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Section: Original Research

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Authors: Toby G. Pavey, Nicola W. Burton, and Wendy J Brown

Affiliations: Centre for Research on Exercise, Physical Activity and Health (CRExPAH), School of Human Movement Studies, The University of Queensland, Brisbane, Australia.

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Affiliations: Centre for Research on Exercise, Physical Activity and Health (CRExPAH),

School of Human Movement Studies, The University of Queensland, Brisbane, Australia.

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Corresponding author:
Toby Pavey
School of Human Movement Studies
University of Queensland
St. Lucia Campus
Brisbane, Australia
QLD, 4072
Phone: (+61) 7 3346 9898
Fax: (+61) 7 3365 6877
Email: t.pavey@uq.edu.au

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ABSTRACT

Background: There is growing evidence that regular physical activity (PA) reduces the risk of poor mental health. Less research has focused on the relationship between PA and positive wellbeing. The study aims were to assess the prospective associations between PA and optimism, in both young and mid-aged women. **Methods:** 9688 young women (born 1973-78) completed self-report surveys in 2000 (age 22-27), 2003, 2006, and 2009; and 11,226 mid-aged women (born 1946-51) completed surveys in 2001 (age 50 to 55) 2004, 2007 and 2010, as part of the Australian Longitudinal Study on Women's Health. Generalised estimating equation models (with 3-year time lag) were used to examine the relationship between PA and optimism in both cohorts. **Results:** In both cohorts, women reporting higher levels of PA had greater odds of reporting higher optimism over the 9-year period, (young, OR=5.04, 95%CI: 3.85-6.59; mid-age, OR=5.77, 95%CI: 4.76-7.00) than women who reported no PA. Odds were attenuated in adjusted models, with depression accounting for a large amount of this attenuation (young, OR=2.00, 95%CI: 1.57-2.55; mid-age, OR=1.64 95%CI: 1.38-1.94). **Conclusions:** Physical activity can promote optimism in young and mid-aged women over time, even after accounting for the negative effects of other psychosocial indicators such as depression.

Key words: Health promotion; exercise; mental health; epidemiology

INTRODUCTION

The benefits of physical activity (PA) for physical health and preventable mortality are undeniable.[1-3] Further, there is growing evidence that the benefits of PA also extend to mental health and psychological well-being.[4,5] However, most PA research has focussed on poor mental health, such as depression and anxiety.[6,7] Several studies have shown inverse relationships between PA and depression, anxiety, psychological distress and phobias, in both cross sectional and prospective studies.[6,8-11] Much less work has focussed on PA and positive wellbeing.

One key component of positive wellbeing is optimism. Optimism is a world view or explanatory style, where the individual interprets and anticipates situations as having the best (optimal) outcome. Optimists have the generalised expectancy that good things will happen, and tend to be confident and persistent in the face of life challenges, and cope better with stressful events.[12] Although there may be some heredity influence, optimism is considered to be a learned trait, and can be modified by environmental factors and personal experiences.[13]

Physical activity may be a means by which to build optimism. One mechanism for this is via mastery experiences, whereby individuals experience success and achievement that is then generalised to other aspects of their life.[14,15] Mastery experiences promote self-efficacy, the belief that one is capable of accomplishing specific tasks,[16] which in turn increases optimism.[14] PA can provide a context for experiencing achievement, such as performance attainment, meeting socially desirable lifestyle goals (healthy living, weight management), or competitive performance against others. PA can also provide opportunities for pleasant experiences such as socializing and engaging with the environment, which can also enhance optimism. Physical activity can promote self esteem, confidence, and self worth,[17] which are interrelated with optimism.[18] Physical activity can provide anti-depressive and anxiolytic effects,[12] which also contributes to building optimism.[19]

Two previous studies have examined associations between PA and optimism, but using a cross sectional design and only small samples.[19,20] In a study of university staff (n=188) Kavussanu and McAuley,[19] showed that those who exercised at least four times/week (high active) had significantly higher concurrent levels of optimism than those who exercised only once or not at all (low active). Venne and colleagues,[20] found that among final year collegiate students, athletes (n=34) had significantly higher levels of optimism than non-atheletes (n=67). More research is needed using longitudinal data and more diverse samples. The aims of this study were, therefore, to assess the prospective associations between physical activity and optimism, in a large representative sample of young and mid-aged women.

