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# Effects of physical activity on emotional well-being among older Australian women
## Cross-sectional and longitudinal analyses

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**Abstract**

**Objective:** To explore relationships between physical activity and mental health cross-sectionally and longitudinally in a large cohort of older Australian women. **Method:** Women in their 70s participating in the Australian Longitudinal Study on Women's Health responded in 1996 (aged 70–75) and in 1999 (aged 73–78). Cross-sectional data were analyzed for 10,063 women and longitudinal data for 6472. Self-reports were used to categorize women into four categories of physical activity at each time point as well as to define four physical activity transition categories across the 3-year period. Outcome variables for the cross-sectional analyses were the mental health component score (MCS) and mental health subscales of the Medical Outcomes Study Short Form (SF-36). The longitudinal analyses focused on changes in these variables. Confounders included the physical health component scale (PCS) of the SF-36, marital status, body mass index (BMI) and life events. Adjustment for baseline scores was included for the longitudinal analyses. **Results:** Cross-sectionally, higher levels of physical activity were associated with higher scores on all dependent variables, both with and without adjustment for confounders. Longitudinally, the effects were weaker, but women who had made a transition from some physical activity to none generally showed more negative changes in emotional well-being than those who had always been sedentary, while those who maintained or adopted physical activity had better outcomes. **Conclusion:** Physical activity is associated with emotional well-being among a population cohort of older women both cross-sectionally and longitudinally, supporting the need for the promotion of appropriate physical activity in this age group. 

*Keywords:* Ageing; Mental health; Physical activity; Population research; Surveys; Women

## Introduction

The positive effects of regular leisure-time physical activity on physical health and well-being have been extensively documented [1,2], and there is substantial evidence identifying the biological mechanisms by which these occur [3]. While there is also evidence that people who are physically active have better emotional health than those who are sedentary [4], the evidence for causality is less conclusive and the mechanisms underlying this effect are open to debate. Thus, the question of whether physical activity should be promoted as a strategy for improving emotional health remains open [5]. This paper examines cross-sectional and longitudinal relationships between physical activity and emotional well-being in a cohort of older women while controlling for a number of possible confounders.

Women have lower levels of physical activity than men, and leisure-time physical activity tends to decrease with age, meaning that older women are the population group who are least likely to engage in health-related physical activity [6,7]. Women, particularly older women, have been neglected in research on physical activity and its promotion [8,9], at least in part because of social stereotypes suggesting that exercise is inappropriate or unsafe for older women [10]. There is, however, considerable evidence that physical activity has health benefits that are particularly relevant to older women, including improvements in sleeping patterns [11],

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relief of chronic pain [12], maintenance of the strength, coordination and balance required to maintain activities of daily living and avoid falls and fractures [13] and the prevention or alleviation of heart disease, osteoporosis and Type II diabetes [14].

This paper focuses on a further rationale for the promotion of physical activity among older people and its relationship with emotional well-being. It is well established that physical activity is associated positively with emotional well-being and negatively with anxiety and depression, both in research focusing on the acute effects of a single bout of activity and in that dealing with the relationship between regular physical activity and emotional well-being in general [15,16]. However, the question of whether the association is causal is less clear [5].

A number of physiological mechanisms by which exercise might cause positive mood states and emotional well-being have been proposed. There is a strong suggestion that physical activity improves mental health by improving the body's ability to deal with the effects of stress [16]. Other possible explanations include increases in body temperature and alterations to adrenaline and to endorphin levels, but these mechanisms are specific to the acute effects of high-intensity activity and do not appear to explain the long-term relationship between regular moderate activity and positive mood [17].

In general, research on the relationship between physical activity and emotional well-being has focused on young to middle-aged participants, used small and self-selected samples and focused on people with a lifetime history of physical activity or on groups with identified psychological distress [5]. Thus, the question of whether physical activity promotion at a population level might improve emotional health has yet to be answered. Further, the effects of confounders such as level of physical health have often been neglected. Among older women in particular, physical health may well determine both an individual's ability to be physically active and her level of emotional well-being. Thus, the relationship between the two may not be a causal one. The Australian Longitudinal Study on Women's Health, also known as Women's Health Australia (WHA), provides an opportunity to examine this relationship both cross-sectionally and longitudinally in a large representative cohort of older women and to explore the effects of other variables.

