayed in Figure 1. In concurrent models, most coefficients were significantly higher for each activity level above the none level than for the none level. Exceptions were the low PA level and the low and intermediate (only) walking levels for role limitations from emotional problems. Overall, coefficients were higher with increasingly higher levels of TPA and walking levels, indicating better HRQL with more PA. Larger coefficients were seen for TPA than for (only) walking. The strongest associations were found for physical functioning (9.3 points higher for the highest level of TPA and 8.4 points higher for the highest walking level, than the none level), vitality (8.9 points higher for the highest level of TPA and 6.6 points higher at the highest walking level), and social functioning (8.6 points higher at the highest level of TPA and 6.8 points higher at the highest walking level).

In prospective models, the dose–response relationships were attenuated, with the greatest point difference from the none level being 3.75 (for physical functioning at the intermediate walking level). Intermediate and sufficient levels of TPA and (only) walking were associated with improvements in general health perceptions, MCS, vitality, and mental health. Sufficient levels of TPA and (only) walking were also significantly associated with improved bodily pain, and a sufficient level of TPA was associated with improved physical functioning, social functioning, and role limitations from emotional problems.

Discussion

As far as we are aware, this is the first study to describe the nature of the dose–response relationship between PA and the multidimensional aspects of HRQL, both

Table 1. Select characteristics of women with depressive symptoms in 2001 (n=1,904, aged 50−55 years)[a]

Variables	n (%)
Country of birth[b]	
Australia	1,451 (76.2)
Other English-speaking	270 (14.2)
Other non−English-speaking	183 (9.6)
Area of residence[c]	
Urban	728 (38.2)
Large rural town	295 (15.5)
Small rural town/remote area	872 (45.8)
Missing	9 (0.5)
Education[b]	
Some high school or less	975 (51.2)
Completed high school	306 (16.1)
Trade/certificate/diploma	368 (19.3)
University degree	255 (13.4)
Income management	
Impossible/difficult all of the time	428 (22.5)
Difficult some of the time	603 (31.7)
Not too bad	649 (34.1)
Easy	215 (11.3)
Missing	9 (0.5)
Marital status	
Married/partnered	1,422 (74.7)
Not married or partnered	477 (25.0)
Missing	5 (0.3)
BMI (kg/m^2)[d]	
Healthy weight (18.5 to <25)	697 (36.6)
Underweight (<18.5)	40 (2.1)
Overweight (25 to <30)	559 (29.4)
Obese (≥30)	496 (26.0)
Missing	112 (5.9)
Diagnosed or treated anxiety/other psychiatric condition[e]	
No	1,241 (65.2)
Yes	643 (33.8)
Missing	20 (1.0)
Smoking status	
Never smoked	1,041 (54.7)

(continued on next page)

concurrently and prospectively, in women reporting depressive symptoms. The current study included women who reported depressive symptoms in 2001.

Overall, associations were observed between TPA and (only) walking with HRQL. Positive concurrent associations were observed between the PA measures and all HRQL measures, and associations were stronger for TPA than for (only) walking. Although women doing the most TPA and (only) walking had the highest HRQL scores, even those doing low levels of TPA or (only) walking had better HRQL than women doing no PA. Prospectively, associations were attenuated, with greater attenuation for physical HRQL than for psychological HRQL. This might suggest that the physical and psychological benefits derived from PA are greater in the immediate context than over time.

In concurrent modeling, clinically meaningful improvements in scores (≥3 points)[20] were observed for women doing low to sufficient levels of TPA and (only) walking, although most clinically meaningful improvements were seen for women doing sufficient TPA or (only) walking. The strongest relationships were for PA and physical functioning, vitality, and social functioning. Compared with no TPA, low to sufficient TPA was associated with markedly higher scores for physical functioning, vitality, and social functioning (3.2−9.1-point higher scores). The current findings are consistent with previous cross-sectional studies with people without depression, demonstrating positive associations between PA and HRQL,[4–12,18] vitality,[20,29] and social well-being,[26,27,42] and stronger associations with physical HRQL at higher PA levels.[12,26] The results also support other research demonstrating the value of walking for HRQL in women,[18,27] although this may be potentially lower than for other types of PA.[4]

Prospectively, all physical HRQL subscale scores were attenuated, and overall PCS scores were no longer significantly associated with TPA or (only) walking. However, associations were observed for most physical HRQL subscale scores, including physical functioning. The associations were seen among women doing sufficient TPA or (only) walking, and were weak. By contrast, in a study of nondepressed women of the same age in ALSWH, improvements in PCS were observed for women doing at least an intermediate level of TPA, although