METHOD

The Australian Longitudinal Study on Women's Health (ALSWH) is a prospective study of factors shaping the health and well-being of three cohorts of Australian women (young, born in 1973–1978; mid-age, 1946–1951; and older, 1921–1926), who were randomly recruited from the national Medicare health insurance database. The focus of this paper is on the young and mid-aged cohorts who completed their first mailed surveys in 1996, and then at 3 year intervals on a rolling basis from 1998. In 1996, the cohorts were generally representative of women in the same age groups in the Australian population.[21] The study was approved by the Universities of Newcastle and Queensland Research Ethics Committees and all participating women provided informed consent. More details can be found at http://www.alswh.org.au.

Optimism was first measured in 2000 (survey 2) in the young cohort and in 2001 (survey 3) in the mid-aged cohort. These surveys were therefore used as the baseline for the current analyses, with data drawn from surveys 2 (2000) to 5 (2009) in the young cohort and

surveys 3 (2001) to 6 (2010) in the mid-age cohort.   Response rates to each survey are shown in Supplementary Materials 1 and 2.

Outcome variables

Optimism was measured using the Life Orientation Test—Revised (LOTR) which has previously been shown to have acceptable validity and reliability.[22, 23] Women were asked about expectations for the future, with response options 'strongly disagree'; 'disagree'; 'neutral'; 'agree'; 'strongly agree', coded from 0 to 4 for the three positively phrased items, and in reverse order for the negatively phrased items. Scores were summed, with a range of 0 to 24, with higher scores indicating more optimism (the four filler items of the LOTR were not included in the ALSWH surveys).

Main explanatory variable

PA was assessed using a modified version of the Active Australia survey, which has acceptable validity and reliability measurement properties for population surveys.[24] Women were asked to report time (hours and minutes) spent walking briskly and in moderate-intensity leisure activities (e.g. golf, recreational swimming,) in the last week. Responses to these questions were summed and assigned a MET value of 3.33, to create a moderate intensity PA MET.min/week variable. Women were also asked to report time spent in vigorous leisure activity (e.g. competitive sport, running, aerobics), with a MET value of 6.66 applied to create a vigorous intensity PA MET.min/week variable. The values of 3.33 and 6.66 METS were chosen to reflect published MET values for vigorous and moderate intensity activities.[25, 27] These two MET.min/week scores were summed and the total categorised as: none; >0 to <500 (low); 500 to <1000 (moderate); ≥1000 (high), to indicate the overall volume of PA. The moderate and high categories (≥500 MET.min/week) are commensurate with meeting PA guidelines of at least 150 minutes/week of moderate intensity activity.[25, 28]

We choose to use MET.mins as the unit of physical activity, as this is widely used in physical activity epidemiology as a means by which to derive an estimate of energy expenditure across activities of different intensity.[26]

Other explanatory variables

Socio-demographic variables, including age, area of residence, and marital status, were derived from the 2000 survey for the young cohort and the 2001 survey for the mid-age cohort, as these were the baseline surveys for the current analyses. Data were categorised as shown in Table 1. Highest level of education was derived from the initial survey in 1996.

Smoking status and alcohol consumption were categorized based on NHMRC guidelines (as shown in Table 1).[29] Sitting-time was categorised as per previous protocols, based on the question "How many hours EACH DAY do you typically spend sitting down while doing things like visiting friends, driving, reading, watching television, or working at a desk or computer on (a) a usual week-day and (b) a usual weekend-day".[30]

Health-related variables included: number of chronic conditions diagnosed by a doctor in the previous 3 years (including various cardiovascular, metabolic, respiratory and musculoskeletal conditions, 13 in total, see Table 1); and BMI, calculated as kg/m^2 using self-reported weight and height.[31] Depressive symptoms were assessed using the 10-item Center for Epidemiological Studies Depression Scale (CESD-10),[32] with a range of scores from 0 to 30. The Anxiety construct from the Goldberg Anxiety and Depression Scale (GADS) was used to assess anxiety, with a range of 0 to 9.[33] For both these scales, higher scores indicate more frequent symptoms.