WHA, a longitudinal survey of the health and well-being of three cohorts of Australian women, has been described in detail elsewhere [18,19]. The project uses mailed surveys to collect self-report data on health and related variables from three cohorts of Australian women who were aged 18–23 years ("young"), 45–50 years ("mid-age") and 70–75 years ("older") when the project began in 1996. Over 40,000 women were recruited on a random basis from the Australian population, with the national health insurance database (Medicare) as the sampling frame and systematic oversampling of women living in rural and remote areas. The project is designed run for 20 years, with the overall goal to conduct a series of interlocking data analyses in order to develop an understanding of factors that affect the health and well-being of women and in order to inform Australian government health policy [19].

Physical activity is one of a large number of variables assessed among the older cohort. The project provides a context for the assessment of the relationship between physical activity and emotional well-being and allows adjustment for a range of possible confounders. There is evidence, for example, that sedentariness among older adults is predicted by perceived or actual deficits in physical health [20], by obesity [21], by marital status [22] and by disruptive life events [23], all of which have been assessed in this survey. Previous research with the older cohort of WHA has demonstrated a cross-sectional relationship between physical activity and a range of measures of physical health and well-being, including perceived physical health, symptoms such as backache and medical conditions such as hypertension and osteoporosis [24]. This paper extends that work to examine the relationship between physical activity and emotional well-being cross-sectionally and longitudinally over 3 years, both with and without adjustment for a range of confounders.

## Method

### *Participants*

This analysis focuses on Survey 1 (1996) and Survey 2 (1999) data from the older cohort. A total of 12,939 older women responded to Survey 1 (aged 70–75) and 10,432 to Survey 2 (when they were aged 73–78), excluding 507 women who provided no contact details at Survey 1 and thus could not be recontacted, 490 who had died and 109 who were too ill to respond, representing an 88.2% retention rate. Overall, 4.9% withdrew from the study at Survey 2, 4% did not respond and 2.9% could not be relocated.

Data from 10,063 women (78% of those who responded to Survey 1) who provided complete data on all relevant variables were included in the cross-sectional analyses. Data from 6472 women (62% of those who responded to Survey 2) were used in the longitudinal analyses. This excludes 9% who completed a short version of the survey by phone and 29% who had missing data on at least one of the variables at Survey 1 or 2.

### *Survey*

Respondents completed a 24-page survey comprising over 300 items, which addressed health status, health service use and satisfaction, health-related behaviours and sociodemographic variables [19]. The current analysis used the following variables.

*Physical activity*

Level of exercise at Survey 1 was determined from self-reported frequency of engaging in "vigorous activity" and "less vigorous" exercise, as described elsewhere [24]. Responses of never, once a week, two or three times per week, four, five or six times per week, once every day and more than once every day were scored 0, 1, 2.5, 5, 7 and 10, respectively, to approximate weekly frequencies of exercise. They were weighted by multiplying the "vigorous" score by 5 and the "less vigorous" score by 3 and summed to provide a score with a theoretical range from 0 to 80. Scores were then categorized as $<5$ (none or very low), from 5 to $<15$ (low), from 15 to $<25$ (moderate) and 25 or more (high).

Level of exercise at Survey 2 was determined from self-reported time spent engaging in "vigorous activity," "moderate activity" and "walking" in the previous week, as described elsewhere [25]. Number of minutes of exercise was weighted by multiplying "vigorous activity" by 7.5, "moderate activity" by 4 and "walking" by 3. Scores were then categorized as $<40$ (none or very low), from 40 to $<600$ (low), from 600 to $<1200$ (moderate) and 1200 or more (high).

The use of different methods for assessing physical activity at Surveys 1 and 2 is explained by developments in the assessment of physical activity among women. Survey 1 used validated items that were concurrently being used in other large-scale national surveys [26]. Subsequent work [27] has demonstrated the validity of a different set of items, which were adopted for Survey 2 in order to reflect best practice at the time. Australian research has demonstrated very high ($>95\%$) concordance between the methods but shown that the second is somewhat more accurate, particularly for women and those with low body weight [25].

