

Elsevier required licence: © <2019>. This manuscript version is made available under the CC-BY-NC-ND 4.0 license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

The definitive publisher version is available online at

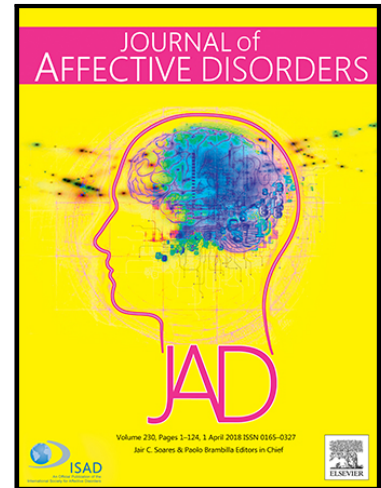
[\[https://www.sciencedirect.com/science/article/pii/S0165032718316161?via%3Dihub\]](https://www.sciencedirect.com/science/article/pii/S0165032718316161?via%3Dihub)

Accepted Manuscript

Physical activity and depression symptoms in women with chronic illness and the mediating role of health-related quality of life

Erica McIntyre , Romy Lauche , Jane Frawley , David Sibbritt ,
Prasuna Reddy , Jon Adams

PII: S0165-0327(18)31616-1
DOI: <https://doi.org/10.1016/j.jad.2019.04.057>
Reference: JAD 10718



To appear in: *Journal of Affective Disorders*

Received date: 27 July 2018
Revised date: 7 March 2019
Accepted date: 8 April 2019

Please cite this article as: Erica McIntyre , Romy Lauche , Jane Frawley , David Sibbritt ,
Prasuna Reddy , Jon Adams , Physical activity and depression symptoms in women with chronic
illness and the mediating role of health-related quality of life, *Journal of Affective Disorders* (2019), doi:
<https://doi.org/10.1016/j.jad.2019.04.057>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Highlights

- Women who were more physically active had less severe depression symptoms
- Health-related quality of life is an important predictor of depression symptoms
- HRQoL partially mediated (yet negligible) the effect of physical activity on depression symptoms
- Women who were more physically active had better health-related quality of life

ACCEPTED MANUSCRIPT

Manuscript title

Physical activity and depression symptoms in women with chronic illness and the mediating role of health-related quality of life

Authors:

Erica McIntyre¹

Romy Lauche¹

Jane Frawley¹

David Sibbritt¹

Prasuna Reddy^{1,2}

Jon Adams¹

¹ University of Technology Sydney, Faculty of Health, Ultimo NSW, Australia

² Institute of Psychiatry, Psychology and Neuroscience, King's College London, UK

Corresponding author:

Dr Erica McIntyre

Faculty of Health, University of Technology Sydney

PO Box 123 Broadway NSW 2007 Australia

Phone: +61 (02) 9514 5942

Email: erica.mcintyre@uts.edu.au

Abstract

Background: The aim of this study was to determine the impact of physical activity on depression symptom severity in women 45 years and older with a chronic illness diagnosis, and explore relations between physical activity and psychological and health-related characteristics predicting depression symptoms.

Methods: 1,932 women diagnosed with one of five chronic illnesses: asthma, depression, diabetes, osteoarthritis, or osteoporosis participated in a sub-study of the 45 and Up Study—a cross-sectional study of people aged 45 years and older. The survey included items measuring demographics, depression symptoms, health-related quality of life (HRQoL), health-related hardiness, sleep quality, and health behaviours, such as physical activity.

Results: A multiple regression model explained 43% of the variance in depression symptoms ($R^2 = .43$, $F(18) = 61.72$, $p < .001$); intensity of physical activity was a significant predictor of depression symptoms ($p < .001$), and HRQoL was found to explain the most variance ($B = -10.00$) in depression symptoms. Mediation analysis confirmed that HRQoL partially mediated the relation between physical activity and depression symptoms; however, the effect was very small.

Limitations: Cross-sectional data and self-report measures limit the implications of the findings.

Conclusion: Women with chronic illness engaging in more vigorous physical activity had less severe depression symptoms. Findings suggest that improving HRQoL is critical to the prevention and management of depression symptoms in women with chronic illness. Psychological and health-related factors that influence HRQoL, such as sleep quality and health-related hardiness, are important clinical considerations for health practitioners.

Key words

Depression; Health Behavior; Exercise; Women's Health; Quality of Life, Chronic Disease

Introduction

As life expectancy continues to increase, healthy ageing has become a public health priority. The World Health Organization (WHO) estimates that from a total of 56 million deaths in 2015, 40 million were due to non-communicable diseases (WHO, 2017). Depression is a chronic illness that affects an estimated 300 million people worldwide (WHO, 2018), of which a disproportionate number are women (Steel et al., 2014). In Australia, one in six women will experience some level of depression compared to one in eight men (Australian Bureau of Statistics, 2007).