Statistical analysis

Differences in baseline covariates between the PA groups (none, low, moderate and high) were analysed using the Chi-square test for categorical variables and ANOVA for

continuous variables. Associations between PA and optimism were investigated using linear generalised estimating equation models with a 3-year time lag, in which PA scores measured at surveys 2 to 4 were matched with optimism scores measured at surveys 3 to 5. Odds ratios (OR) for higher optimism were calculated for three categories of PA (low, moderate, high) with the 'none' group (0 MET.min/week) as the reference category. The initial unadjusted odds ratios were then adjusted for: (1) sociodemographic (age, education, marital status, area of residence), health behaviours (smoking, alcohol and sitting), and health (chronic conditions and BMI); (2) depression: and (3) anxiety. Cases with missing values on the outcome and explanatory variables were omitted from analyses. Selection of the covariates was based on previous ALSWH PA studies which showed significant relationships between PA and these variables,[30,34] and other research demonstrating an inverse relationship between PA with depression and anxiety.[35] As previous research suggests a stronger relationship for depression than anxiety,[36] and our preliminary analyses indicated greater model attenuation with depression than anxiety, a product term (PA*depression) was added to assess the potential interaction effect between PA and depression categories, with participants who scored 10 points or higher on the CESD classified as having depressive symptoms.

All statistical analyses were conducted in SPSS version 20. P-values were based on two-sided tests and were considered statistically significant at $p < 0.05$.

RESULTS

Characteristics of the young women

Of the 9688 women who returned the baseline survey (2000) 98.5% (9545) provided PA data. Of these, 9.6% (919) reported doing no PA (i.e. 0 MET.min/week), 29.2% (2787) were low active (>0 to <500 MET.min/week), 22.4% (2142) were moderately active (500 to <1000 MET.min/week), and 38.7% (3697) were high active (>1000 MET.min/week).

Sociodemographic, behavioural and health data, by PA category, for the baseline sample are shown in Table 1. The mean age of the women in 2000 was 24.6 (range 20.6 to 28.5) years, with no differences between women in the four PA categories. Women in the low, moderate and high PA categories had a higher level of optimism, education, fewer chronic conditions, and were less likely to be obese than those who were inactive (p<0.01). High active women were also more likely to be partnered and not smoke than inactive women. Moderate and high active women were more likely to have lower levels of depression and anxiety than women in the none and low PA categories. (p<0.01).

Those who were excluded from the analyses due to missing data were more likely to have low levels of education (p<0.001), be current smokers (p<0.001), and to report two or more chronic conditions (p<0.001) than those who were included.

Characteristics of the mid-aged women

Of the 11226 women who returned survey 3 (baseline), 98.1% (11009) provided PA data. Of these, 18.2% (2005) reported doing no PA, 29.7% (3226) were low active, 21.0% (2309) were moderately active, and 31.1% (3429) were high active. Sociodemographic, behavioural and health data by PA category, for the baseline sample are shown in Table 2. The mean age of the women in 2001 was 52.5 (range 49.5 to 56.0) years. Compared with women who reported no activity, women in the low, moderate and high PA categories were more likely to have a higher levels of optimism, education, not smoke, sit less, have fewer chronic conditions and were less likely to be obese (p<0.01). Moderate and high active women were more likely to have lower levels of depression and anxiety than women who reported no and low activity (p<0.01).

Those who were excluded from the analyses due to missing data were more likely to have low levels of education (p<0.001), be 'not partnered' (p<0.001), be current smokers

(p<0.001), be non-drinkers (p<0.001), and to report three or more chronic conditions (p<0.001) than those who were included.

Relationships between PA and optimism

In both cohorts, women who reported higher levels of PA had greater odds of reporting higher optimism, than women who reported no PA. Adding the sociodemographic, behavioural and health covariates (model 2) resulted in lower ORs for both the young and mid-age women. The addition of depression (model 3) resulted in more marked attenuation of the ORs, with little further effect when anxiety was added to the model (model 4).