Table 1. Select characteristics of women with depressive symptoms in 2001 (n=1,904, aged 50−55 years)[a] *(continued)*

Variables	n (%)
Ex-smoker	503 (26.4)
Current smoker	357 (18.7)
Missing	3 (0.2)
Alcohol consumption	
Low-risk drinker (1−14 drinks/week)	885 (46.5)
Non-drinker	221 (11.6)
Rarely drinks (<1 drink/week)	537 (28.2)
Risky drinker (≥15 drinks/week)	115 (6.0)
Missing	146 (7.7)

[a]Data collected in 2001 unless indicated otherwise. Those with missing data in 2001 but that had data available for at least two other time periods were included.
[b]Assessed in 1996.
[c]Derived from postal code.
[d]Based on self-reported weight and height (kg/m²).
[e]Diagnosed or received treatment for anxiety or other psychiatric conditions in the past 3 years.

these improvements were not clinically meaningful (<3.0-point improvement).[18] Clinically meaningful improvements in physical functioning were observed with increasing TPA and walking levels in that study.[18] The current findings are consistent with other prospective research in general populations, which demonstrates a positive association between PA and improvements in physical functioning,[13,16,19,28] and add to this evidence by suggesting that PA-related improvements in physical HRQL may be limited to specific components of HRQL in women with depressive symptoms.

In prospective models of psychological HRQL, findings were also attenuated. MCS, vitality scores, and mental health scores were, however, improved for women at intermediate and sufficient TPA and (only) walking levels. These results confirm cross-sectional research demonstrating an association between walking and psychological and social HRQL,[27] and between recommended levels of PA and HRQL.[12] Results are also consistent with other prospective research indicating associations between PA and mental health, vitality, and social functioning.[13,16,24] As previously reported, in middle-aged women in ALSWH without depression, MCS and mental health scores were not associated with TPA and walking prospectively except at very high levels of TPA.[18] Vitality was improved across all levels of TPA and most walking levels for those women, and associations at the intermediate and sufficient levels were clinically meaningful (3.0−5.4-point improvements).[18] In the current study, the remaining psychological HRQL scores (social functioning and role limitations—

emotional) were improved among women doing sufficient TPA or (only) walking. Only women at a sufficient level of TPA had a clinically meaningful improvement, and this improvement (3.4 points) was in social functioning. As these two SF-36 scales were not evaluated in the previous work with ALSWH women without depression,[18] the current results cannot be compared with the earlier findings. Overall, it seems that PA has a greater influence on psychological HRQL in women in their 50s and 60s with depression than in those without depression. This may be because there is greater capacity for improvement in psychological HRQL in those with depression than those without.

The major strength of this study was the use of data from four time points from a large population-based cohort. Important confounders were included in analysis, made possible by the large number of variables included in ALSWH. The main limitation is the reliance on self-report data, which are subject to recall and measurement bias. The strength of the associations may have been underestimated as a result, as misclassification is possible. However, the PA measures have adequate reliability and validity,[36,37] and HRQL is a subjective judgement. Of note is that the sample was selected on the basis of reporting depressive symptoms in 2001, and it is acknowledged that these symptoms may have changed over time. The generalizability of the findings is limited by the potential effect of study attrition. The ALSWH included reasonably representative national samples of women responding at baseline[32] but, as with all prospective studies, participants have withdrawn over time, with more healthy women remaining in the study.[33] Therefore, the findings cannot be generalized to all Australian women in their 50s and 60s who have reported depressive symptoms.

Overall, the findings indicate that most improvements in HRQL for Australian women in their 50s and 60s with depressive symptoms are associated with participation in levels of activity that reflect guidelines[40] (≥600 MET. min/week of PA, equivalent to ≥150 minutes of moderate-intensity PA or ≥200 minutes of [only] walking). Smaller gains in HRQL are possible with smaller doses of TPA or (only) walking. This study adds to the literature by documenting the 9-year dose−response relationship between PA and measures of well-being in women in their 50s and 60s with depressive symptoms. These findings add to the growing body of evidence indicating that PA can improve HRQL, and demonstrate that PA may provide a mechanism by which

Table 2. Physical activity and health-related quality of life scores of women with depressive symptoms in 2001[a]