Four transition categories were identified for physical activity: Sedentary (none or very low at both surveys), Exercise Adoption (none or very low at Survey 1; low, moderate or high at Survey 2), Exercise Cessation (low, moderate or high at Survey 1; none or very low at Survey 2) and Maintenance (low, moderate or high at both surveys).

*Outcome variables*

Outcome variables at Survey 1 were the four mental health subscales and the mental health component score (MCS) of the Medical Outcomes Study Short Form (SF-36) [28]. The SF-36 is a comprehensive measure of health-related quality of life, which produces eight subscales, of which the four mental health subscales were used as outcomes in this analysis. These relate to emotional well-being: vitality, social functioning, role-emotional and mental health. In addition, the MCS was calculated. All measures were standardized for this population [29]. Outcome variables for mental health change were calculated by subtracting the Survey 1 score from the Survey 2 score for each of these variables.

*Confounders*

The following variables from Survey 1 were included as potential confounders: age in years, marital status (dichotomized as currently married/other), body mass index (BMI) based on self-reported height and weight, the physical component summary score (PCS) of the SF-36 [28] and a measure of life events. This latter measure was derived from a list of 24 major life events based on Norbeck [30]. Participants reported whether they had experienced each life event in the previous 12 months. The number of reported life events was positively skewed and categorized as 0, 1, 2, 3 and 4 or more.

*Statistical analyses*

Cross-sectional analyses of the relationship between mental health and physical activity were conducted using Survey 1 data. Simple and multiple linear regression were used to estimate mean mental health scores at Survey 1 within the four categories of physical activity. Multivariate models were used to control for possible confounding effects of PCS, marital status, BMI and life events.

Longitudinal analyses were similar except that they focused on transitions between Surveys 1 and 2. Simple and multiple linear regression were used to estimate mean change in mental health in relation to physical activity transition category. Multivariate analyses included the confounders used in the cross-sectional analyses as well as the baseline measures on the dependent variables.

## Results

*Demographics*

Of those women who responded to Survey 1 and are included in the cross-sectional analysis, 57% were married, 34% widowed, 6% separated or divorced and 3% always-single. Overall, 77% were born in Australia, 13% in other primarily English-speaking countries and 10% in non-English-speaking countries. Thirty-five percent had no formal educational qualifications, 38% had the equivalent of 10 or 11 years of schooling, 12% the equivalent of 12 years of schooling (high school graduate) and 15% had postsecondary qualifications. Comparisons with census data from the Australian Bureau of Statistics indicate that the respondents were demographically representative of Australian women in these age groups, with a slight overrepresentation of married, Australian-born and highly educated subgroups [18].

*Cross-sectional analyses*

Table 1 presents raw and adjusted means for the MCS and the four mental health subscales of the SF-36 at Survey 1 across the four physical activity categories as well

Table 1
Mean scores on the MCS of the SF-36 and the four "mental health" subscales, in 1996, by physical activity category in 1996 ($n = 10{,}063$), with and without adjustment for confounders

| | | None or very low ($n = 2826$) | Low ($n = 2935$) | Moderate ($n = 3055$) | High ($n = 1247$) | $F$ | $P$-value |
|---|---|---|---|---|---|---|---|
| MCS | Crude | 48.5 | 51.0*** | 51.5*** | 51.6*** | 56.67 | <.001 |
| | Adjusted[a] | 47.5 | 50.3*** | 50.9*** | 51.5*** | 79.02 | <.001 |
| Vitality | Crude | 51.9 | 61.1*** | 63.9*** | 68.8*** | 270.78 | <.001 |
| | Adjusted[a] | 57.1 | 59.8*** | 61.0*** | 63.0*** | 50.22 | <.001 |
| Social functioning | Crude | 74.0 | 84.3*** | 85.8*** | 87.8*** | 163.44 | <.001 |
| | Adjusted[a] | 78.0 | 82.3*** | 82.4*** | 81.9*** | 28.24 | <.001 |
| Emotional role | Crude | 66.5 | 78.9*** | 81.6*** | 84.7*** | 117.10 | <.001 |
| | Adjusted[a] | 67.2 | 76.3*** | 78.2*** | 80.7*** | 61.91 | <.001 |
| Mental health | Crude | 72.9 | 78.4*** | 79.7*** | 80.4*** | 106.64 | <.001 |
| | Adjusted[a] | 73.0 | 77.2*** | 78.3*** | 78.8*** | 62.68 | <.001 |