Interaction between PA and depression

The product term PA*depression was statistically significant for both young and mid-aged women (p=0.01) (Table 4). After stratification by CESD, the ORs for higher optimism were significantly greater in both the low and high CESD groups with increasing PA. When PA*CESD was used as the independent variable, ORs for higher optimism increased with increasing PA in both CESD groups, in both young and mid-aged women. The effects were much greater for women in the low than in the high CESD stratum.

DISCUSSION

The aim of this study was to assess whether PA was prospectively associated with optimism in young and mid-age women. The results suggested a positive association and a dose response relationship, with increasing levels of PA associated with higher optimism scores over time, even after accounting for several confounders, including the negative effects of depression and anxiety. The results support previous cross sectional research that indicated a positive association, and provides more robust evidence for a causal association between PA and optimism.[37]

Our dose response results lend support to the current physical activity guidelines which highlight that doing some PA is better than none, and that meeting PA guidelines (500 MET.mins/week or 150 minutes of moderate intensity PA) or more, provides greater health benefits.[28] In our study, the most active individuals (>1000 MET.mins/week) had the highest optimism levels.

The introduction of sociodemographic, health and psychological variables attentuated the relationship between PA and optimism. This was most evident for depression. A proposed mechanism for the development of optimism through PA, is the prevention and management of symptoms of depression. The results of the PA and depression interaction support this notion. Women categorised as having low levels of depressive symptoms had higher optimism scores across all PA levels, than women categorised as having high levels of depressive symptoms. However, even after adjustment for depression, there was still a significant positive association between PA and optimism. This suggests that PA could be useful strategy to build optimism even among women with depressive symptoms.

Optimism is an important outcome as it is not only an indicator of good mental health, but it is also associated with good physical health. A recent meta-analysis of cross-sectional and prospective studies showed optimism to be a significant predictor of reduced risk of poor physical health outcomes, including, mortality, cardiovascular disease, immune function, cancer and pain.[38] Optimism has also been associated with adaptive behaviours, e.g. adherence to medical treatment for chronic conditions.[39,40] Optimism may be particularly important for successful aging. Several studies have shown that optimism in younger life predicts better physician and self-rated health, and reduced all-cause mortality 30-40 years later.[41-43] Further, optimism can predict better recovery from surgery, lower levels of pain, and fewer detrimental health effects resulting from falls, better social functioning, vitality and lower stress in older adults.[44-47]

The strengths of this study include the large, representative, and population based samples; the long term follow-up, and the inclusion of many potential confounding variables, in particular depression. Moreover, because of the time lag between the PA and outcome measures, it is likely that the direction of the relationship supports a role for PA in the development of optimism, but it is possible that the relationship may be bi-directional, with higher optimism supporting more PA.

The limitations include the fact that all the data were self-reported, which are vulnerable to recall and social desirability biases. Further, we only assessed the association between moderate and vigorous PA with optimism, and did not consider lower intensity house and garden work. A previous study with this cohort has shown a weak inverse association between house and garden work and well-being.[48] Common with all prospective studies, attrition rates varied between study baseline (survey 2 and 3) and follow-ups (ranging from 3% to 10%). As the women remaining in the study are likely to be more healthy and resilient, and because there were also sociodemographic differences between those whose data were included and excluded in the analyses, the reported odds ratios for optimism are potentially under-estimated. Finally, the results presented here, may not be generalisable to other populations.

In conclusion, a positive dose-response relationship was found between PA and optimism, with the most active women having higher optimism over time. This extends other research that demonstrates reduced risk of poor physical and mental health with PA, indicating that PA may also promote positive well-being in the form of optimism.

Acknowledgments

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Table 1 Characteristics of the 9545 young women by physical activity category (baseline year 2000)