Variables	2001	2004	2007	2010
Total physical activity categories (MET.min/week),[b] n (%)[c]				
None (0 to <40)	429 (23.2)	354 (20.7)	334 (20.1)	337 (21.7)
Low (40 to <300)	366 (19.8)	246 (14.4)	220 (13.3)	203 (13.1)
Intermediate (300 to <600)	330 (17.9)	277 (16.2)	257 (15.5)	236 (15.2)
Sufficient (600+)	724 (39.2)	837 (48.3)	848 (51.1)	779 (50.1)
Walking categories (MET.min/week),[d] n (%)[c]				
None (0 to <40)	428 (35.0)	353 (31.0)	334 (32.7)	337 (34.0)
Low (40 to <300)	320 (26.1)	220 (19.3)	190 (18.6)	180 (18.2)
Intermediate (300 to <600)	230 (18.8)	218 (19.2)	206 (20.2)	180 (18.2)
Sufficient (600+)	246 (20.1)	347 (30.5)	291 (28.5)	293 (29.6)
SF-36 subscales, M (SD)				
Physical Components Summary	46.2 (11.3)	44.6 (10.9)	44.6 (10.9)	43.6 (10.9)
Mental Components Summary	32.8 (11.2)	38.9 (12.8)	40.8 (12.7)	41.8 (12.9)
Bodily pain	57.1 (24.5)	57.5 (23.6)	58.0 (24.0)	56.6 (23.6)
Physical functioning	75.3 (20.2)	73.7 (20.9)	73.9 (20.9)	72.6 (21.0)
General health perception	58.0 (21.3)	59.3 (21.8)	61.2 (21.5)	60.4 (21.2)
Role limitations from physical problems,[e] n (%)[c]				
≤50	976 (51.5)	858 (47.8)	768 (44.0)	750 (45.5)
>50	920 (48.5)	938 (52.2)	976 (56.0)	897 (54.5)
Vitality	35.8 (18.8)	42.8 (21.0)	45.7 (20.8)	46.4 (20.7)
Social functioning	60.3 (25.5)	68.5 (25.6)	70.4 (25.9)	70.9 (26.5)
Mental health	52.3 (17.0)	60.6 (18.9)	62.7 (19.1)	64.1 (19.3)
Role limitations from emotional problems, n (%)[e]				
≤50	1,007 (53.1)	719 (40.1)	587 (33.8)	508 (30.8)
>50	888 (46.9)	1,073 (59.9)	1,151 (66.2)	1,139 (69.2)

[a]Health-related quality of life was measured with SF-36 component scales and subscales. Each component summary score was standardized to range from 0 to 100, with the population average of each cohort set at 50. Higher scores indicate better health-related quality of life.

[b]Total physical activity included total minutes spent in moderate-intensity physical activity, vigorous-intensity physical activity and walking in the previous week. MET.min/week=sum of total physical activity minutes in the previous week after weighting time walking minutes by 3.0, moderate minutes by 4.0, and vigorous minutes by 7.5.[38] Significant linear trends across levels of total physical activity were observed for each health-related quality of life measure at each survey (see Appendix Table 2 for details, available online).

[c]Percentage may not add up to 100% due to rounding errors.

[d]In the women whose only physical activity was walking, the numbers in the "none" category for walking in 2001 and 2004 are different from those in the "none" category for total physical activity in those years. The reason is that one woman in 2001 and another in 2004 reported <40 MET.min/ week of moderate to vigorous physical activity and, therefore, were included in the "none" physical activity category; however, their reports of low levels of moderate and vigorous physical activity precluded their inclusion in the walking-only analysis. Significant linear trends across levels of (only) walking were observed for each health-related quality of life measure at each survey (see Appendix Table 2 for details, available online).

[e]The role limitations variables were bimodal and therefore were dichotomized for analysis.

SF-36, Medical Outcomes Study's short-form 36 health survey.

to improve the quality of life in women with depressive symptoms.

The implications of these findings are that encouraging walking or a mixture of different types of activity at levels commensurate with current PA guidelines will improve aspects of well-being, including mental health and vitality, which are important for women with depressive symptoms. The findings show that higher

Table 3. Associations between physical activity and (only) walking with physical health-related quality of life[a]