There is a bidirectional relationship between depression and chronic illness. Poor health behaviours, together with the psychological and biological changes associated with depression, increase the risk of developing a chronic illness, while the presence of a chronic health condition and associated physical changes may initiate depression (Katon, 2011). A meta-analysis of 13 studies, representing 6,916 participants found depression predicted diabetes (Mezuk et al., 2008). This meta-analysis also incorporated seven studies, representing 6,414 individuals that identified diabetes as a risk factor for the development of depression. In addition, research has found depression often worsens the outcomes of chronic illness due to neurobiological changes, endocrine factors and inflammatory responses, and that on average individuals with chronic health disorders die 5-10 years earlier if they have co-morbid depression (Katon, 2011).

Self-care health behaviours such as physical activity are critical for the management of chronic illness. The benefits of exercise for older adults with chronic health conditions are widespread and include an improved sense of wellbeing, less pain and improved mobility (Sawatzky et al., 2007). Recent research exploring the effects of different proportions of moderate and vigorous exercise on health of 204,542 older Australian adults (Gebel et al., 2015) demonstrated a dose-response relationship between vigorous exercise and health outcomes, which was consistent across gender, body mass index scores and individuals with or without a chronic illness. Other studies confirmed that more intense exercise (Balchin et al., 2016) or increased frequency of

exercise sessions (Brown et al., 2005; Heesch et al., 2015; Perales et al., 2014) might improve participants' mental health and decrease psychological distress.

Health-related quality of life (HRQoL)—or general health status—is also associated with depression symptoms (Goldney et al., 2004; Greer et al., 2016). Variables found to predict HRQoL are also risk factors for depression; for example, health-related hardiness (control dimension) (Eschleman et al., 2010; Smith et al., 2004), sleep quality, (Furihata et al., 2012; Strine and Chapman, 2005), and certain health behaviours, such as smoking and physical inactivity (McAuley et al., 2006; van Uffelen et al., 2013). The associations between physical activity and HRQoL and between HRQoL and depression have been studied in a range of cohorts (Schuch et al., 2011). In addition, previous research suggests that physical activity may affect HRQoL and depression symptoms via different mechanisms (Schuch et al., 2011). We also know that HRQoL is impacted by chronic illness; however, the potential mediating role of HRQoL on the relations between health-related variables and depression symptoms has yet to be explored.

Women are more likely to experience depression than men (WHO, 2018). While numerous studies have demonstrated the benefits of physical activity on depression symptoms (Herring et al., 2012), there is an important need to explore the association between the frequency and intensity of physical activity and depression symptoms in women with chronic illness. The likelihood of developing chronic illness increases with aging, and older Australians are more likely to have multiple chronic illnesses (Gunn et al., 2010). Consequently, there is a need to understand how psychological and health-related factors interact and influence depression symptoms specifically in middle-aged and older women with chronic illness. Accordingly, the aims of this study were to: 1) determine the impact of physical activity (frequency and intensity) on depression symptom severity in women 45 years and older with one of five chronic disease diagnoses, and 2) explore the relations between physical activity and the psychological and health-related characteristics predicting depression symptoms in these women.

Methods

Study design and setting

This cross-sectional survey is a sub-study of The Sax Institute's 45 and Up Study—an Australian study of healthy ageing of men and women aged 45 years and older. The methods for the baseline 45 and Up Study have been previously described (45 and Up Study Collaborators, 2008). Ethical approval for the baseline and sub-studies was obtained from the University of NSW Human Research Ethics Committee; and the University of Technology Sydney Human Research Ethics Committee.

Participants

For the baseline study participants were randomly selected from the Department of Human Services database, which contains records for the majority of the [Australian](#) general population. There were 266,848 participants in the baseline study (recruited between 2006-2009) who met the criteria of being 45 years or older and living in the state of New South Wales, Australia. Participants provided consent to be followed-up upon recruitment to the 45 and Up Study. Invitations to participate in the sub-study were posted to 4,000 women who self-reported they had been medically diagnosed with one of five chronic diseases: asthma, depression, diabetes, osteoarthritis, or osteoporosis (i.e. 800 for each chronic illness). Of these, 1932 women completed the questionnaires and provided consent; a response rate of 48.3%. The data were collected between September and December 2016.

Variables and measurement instruments

Demographic variables. Demographic information collected included age, highest level of education, and marital status. In addition, area of residence was determined using the ARIA+ remoteness score (AIHW, 2004). Further, women were asked how they managed on their available income with a 5-item response format (1 = it is impossible, 2 = it is difficult all the time, 3 = it is difficult some of the time, 4 = it is not too bad, 5 = it is easy).