Variable*	None (n=919)		Low (n=2787)		Moderate (n=2142)		High (n=3697)		Physical activity
	N	(%)	N	(%)	N	(%)	N	(%)	p-value
Categorical data									
Highest level of education									p<0.001
Primary school	198	22.5	416	14.9	274	12.8	445	12.0	
High school	470	51.5	1516	54.4	1223	57.1	2099	56.8	
Post school trade or certificate	175	19.0	509	18.3	373	17.4	623	16.9	
University degree	70	7.6	332	11.9	262	12.2	515	13.9	
Missing	6	0.7	14	0.5	10	0.5	15	0.4	
Marital status									p<0.001
Partnered	516	56.1	1421	51.0	958	44.7	1387	37.5	
Not partnered	392	42.7	1351	48.5	1174	54.8	2296	62.3	
Widowed	2	.2	1	0.1	1	0.0	0.0	0.0	
Missing	9	1.0	14	0.5	9	0.4	15	0.4	
Area									p=0.280
Urban	473	51.5	1554	55.8	1185	55.3	2013	54.4	
Rural	401	42.6	1119	40.2	865	40.4	1530	41.4	
Remote	44	4.8	103	3.7	80	3.7	136	3.7	
Missing	1	0.1	11	0.4	12	0.6	18	0.5	
Smoking									p<0.001
Never	466	50.7	1517	54.4	1264	59.0	2195	59.4	
Ex-smoker	151	16.4	450	16.1	250	11.7	520	14.1	
Current smoker	291	31.7	807	29.0	612	28.6	945	25.6	
Missing	11	1.2	13	0.5	16	0.7	37	1.0	
Alcohol consumption**									p<0.001
Low risk	396	43.1	1476	53.0	1308	61.1	2345	63.4	
Non-drinker	156	17.0	301	10.8	160	7.5	231	6.2	
Rarely	328	35.7	898	32.2	573	26.8	949	25.7	
Risky	28	3.0	88	3.2	81	3.8	139	3.8	

High risk	4	0.4	4	0.1	8	0.4	9	0.2	
Missing	7	0.8	20	0.7	12	0.6	24	0.6	
Sitting-time (hours/day)									p<0.001
<4	180	19.6	596	20.4	406	19.0	813	22.0	
4-<8	399	43.4	1260	45.2	1066	49.8	1866	50.5	
8-<11	198	21.5	659	23.6	454	21.2	703	19.0	
≥11	54	5.9	156	5.6	110	5.1	134	3.6	
Missing	88	9.6	143	5.1	106	4.9	181	4.9	
BMI (kg/m^2)									p<0.001
Underweight (< 18.5)	67	7.3	172	6.2	130	6.1	205	5.5	
Normal (18.5 to <25)	438	47.7	1489	53.4	1217	56.8	2273	61.5	
Overweight (25 to <30)	140	15.2	463	16.6	391	18.3	704	19.0	
Obese (= > 30)	126	13.7	298	10.7	206	9.6	283	7.7	
Missing	148	16.1	365	13.1	198	9.2	232	6.3	
Chronic conditions***									p<0.001
None	507	55.2	1637	58.7	1314	61.3	2225	60.2	
One	234	25.5	714	25.6	534	24.9	995	26.9	
Two	115	12.5	292	10.5	198	9.2	297	8.0	
Three or more	55	6.0	113	4.1	78	3.6	136	3.7	
Missing	8	0.9	31	1.1	18	0.8	44	1.2	
Continuous data									
Age in years (mean, SD)	24.8 (1.48)		24.6 (1.49)		24.5 (1.45)		24.5 (1.45)		p=0.018
Optimism (LOT-R)	13.6 (4.18)		14.7 (4.19)		15.0 (4.25)		15.2 (4.16)		p<0.001
CESD-10 (mean, SD)	8.9 (6.0)		7.9 (5.5)		7.4 (5.4)		7.2 (5.4)		p<0.001
Anxiety (Goldberg scale) (mean, SD)	5.1 (2.6)		4.9 (2.6)		4.7 (2.7)		4.6 (2.7)		p<0.001

*All measures from the 2000 survey, except education (1996).

** NHMRC categories (23)

***chronic conditions included: arthritis, type1/type2 diabetes, heart disease, stroke, thrombosis, asthma, bronchitis, osteoporosis, cancer (breast, cervical, bowel, other), chronic fatigue syndrome, HIV or AIDS, Hepatitis (B or C), other major illness.