	PCS			Bodily pain			Physical functioning			General health perception			Role limitations-physical		
	β	95% CI	p-value	β	95% CI	p-value	β	95% CI	p-value	β	95% CI	p-value	OR	95% CI	p-value
Concurrent models:[b] TPA, MET.min/week[c]															
2	**1.97**	**1.23 to 2.72**	**<0.0001**	**3.36**	**1.67 to 5.06**	**<0.0001**	**4.79**	**3.41 to 6.22**	**<0.0001**	**2.09**	**0.81 to 3.37**	**0.001**	**1.46**	**1.15 to 1.85**	**0.002**
3	**2.52**	**1.78 to 3.26**	**<0.0001**	**3.50**	**1.82 to 5.19**	**<0.0001**	**6.51**	**5.08 to 8.02**	**<0.0001**	**3.28**	**2.00 to 4.56**	**<0.0001**	**1.56**	**1.23 to 1.97**	**<0.0001**
4	**3.79**	**3.15 to 4.43**	**<0.0001**	**6.14**	**4.70 to 7.58**	**<0.0001**	**9.31**	**8.00 to 10.75**	**<0.0001**	**5.97**	**4.86 to 7.09**	**<0.0001**	**2.27**	**1.86 to 2.77**	**<0.0001**
Prospective models:[d] TPA, MET.min/week[c]															
2	0.11	−0.80 to 1.02	0.72	1.78	−0.24 to 3.80	0.084	0.84	−0.73 to 3.23	0.458	1.29	−0.26 to 2.85	0.103	1.10	0.83 to 1.46	0.494
3	0.40	−0.52 to 1.31	0.40	1.80	−0.23 to 3.83	0.083	2.23	0.83 to 4.87	0.052	**1.97**	**0.39 to 3.54**	**0.014**	1.03	0.78 to 1.37	0.811
4	0.62	−0.16 to 1.41	0.12	**2.29**	**0.55 to 4.02**	**0.010**	**2.64**	**0.51 to 4.83**	**0.014**	**2.96**	**1.59 to 4.33**	**<0.0001**	1.05	0.83 to 1.33	0.665
Concurrent models:[b] (only) walking, MET.min/week[e]															
2	**1.93**	**1.13 to 2.74**	**<0.0001**	**3.38**	**1.58 to 5.19**	**<0.0001**	**4.75**	**3.31 to 6.23**	**<0.0001**	**1.76**	**0.38 to 3.13**	**0.012**	**1.47**	**1.14 to 1.88**	**0.003**
3	**2.45**	**1.61 to 3.29**	**<0.0001**	**3.18**	**1.30 to 5.06**	**0.001**	**6.89**	**5.35 to 8.37**	**<0.0001**	**3.10**	**1.66 to 4.54**	**<0.0001**	**1.44**	**1.11 to 1.86**	**0.005**
4	**3.29**	**2.50 to 4.08**	**<0.0001**	**4.88**	**3.12 to 6.63**	**<0.0001**	**8.36**	**6.96 to 9.80**	**<0.0001**	**4.09**	**2.72 to 5.46**	**<0.0001**	**1.80**	**1.41 to 2.29**	**<0.0001**
Prospective models:[d] (only) walking, MET.min/week[e]															
2	0.33	−0.67 to 1.32	0.52	1.57	−0.60 to 3.73	0.156	1.38	−0.96 to 4.58	0.339	1.18	−0.51 to 2.88	0.172	1.08	0.82 to 1.43	0.565
3	0.93	−0.11 to 1.98	0.08	2.27	−0.01 to 4.55	0.051	**3.75**	**1.15 to 6.96**	**0.010**	**2.63**	**0.83 to 4.44**	**0.004**	1.11	0.83 to 1.49	0.479
4	0.41	0.57 to 1.39	0.42	**2.23**	**0.11 to 4.36**	**0.040**	2.32	−0.49 to 5.67	0.155	**2.89**	**1.19 to 4.59**	**0.001**	0.99	0.76 to 1.30	0.959

Note: Boldface indicates statistical significance ($p<0.05$).
[a]1=none (0 to <40 MET.min/week—the referent category, not shown); 2=low (40 to <300 MET.min/week); 3=intermediate (300 to <600 MET.min/week); 4=sufficient (600+ MET.min/week). All models adjusted for survey year, area of residence in 1996 to account for sampling process, country of birth, area of residence, educational attainment, income management, marital status, number of stressful life events, provision of care to children, provision of care to adults, social support, BMI, menopausal status, number of chronic conditions, diagnosis or treatment for anxiety or other psychiatric condition, smoking status, and alcohol consumption. Estimates for the physical functioning scale are bootstrapped-corrected for skewed outcomes. βs and 95% CIs are presented for linear models and ORs and 95% CIs for logistic models. Improvements in scores across physical activity categories (≥3 points)[20] are considered clinically meaningful improvements.
[b]TPA and (only) walking were assessed at the same time as health-related quality of life (short-form 36 scores). TPA includes women whose only physical activity was walking.
[c]MET.min/week=sum of total physical activity minutes after weighting time walking minutes by 3.0, moderate minutes by 4.0, and vigorous minutes by 7.5.[38]
[d]TPA and (only) walking were assessed 3 years earlier than health-related quality of life (short-form 36 scores). TPA includes women whose only physical activity was walking.
[e]In women whose only reported physical activity was walking, MET.min/week=total walking minutes weighted by the metabolic equivalent value assigned to walking (3.0).[38]
PCS, Physical Component Summary; TPA, total physical activity.