[a] Means adjusted for 1996 values of SF-36 PCS, marital status, BMI and recent life events.
*** Mean significantly different from None/Very Low category ($P < .001$).

as the results of analysis of variance with and without adjustment for confounders. (Exploratory analyses adjusting for various subsets of the confounders found essentially the same pattern of results and thus are not reported here.) On every SF-36 variable, group means increased with increasing levels of exercise, and for every level of physical activity, the group mean was significantly higher than that of the "None or Very Low" physical activity group. This pattern was maintained after adjustment.

*Retention rate*

Before conducting longitudinal analyses, the retention rate between Surveys 1 and 2 was examined separately for each of the four physical activity groups identified at Survey 1. For the "None or Very Low" category, 61% were available for inclusion in the longitudinal analysis, and the corresponding figures for "Low," "Moderate" and "High" were 73%, 76% and 75%, respectively ($\chi^2 = 280.2$, $df = 6$, $P < .001$; Cramer's $V = 0.11$).

*Longitudinal analyses*

Table 2 presents raw and adjusted means for change in the MCS and the four mental health subscales across the four physical activity transition categories as well as the results of analysis of variance with and without adjustment. MCS change showed no difference across physical activity transition categories either with or without adjustment, but there were significant effects for each of the subscales, and the pattern of significance showed some consistencies. By comparison with the "Sedentary" group, the "Exercise Cessation" group showed a significantly greater decrease in vitality and in social functioning than the "Sedentary" group, both with and without adjustment, and a significantly greater decrease in mental health on the unadjusted change scores. The "Exercise Adoption" group showed significantly more positive (or less negative) changes on social functioning without adjustment and on all four subscales with adjustment. The "Maintenance" group showed significantly more positive (or less nega-

Table 2
Mean change in the MCS of the SF-36 and the four "mental health" subscales, in 1999, by physical activity transition category ($n = 6472$), with and without adjustment for confounders

| | | Sedentary ($n = 883$) | Exercise cessation ($n = 1103$) | Exercise adoption ($n = 654$) | Exercise maintenance ($n = 3832$) | $F$ | $P$-value |
|---|---|---|---|---|---|---|---|
| MCS | Crude | 0.70 | −0.10 | 1.04 | 0.34 | 2.53 | .055 |
| | Adjusted[a] | 0.26 | 0.14 | 0.73 | 0.44 | 0.87 | .455 |
| Vitality | Crude | −2.15 | −6.04*** | −0.85 | −2.74 | 17.21 | <.001 |
| | Adjusted[a] | −5.23 | −7.21** | −1.70*** | −1.71*** | 43.52 | <.001 |
| Social functioning | Crude | −1.12 | −7.89*** | 2.43* | −0.06 | 34.58 | <.001 |
| | Adjusted[a] | −5.19 | −8.51** | 1.25*** | 0.87*** | 66.50 | <.001 |
| Emotional role | Crude | −0.64 | −2.81 | 1.52 | −0.19 | 2.06 | .104 |
| | Adjusted[a] | −5.81 | −3.51 | −1.30* | 0.37*** | 10.39 | <.001 |
| Mental health | Crude | 0.96 | −0.70* | 1.94 | 0.38 | 5.48 | <.001 |
| | Adjusted[a] | −0.12 | −0.56 | 1.38* | 0.71 | 4.87 | .002 |

[a] Means adjusted for 1996 values of the dependent variable, SF-36 PCS, marital status, BMI and recent life events.
* Mean significantly different from None/Very Low category ($P < .05$).
** Mean significantly different from None/Very Low category ($P < .01$).
*** Mean significantly different from None/Very Low category ($P < .001$).

tive) changes on three of the four subscales, though only after adjustment.

## Discussion

This analysis of self-report data from a large and demographically representative sample of Australian women in their 70s showed strong cross-sectional relationships between physical activity and emotional well-being, both with and without adjustment for a range of potential confounders. The longitudinal data show relationships, which are not as strong or consistent, but the pattern of results suggests that women who had made a transition from some physical activity to none generally showed more negative changes in emotional well-being than those who had always been sedentary, while those who maintained or adopted physical activity tended to have better outcomes.