Table 2 Characteristics of the 11009 mid-age women by physical activity category (baseline year 2001)

Variable*	Physical activity								p-value
	None (n=2005)		Low (n=3226)		Moderate (n=2309)		High (n=3429)		
	N	(%)	N	(%)	N	(%)	N	(%)	
Categorical data									
Highest level of education									p<0.001
Primary school	532	26.5	496	15.2	292	12.6	464	13.5	
High school	992	49.5	1546	47.3	1080	46.8	1698	49.5	
Post school trade or certificate	296	14.8	697	21.3	473	20.5	729	21.3	
University degree	171	8.5	507	15.5	436	18.9	511	14.9	
Missing	14	0.7	20	0.6	10	1.2	27	0.8	
Marital status									p=0.246
Partnered	1602	79.9	2697	82.6	1903	82.4	2740	79.9	
Not partnered	332	16.6	474	14.5	330	14.3	555	16.2	
Widowed	60	3.0	86	2.6	68	2.9	118	3.4	
Missing	11	0.5	9	0.3	8	0.3	16	0.5	
Area									p=0.070
Urban	694	34.6	1227	37.6	923	40.0	1280	37.3	
Rural	1184	59.1	1861	57.0	1261	54.6	1953	57.0	
Remote	114	5.7	163	5.0	118	5.1	177	5.2	
Missing	13	0.6	15	0.5	7	0.3	19	0.6	
Smoking									p<0.001
Never	1119	55.8	2070	63.4	1457	63.1	2076	60.5	
Ex-smoker	449	22.4	733	22.4	585	25.3	902	26.3	
Current smoker	431	21.5	449	13.7	254	11.0	439	12.8	
Missing	6	0.3	14	0.4	13	0.6	12	0.3	
Alcohol consumption**									p<0.001
Low risk	776	38.7	1582	48.4	1212	52.5	1854	54.1	
Non-drinker	309	15.4	377	11.5	253	11.0	370	10.8	

Rarely	632	31.5	858	26.3	570	24.7	805	23.5	
Risky	94	4.7	158	4.8	94	4.1	141	4.1	
High risk	20	1.0	22	0.7	13	0.6	22	0.6	
Missing	174	8.7	269	8.2	166	7.2	237	6.9	
Sitting-time (hours/day)									p<0.001
<4	471	23.5	893	27.3	602	26.1	1041	30.4	
4-8	879	43.8	1505	46.1	1158	50.2	1683	49.1	
8-11	313	15.6	522	16.0	345	14.9	408	11.9	
>11	120	6.0	126	3.6	55	2.4	77	2.2	
Missing	222	11.1	220	6.7	149	6.5	220	6.4	
BMI (kg/m^2)									p<0.001
Underweight (< 18.5)	31	1.5	39	1.2	27	1.2	53	1.5	
Normal (18.5 to <25)	612	30.5	1184	36.3	975	42.2	1619	47.2	
Overweight (25 to <30)	588	29.3	979	30.0	728	31.5	1051	30.7	
Obese (= > 30)	612	30.5	817	25.0	451	19.5	542	15.8	
Missing	162	8.1	247	7.6	128	5.5	164	4.8	
Chronic conditions***									p<0.001
None	870	43.4	1682	51.5	1257	54.4	1851	54.0	
One	653	32.6	978	29.9	671	29.1	1060	30.9	
Two	286	14.3	388	11.9	249	10.8	334	9.7	
Three or more	175	8.7	191	5.8	104	4.5	140	4.1	
Missing	21	1.0	27	0.8	28	1.2	44	1.3	
Continuous data									
Age in years (mean, SD)	52.5 (1.46)		52.4 (1.46)		52.5 (1.46)		52.5 (1.46)		p=0.846
Optimism (LOT-R)	14.4 (4.14)		15.6 (3.91)		16.0 (3.80)		16.3 (3.82)		p<0.001
Depression (CESD-10)	7.8 (6.1)		6.3 (5.3)		5.5 (4.9)		2.2 (5.0)		p<0.001
Anxiety (Goldberg scale)	4.8 (2.7)		4.4 (2.7)		4.1 (2.7)		3.9 (2.7)		p<0.001

*All measures taken at survey 2000, except education (survey 1).

** NHMRC categories (23)

***chronic conditions included: Arthritis, type1/type2 diabetes, heart disease, stroke, thrombosis, asthma, bronchitis, osteoporosis, cancer (breast, cervical, bowel, other), chronic fatigue syndrome, HIV or AIDS, Hepatitis (B or C), other major illness.