Table 4. Associations between physical activity and (only) walking with psychological health-related quality of life[a]

	MCS			Vitality			Social functioning			Mental health			Role limitations-emotional		
	β	95% CI	*p*-value	β	95% CI	*p*-value	β	95% CI	*p*-value	β	95% CI	*p*-value	OR	95% CI	*p*-value
Concurrent models:[b] TPA MET.min/week[c]															
2	**1.23**	**0.30 to 2.16**	**0.010**	**3.17**	**1.74 to 4.61**	**<0.001**	**4.62**	**2.66 to 6.51**	**<0.001**	**2.20**	**0.85 to 3.55**	**0.001**	1.22	0.98 to 1.54	0.079
3	**1.53**	**0.61 to 2.46**	**0.001**	**5.06**	**3.62 to 6.49**	**<0.001**	**4.66**	**2.61 to 6.58**	**<0.001**	**2.33**	**0.99 to 3.67**	**0.001**	**1.34**	**1.07 to 1.68**	**0.011**
4	**3.35**	**2.57 to 4.13**	**<0.001**	**8.91**	**7.68 to 10.1**	**<0.001**	**8.61**	**6.89 to 10.29**	**<0.001**	**4.50**	**3.36 to 5.64**	**<0.001**	**1.59**	**0.32 to 1.92**	**<0.001**
Prospective models:[d] TPA MET.min/week[c]															
2	1.06	−0.08 to 2.20	0.070	0.65	−1.12 to 2.41	0.472	2.98	1.81 to 5.22	0.052	1.41	−0.24 to 3.07	0.095	1.22	0.93 to 1.60	0.157
3	**1.60**	**0.45 to 2.75**	**0.006**	**1.80**	**0.01 to 3.59**	**0.048**	3.04	0.39 to 6.69	0.061	**2.17**	**0.50 to 3.84**	**0.011**	1.30	0.99 to 1.71	0.060
4	**1.81**	**0.84 to 2.79**	**<0.001**	**2.80**	**1.25 to 4.35**	**<0.001**	**3.40**	**1.35 to 6.29**	**0.015**	**2.36**	**0.93 to 3.79**	**0.001**	**1.31**	**1.04 to 1.64**	**0.020**
Concurrent models:[b] (only) walking MET.min/week[e]															
2	**1.17**	**0.19 to 2.14**	**0.019**	**3.00**	**1.48 to 4.52**	**<0.001**	**4.44**	**2.20 to 6.55**	**<0.001**	**1.96**	**0.53 to 3.38**	**0.007**	0.92	0.69 to 1.23	0.081
3	**1.05**	**0.04 to 2.07**	**0.042**	**4.54**	**2.95 to 6.12**	**<0.001**	**4.29**	**2.09 to 6.52**	**<0.001**	**1.76**	**0.28 to 3.24**	**0.020**	0.76	0.54 to 1.05	0.232
4	**2.30**	**1.35 to 3.24**	**<0.001**	**6.63**	**5.14 to 8.11**	**<0.001**	**6.78**	**4.71 to 8.94**	**<0.001**	**3.02**	**1.64 to 4.40**	**<0.001**	**0.92**	**0.69 to 1.21**	**<0.001**
Prospective models:[d] (only) walking MET.min/week[e]															
2	0.82	−0.39 to 2.03	0.185	0.78	−1.08 to 2.64	0.409	3.24	2.70 to 6.10	0.079	1.23	−0.52 to 2.99	0.169	1.02	0.72 to 1.45	0.303
3	**1.62**	**0.34 to 2.89**	**0.013**	**2.66**	**0.68 to 4.64**	**0.008**	3.13	1.24 to 6.97	0.139	**2.24**	**0.38 to 4.10**	**0.018**	0.74	0.49 to 1.11	0.079
4	**1.69**	**0.51 to 2.88**	**0.005**	**3.45**	**1.60 to 5.30**	**<0.001**	2.77	−0.57 to 7.07	0.168	**2.06**	**0.33 to 3.79**	**0.020**	1.15	0.81 to 1.62	0.329

Note: Boldface indicates statistical significance (*p*<0.05).