Depression symptoms. The Center for Epidemiological Studies Depression scale 10-item version (CESD-10) was used to measure severity of depression symptoms in the previous week. The 10-item version was specifically designed for older populations to reduce participant burden (Irwin et al., 1999). A total score of 10 or over (range 0-30) indicate clinically relevant depression (Andresen et al., 1994). In this sample the CESD-10 demonstrated excellent internal reliability (Cronbach α = .82), and acceptable convergent validity being moderately correlated ($r = .65, p < .001$) with the item measuring [the anxiety and depression dimension from the EuroQol Five-Dimensional Questionnaire 3 \(EQ-5D-3L\)](#).

Physical activity. Physical activity was measured with items adapted from the Active Australia Survey (AAS) (Australian Institute of Health and Welfare, 2003). Women were asked to indicate the frequency (number of sessions) of their participation in and time spent doing (total hours and minutes) four types of physical activities of various intensity over the last week: 1) walking briskly (for recreation or exercise, or to get from place to place), 2) moderate leisure activity (like social tennis, moderate exercise classes, recreational swimming dancing), and 3) vigorous leisure activity (that makes you breathe harder or puff and pant like aerobics, competitive sport, vigorous cycling, running, swimming), and 4) vigorous household and garden chores (that makes you breathe harder or puff and pant). The AAS is a widely used measure of physical activity that has been validated in Australian general population samples (Brown et al., 2004).

Covariates and potential confounding variables. [Potential confounding variables](#) were [identified](#) from previous research in the topic area (Astell-Burt et al., 2014; Brown et al., 2005;

George et al., 2012). Covariates included age, area of residence, ability to manage income, number of chronic disease diagnoses, body mass index (BMI), smoking, sleep quality, health hardiness, health status, and anxiety disorder diagnosis.

Sleep quality was measured using a question from the Medical Outcomes Study (MOS) Sleep Scale; a widely used scale demonstrating adequate validity and reliability in various populations (Hays et al., 2005). Participants reported their average amount of sleep per day in hours and minutes over the previous 4 weeks. A dichotomous score (*0 = inadequate sleep, 1 = optimal sleep*) was created that reflected optimal amount of sleep (7-8 hours per night) using the guidelines developed by Spitzer and Hays (2003).

The 14-item control dimension of the Health-related Hardiness Scale (HRHS) was used to measure a person's perceived control over their health problems. Higher summed scores reflect a greater amount of health hardiness. The HRHS has demonstrated excellent internal reliability and validity in adults with chronic illness (Pollock and Duffy, 1990; Smith et al., 2004). For this analysis, only the 'perceived control' scale was used (7 items).

The EQ-5D-3L was used to measure self-reported health-related quality of life (HRQoL) comprising five health dimensions (mobility, self-care, usual activities, pain/discomfort and anxiety/depression). The EQ-5D-3L is a widely used standardised index validated in Australian samples (Clemens et al., 2014). Although there is a well-known association between depression and HRQoL, the EQ-5D-3L is a multidimensional measure of HRQoL that is a distinct construct from depression symptom severity (Schuch et al., 2011).

Statistical Analyses

Descriptive and multivariate analyses were conducted using IBM SPSS Statistics version 24. Missing values analysis was conducted for the CEDS-10 items (n=61 cases with missing > 2 values) and physical activity items (n=99 cases with missing number of sessions, n=396 cases with missing duration). Missing cases were excluded in relevant analyses.

Preparation of the physical activity variables followed the Active Australia Survey guidelines (George et al., 2012; Mayne et al., 2017). A variable was created that reflected the intensity of physical activity over the previous week by summing the total amount of time spent doing each type of physical activity (weighted x 2 for vigorous activities) and categorised as: no activity (0 minutes), insufficiently active (1–149 minutes), sufficiently active (150–299 minutes), and highly active (300 minutes or more) (Australian Institute of Health and Welfare, 2003; Mayne et al., 2017). The total number of sessions for each physical activity per week was captured in a separate variable.

Multiple regression using general linear model was conducted to determine the predictors of depression symptoms. Statistical significance was set at $p < .05$. Following this, mediator analysis was conducted to examine the influence of HRQoL on the relation between physical activity and depression symptom severity using the PROCESS macro (Version 3.0) for SPSS, controlling for potential covariates, as outlined by Hayes (2009). Total, direct, and indirect effects were estimated using a bootstrap sampling procedure with 5,000 resamples. Unstandardised point estimates and bias corrected 95% confidence intervals (CI) were calculated (Hayes, 2013).