Table 3 Longitudinal analysis of physical activity predicting subsequent increased levels of optimism (young, N=8667; mid-age N=10173)

Physical activity	Odds ratio (95% confidence intervals)			
	Model 1	Model 2	Model 3	Model 4
Young				
None	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Low	2.45 (1.88, 3.19)	1.92 (1.49, 2.48)	1.45 (1.14, 1.84)	1.46 (1.16, 1.84)
Moderate	3.99 (3.03, 5.25)	2.69 (2.06, 3.51)	1.76 (1.37, 2.25)	1.69 (1.33, 2.16)
High	5.04 (3.85, 6.59)	3.33 (2.57, 4.32)	2.00 (1.57, 2.55)	1.94 (1.53, 2.45)
Mid-aged				
None	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Low	2.70 (2.22, 3.28)	1.76 (1.46, 2.12)	1.27 (1.07, 1.50)	1.31 (1.11, 1.54)
Moderate	4.51 (3.69, 5.51)	2.40 (1.97, 2.91)	1.49 (1.25, 1.78)	1.47 (1.24, 1.75)
High	5.77 (4.76, 7.00)	2.92 (2.42, 3.53)	1.64 (1.38, 1.94)	1.56 (1.33, 1.84)

Model 1: Unadjusted

Model 2: adjusted for – age, education, marital status, area, smoking, alcohol consumption, sitting-time, BMI, number of chronic conditions

Model 3: adjusted for – age, education, marital status, area, smoking, alcohol consumption, sitting-time, BMI, number of chronic conditions, depression

Model 4: adjusted for – age, education, marital status, area, smoking, alcohol consumption, sitting-time, BMI, number of chronic conditions, depression, anxiety

**Table 4** Interaction of PA and depression on the association with optimism

	Odds ratio (95% confidence intervals)	
	Young	Mid-aged
PA*depression product term		
p for interaction	<0.001	<0.001
Association between PA and optimism – low depression		
None	1	1
Low	1.50 (1.13, 1.98)	1.44 (1.20, 1.74)
Moderate	1.67 (1.25, 2.23)	1.64 (1.35, 1.99)
High	2.05 (1.55, 2.73)	1.90 (1.58, 2.29)
Association between PA and optimism – high depression		
None	1	1
Low	1.58 (1.04, 2.40)	1.42 (0.99, 2.03)
Moderate	2.42 (1.54, 3.81)	2.12 (1.41, 3.17)
High	2.43 (1.57, 3.78)	1.81 (1.25, 2.64)
Association PA*depression and optimism		
PA none/depression high	1	1
PA low/ depression high	1.60 (1.05, 2.43)	1.39 (0.99, 1.96)
PA moderate/ depression high	2.48 (1.73, 4.40)	2.08 (1.42, 3.05)
PA high/ depression high	2.55 (1.65, 3.93)	1.67 (1.18, 2.38)
PA none/ depression low	7.04 (4.51, 10.99)	7.55 (5.57, 10.22)
PA low/ depression low	10.60 (7.18, 15.66)	10.73 (8.03, 14.33)
PA moderate/ depression low	11.74 (7.90, 17.43)	12.05 (9.00, 16.16)
PA high/ depression low	14.51 (9.84, 21.38)	13.82 (10.38, 18.40)