[a]1=none (0 to <40 MET.min/week—the referent category, not shown); 2=low (40 to <300 MET.min/week); 3=intermediate (300 to <600 MET.min/week); 4=sufficient (600+ MET.min/week). All models adjusted for survey year, area of residence in 1996 to account for sampling process, country of birth, area of residence, educational attainment, income management, marital status, number of stressful life events, provision of care to children, provision of care to adults, social support, BMI, menopausal status, number of chronic conditions, diagnosis or treatment for anxiety or other psychiatric condition, smoking status, and alcohol consumption. Estimates for the social functioning scale are bootstrapped-corrected for skewed outcomes. βs and 95% CIs are presented for linear models and ORs and 95% CIs for logistic models. Improvements in scores across physical activity categories (≥3-points)[20] are considered clinically meaningful improvements.

[b]TPA and (only) walking were assessed at the same time as health-related quality of life (short-form 36 scores). TPA includes women whose only physical activity was walking.

[c]MET.min/week=sum of total physical activity minutes after weighting time walking minutes by 3.0, moderate minutes by 4.0, and vigorous minutes by 7.5.[38]

[d]TPA and (only) walking were assessed 3 years earlier than health-related quality of life (short-form 36 scores). TPA includes women whose only physical activity was walking.

[e]In women whose only reported physical activity was walking, MET.min/week=total walking minutes weighted by the metabolic equivalent value assigned to walking (3.0).[38]

MCS, Mental Component Summary; TPA, total physical activity.

Physical Scales   **Mental Scales**
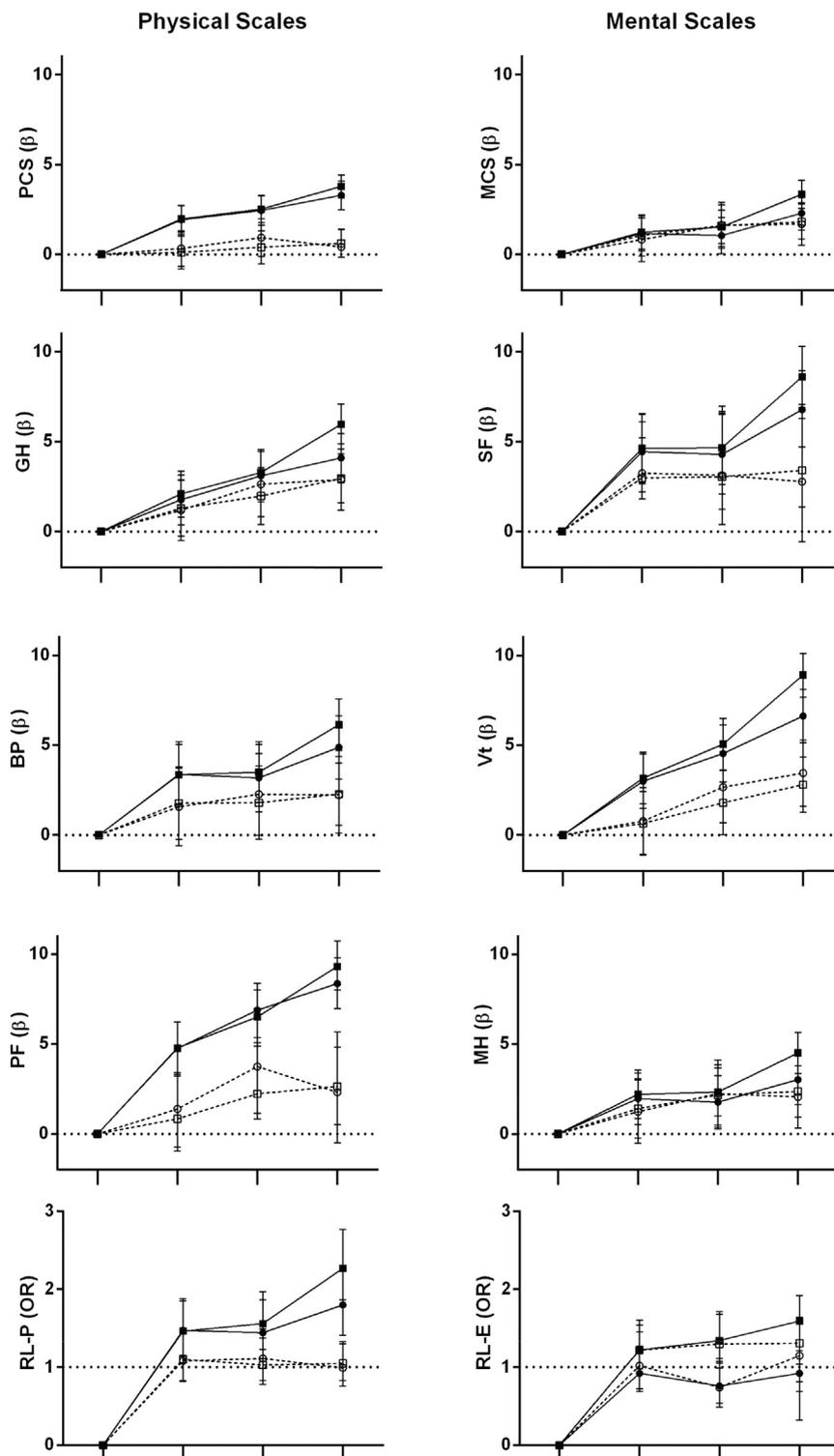
Figure 1. Associations between both total physical activity and walking with measures of health-related quality of life, in Australian women born in 1946−1951.