It must be stressed that the transitions are assessed at two time points only and that the temporal pattern of changes in physical activity and in well-being over the 3-year period has not been explored. Thus, it is possible that women who were no longer active in 1999 had experienced changes in their physical health that had caused both the cessation of physical activity and the reduction in well-being. The longitudinal data do, however, suggest that those older women who are able to maintain physical activity, and particularly those who adopt physical activity, will experience higher levels of well-being. In conjunction with the cross-sectional findings, indicating that physical activity predicts well-being over and above the effects of physical health, this provides strong evidence to suggest that the promotion of physical activity among women in their 70s could have positive effects on emotional well-being.

The design of the project necessitates a reliance on self-report and the level of missing data is quite high, but these limitations are characteristic of all epidemiological survey research and the results are consistent with those of analyses based on other methods [15]. As is the case in other longitudinal research that targets the older community, those women who were lost to follow-up in this project have been demonstrated to have had poorer health when first recruited [31]. Those women who were sedentary at Survey 1 were significantly more likely than the others to be in poor health and also to be lost to follow-up. While this may have led to some bias in the longitudinal analysis, the effect would have been to select out those nonexercisers in the poorest health and thus would have had a conservative effect on the results.

The cross-sectional data support previous research, which demonstrates an association between physical activity and emotional health [4,5,15,16]. Further, they extend previous findings by demonstrating that the cross-sectional relationship is maintained even after adjusting for physical health, BMI and other confounders. Thus, differences in the practical capacity to engage in physical activity do not appear to explain differences in emotional health between sedentary and active older women. The difference may result from physiological differences resulting from physical activity, from larger social networks or from a wider range of pleasurable activities available to those women who are physically active.

The longitudinal data demonstrate that older women who were able to maintain or adopt physical activity between 1996 and 1999 were in somewhat better emotional health 3 years later than were those who were sedentary or ceased physical activity. This effect was also maintained when potential confounders were taken into account. Physical activity among older women is certainly predictive of future emotional well-being, but this effect is mediated by a number of other variables, including the ability to maintain that pattern of activity and the level of physical health in the interim. These other variables, however, are intercorrelated with physical activity, for example, active women are likely to maintain a high level of physical health and thus to be able to continue to exercise.

The items used to assess physical activity at the two time points differed. This decision was taken because of evidence arising in the intervening time period, showing that the second method is somewhat more accurate for women, although the methods do have very high concordance [25]. The present analysis represents a small part of a projected 20-year longitudinal study, and a decision was taken by the research team that all methods of assessment used in the survey should change when necessary to reflect current consensus on best practice. Failure to change methods in the face of new evidence might have made longitudinal analysis more straightforward but over time would lead to the longitudinal study becoming increasingly outdated and irrelevant. Using the different measures to create comparable categories rather than as continuous variables reduces the extent of any bias resulting from this change.

The size of statistically significant effects in large samples also requires some interpretation. There is evidence to indicate that a difference of around two or three points on the MCS of the SF-36 represents a clinically significant difference in well-being, about the degree of difference found between people with a serious physical illness and those in good health [32]. On the four emotional-related subscales, British data indicate that the difference between community-living individuals with long-standing disease and those without is in the order of 5–10 points [33]. The cross-sectional differences between the ''None or Very Low'' physical activity group and the others were of this order, even after adjusting for confounders. The degree of change shown by the exercise cessation group was also within this range for two of the four subscales. Thus, the data support the view that older women who engage in regular physical activity will experience levels of emotional health that are meaningfully better than those who do not.

Taken together, the results suggest that physical activity and mental health certainly go together in older women. Older women who exercise are more likely to be in good

emotional health than are sedentary women, even after taking into account the impact of physical health more generally. Older women who were currently exercising were also more likely to be in good emotional health in another 3 years than were other women, even though the relationship was not a simple univariate one. While neither the cross-sectional nor the longitudinal data can definitively support a causal explanation or clarify the direction of any causal link, they do suggest that the promotion of appropriate physical activity among older women is a valuable health promotion goal.

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