Depression high = CESD ≥10

Depression low = CESD <10

PA = physical activity

Supplementary 1: Participant numbers in young cohort surveys of the Australian Longitudinal Study on Women's Health.
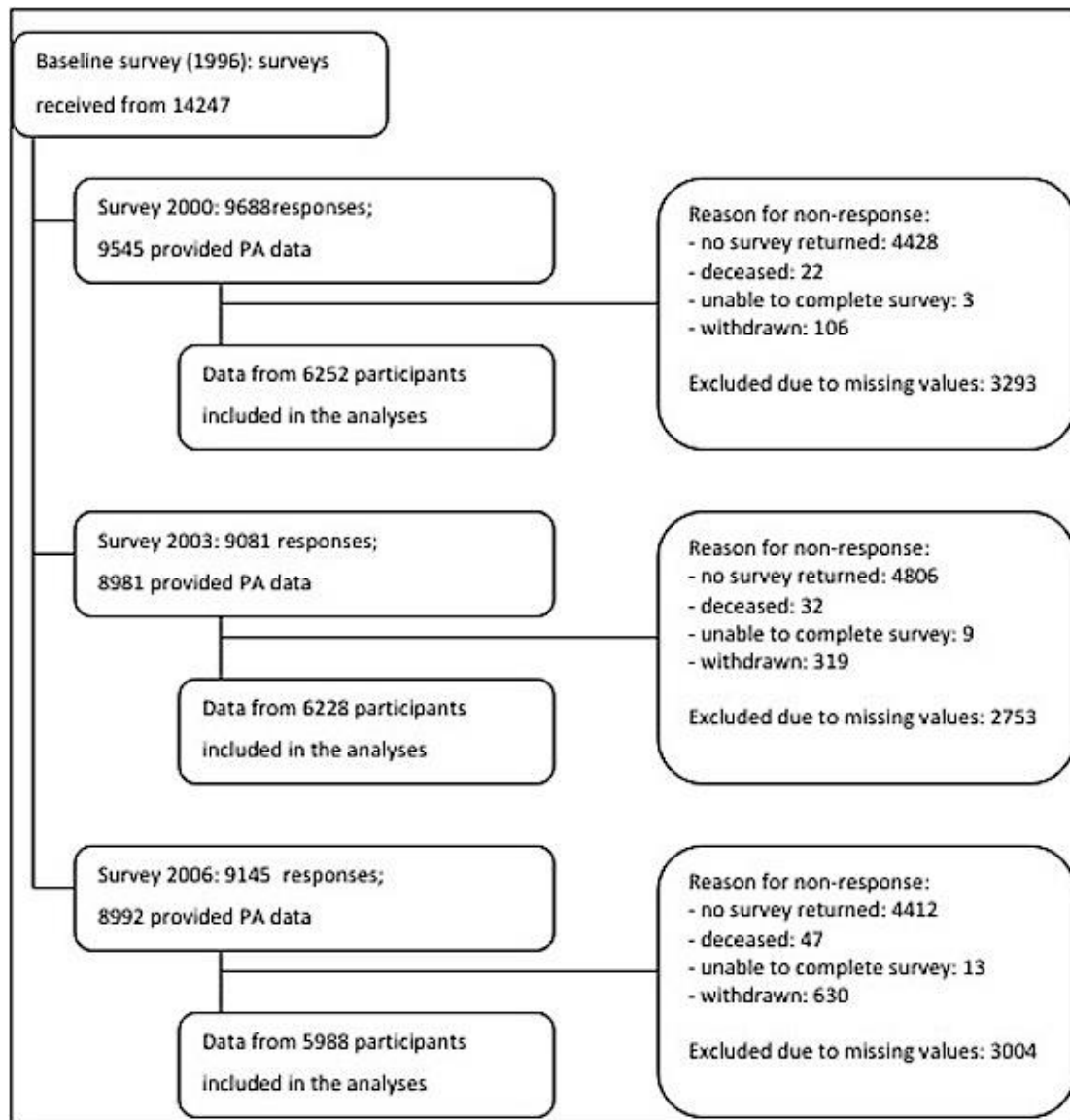
Supplementary 2: Participant numbers in mid-aged cohort surveys of the Australian Longitudinal Study on Women's Health.

Baseline survey (1996): surveys received from 13715

Survey 2001: 11226 responses; 11009 provided PA data

Reason for non-response:
- no survey returned: 2084
- deceased: 115
- unable to complete survey: 21
- withdrawn: 269

Excluded due to missing values: 3359

Data from 7650 participants included in the analyses

Survey 2004: 10905 responses; 10553 provided PA data

Reason for non-response:
- no survey returned: 2074
- deceased: 203
- unable to complete survey: 35
- withdrawn: 498

Excluded due to missing values: 2852

Data from 7701 participants included in the analyses

Survey 2007: 10638 responses; 10392 provided PA data

Reason for non-response:
- no survey returned: 2056
- deceased: 302
- unable to complete survey: 54
- withdrawn: 665

Excluded due to missing values: 2586

Data from 7806 participants included in the analyses