Each graph shows concurrent models of both TPA (solid line and filled square: -∎-) and walking (solid line and filled ball: -●-) and prospective models of TPA (dotted line and open square: -□-) and walking (dotted line and open ball: -○-). The x-axis represents activity level, and the y-axis represents β coefficients and 95% CIs for short-form 36 scores with the first activity category serving as the reference category (β=0). BP, bodily pain; GH, general health; MCS, Mental Component Summary; MH, mental health; PCS, Physical Component Summary; PF, physical functioning; RL-E, role limitation-emotional; RL-P, role limitations-physical; SF, social functioning; Vt, vitality.

PA levels are associated with more benefits, and, just as importantly from a clinical perspective, that even low PA levels are beneficial.

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Appendix

Supplementary data

Supplementary data associated with this article can be found at http://dx.doi.org/10.1016/j.amepre.2014.09.030.

Appendix Table 1. Characteristics of women with depressive symptoms in 2001 who were included or excluded from analysis[a]

Variables	Analysis sample n=1904		Excluded depressed women n=419		p-value[b]
	n	*%*[c]	*n*	*%*[c]	*p*
Sociodemographic variables					
Country of birth[d]					**<0.02**
Australia	1451	(76.2)	309	(73.5)	
Other English speaking	270	(14.2)	36	(8.6)	
Other non-English speaking	183	(9.6)	46	(11.0)	
Missing	0	(0)	28	(6.7)	
Area of residence[e]					0.49
Urban	728	(38.2)	156	(37.2)	
Large rural town	295	(15.5)	58	(13.8)	
Small rural town/remote area	872	(45.8)	205	(48.9)	
Missing	9	(0.5)	0	(0.0)	
Education[d]					**<0.001**
Some high school or less	975	(51.2)	255	(60.1)	
Completed high school	306	(16.1)	56	(13.4)	
Trade/certificate/diploma	368	(19.3)	50	(11.9)	
University	255	(13.4)	35	(8.3)	
Missing	0	(0)	23	(5.5)	
Income management					**<0.001**
Impossible/difficult all of the time	428	(22.5)	137	(32.7)	
Difficult some of the time	603	(31.7)	149	(35.6)	
Not too bad	649	(34.1)	101	(24.1)	
Easy	215	(11.3)	25	(6.0)	
Missing	9	(0.5)	7	(1.7)	
Social variables					
Marital status					0.124
Married/partnered	1422	(74.7)	292	(69.7)	
Not married or partnered	477	(25.0)	118	(28.2)	
Missing	5	(0.3)	9	(2.1)	
Stressful life events[f]					**<0.001**
None	212	(11.1)	70	(16.7)	
One	366	(19.2)	52	(12.4)	
Two	365	(19.2)	74	(17.7)	
Three or more	954	(50.1)	222	(53.0)	
Missing	7	(0.4)	1	(0.2)	

Provision of care to children					**0.003**
Occasionally/never	1633	(85.8)	331	(79.0)	
Daily/weekly	266	(14.0)	82	(19.6)	
Missing	5	(0.3)	6	(1.4)	
Provision of care to adults					0.568
No	1377	(72.3)	309	(73.8)	
Yes	521	(27.4)	109	(26.0)	
Missing	6	(0.3)	1	(0.2)	
Health-related variables					
Body mass index[g]					**<0.001**
Normal weight	697	(36.6)	102	(24.3)	
Underweight	40	(2.1)	8	(1.9)	
Overweight	559	(29.4)	117	(27.9)	
Obese	496	(26.0)	142	(33.9)	
Missing	112	(5.9)	50	(11.9)	
Menopausal status					**<0.001**
Premenopausal	127	(6.7)	18	(4.3)	
Perimenopausal	325	(17.1)	42	(10.0)	
Postmenopausal	410	(21.5)	94	(22.4)	
Surgical menopause	642	(33.7)	189	(45.1)	
Other	385	(20.2)	71	(16.9)	
Missing	15	(0.8)	5	(1.2)	
Number of chronic conditions[h]					**<0.001**
None	490	(25.7)	74	(17.7)	
One	553	(29.0)	110	(26.2)	
Two	435	(22.8)	93	(22.2)	
Three or more	406	(21.3)	135	(32.2)	
Missing	20	(1.0)	7	(1.7)	
Diagnosed or treated anxiety/other psychiatric condition[i]					0.613
No	1241	(65.2)	266	(63.5)	
Yes	643	(33.8)	146	(34.8)	
Missing	20	(1.0)	7	(1.7)	
Health behaviors					
Smoking status					0.019
Never smoked	1041	(54.7)	235	(56.1)	
Ex-smoker	503	(26.4)	86	(20.5)	
Current smoker	357	(18.7)	96	(22.9)	
Missing	3	(0.2)	2	(0.5)	
Alcohol intake					**<0.001**
Low risk drinker (1-14 drinks/week)	885	(46.5)	133	(31.7)	

Non-drinker	221	(11.6)	63	(15.0)	
Rarely drinker (<1 drink/week)	537	(28.2)	135	(32.2)	
Risky drinker (≥15 drinks/week)	115	(6.0)	19	(4.5)	
Missing	146	(7.7)	69	(16.5)	
	Mean	**SD**	**Mean**	**SD**	
Social support [j]	3.2	(1.1)	3.2	(1.1)	0.436
Missing (36 [1.5%])					

SD, standard deviation.

[a]Data collected in 2001 unless indicated otherwise.

[b]Chi-square test for categorical variables, independent t-test for continuous variables.

[c]Percentage may not add up to 100% due to rounding.

[d]Assessed in 1996.

[e]Derived from postal code.

[f]From a list of life events, in the past year; Based on self-reported weight and height (kg/m^2).

[g]Categorized in accordance with the WHO classification.

[h]From a list of health conditions, including diabetes, cancer, and heart disease, reported as diagnosed by a doctor, or treated for, in the previous 3 years.

[i]Diagnosed or received treatment for anxiety or other psychiatric conditions in the past 3 years.

[j]MOS Social Support Index scores have a possible range of 1 to 5, with higher scores indicating greater support.

Appendix Table 2. Test for trend across physical activity levels at each survey[a]

Total physical activity	2001	2004	2007	2010
SF-36 subscales	*p*	*p*	*p*	*p*
Physical components summary	**<.001**	**<.001**	**<.001**	**<.001**
Mental components summary	**<.001**	**<.001**	**<.001**	**<.001**
Bodily pain	**<.001**	**<.001**	**<.001**	**<.001**
Physical functioning	**<.001**	**<.001**	**<.001**	**<.001**
General health perception	**<.001**	**<.001**	**<.001**	**<.001**
Role limitations from physical problems	**<.001**	**<.001**	**<.001**	**<.001**
Vitality	**<.001**	**<.001**	**<.001**	**<.001**
Social functioning	**<.001**	**<.001**	**<.001**	**<.001**
Mental health	**<.001**	**<.001**	**<.001**	**<.001**
Role limitations from emotional problems	**0.009**	**0.004**	**<.001**	**<.001**
Walking	2001	2004	2007	2010
SF-36 subscales	*p*	*p*	*p*	*p*
Physical components summary	**<.001**	**<.001**	**<.001**	**<.001**
Mental components summary	**0.016**	**0.007**	**<.001**	**<.001**
Bodily pain	**0.001**	**0.007**	**<.001**	**<.001**
Physical functioning	**<.001**	**<.001**	**<.001**	**<.001**
General health perception	**<.001**	**<.001**	**<.001**	**<.001**
Role limitations from physical problems	**0.011**	**0.020**	**<.001**	**<.001**
Vitality	**<.001**	**<.001**	**<.001**	**<.001**
Social functioning	**0.009**	**0.002**	**<.001**	**<.001**
Mental health	**0.037**	**0.005**	**<.001**	**<.001**
Role limitations from emotional problems	0.076	**0.043**	**<.001**	**0.004**

[a]A non-parametric test for the ranks across ordered categories was used (STATA version 13.0 nptrend). The test assesses whether there was a significant increase or decrease in the outcome variable across categories. P-values are based on z statistics.