Results

Demographic characteristics

The mean age of participants was 68.74 ($SD = 8.76$, range 53-95) years. The majority of women were married or in a de-facto relationship (61.42%), and lived in a major city (47.3%), with only 11.91% living in an outer regional/remote area. Most women had completed some type of tertiary education or training (59.6%), compared to 7.4% who had no formal school education. The majority of women (66.7%) reported having little or no difficulties with income management, see Table 1 for demographic characteristics.

Insert Table 1.

Depression symptoms

Table 2 shows the mean scores for depression symptom severity by chronic condition. The overall mean CESD-10 score was 7.59 ($SD = 5.54$). Almost a third of the women (31.4%) met the

criteria for clinically relevant depression (Andresen et al., 1994). There was a statistically significant difference between type of chronic condition and depression symptom severity ($p < .001$). The depression group had significantly higher mean depression scores compared to asthma (3.50, 95%CI [2.35, 4.65], $p < .001$), diabetes (2.63, 95%CI [1.45, 3.81], $p < .001$), osteoarthritis (3.00, 95%CI [1.86, 4.15], $p < .001$), and osteoporosis (3.95, 95%CI [2.82, 5.08], $p < .001$). Interestingly, those with a diabetes diagnosis had significantly higher mean depression symptoms than those with osteoporosis (1.32, 95%CI [0.28, 2.37], $p = .005$).

Insert Table 2.

Physical activity

Table 3 presents the level of physical activity for each chronic health condition. Overall, women participated on average in 5.56 ($SD = 6.65$) sessions per week, with 52% participating in five or more sessions, and 18% reporting no physical activity sessions. The majority of women (60.4%) had a total physical activity time that was sufficient to confer a health benefit, of these 64% were highly active.

Insert Table 3.

Multiple regression predicting depression symptom severity

Table 4 reports the results of a multiple regression predicting depression symptom severity in the previous week. The model was significant and explained 43% of the variance in depression symptoms ($R^2 = .43$, $F(18) = 61.72$, $p < .001$). Age, income management, type of health condition, anxiety disorder diagnosis, sleep quality, HRQoL, and health-related hardiness were all statistically significant predictors of depression symptoms (all $p < .001$), as was smoking status ($p = .009$). HRQoL explained the most variance in depression symptoms; women with worse HRQoL had more severe depression symptoms. Time spent doing physical activity (intensity) was a significant predictor of depression symptoms ($p = .04$); women who were highly or sufficiently active had less severe depression symptoms compared to those who did no physical activity. Note that the number of sessions of physical activity was not a statistically significant predictor.

Insert Table 4.

Mediation analysis predicting depression symptom severity

The role of HRQoL as a mediator between physical activity (intensity) and depression symptoms was tested, while controlling for potential covariates from the regression model (i.e. age, qualification, income management, sleep quality, health-related hardiness, and smoking), see Table 5. The mediation model (PROCESS Model 4) accounted for 39% of the variance in depression symptoms ($R^2 = .39$, $F(7, 1684) = 153.61$, $p < .0001$). Mediation analysis found that HRQoL partially mediated the effect of physical activity on depression severity. Those who engaged in a greater amount of vigorous physical activity had better HRQoL and less severe depression symptoms; however, the magnitude of this indirect effect was **negligible** (Effect = $-.0009$, 95% CI = $-.0012$, $-.0006$).

Insert Table 5.

Discussion

This is the first known study to explore the relations between physical activity and the psychological and health-related characteristics predicting depression symptoms in women 45 years and older with chronic illness. The results show a number of key findings. First, we found that 40% of women did not participate in adequate physical activity to confer a health benefit, which is consistent with recent research in an Australian adult population study (Short et al., 2015). Our finding is also consistent with research suggesting middle-aged to older adults report less physical activity than younger age groups (Astell-Burt et al., 2014). Previous research has also reported that participation in physical activity in middle-aged and older women declined over a 9-year period (Heesch et al., 2015, 2016). This is a concerning trend as older age groups are also more likely to have a greater burden of chronic illness (Global Burden of Disease Study 2013 Collaborators, 2015). Consequently, increasing physical activity levels requires urgent attention from primary health care practitioners and chronic illness specialists.

Our study also found that the intensity of physical activity was a predictor of depression symptoms. Women who were more highly active and participated in sufficient activity to confer a health benefit, reported lower depression severity compared to those who did less than the recommended amount of physical activity per week. This finding suggests that the amount of physical activity (considering frequency and intensity) is an important consideration for women with chronic illness who have depression symptoms. A number of studies have investigated the effects of different types of exercise over varying amounts of time on depression symptoms in a range of chronic illness groups with inconsistent results (Helgadóttir et al., 2017; Herring et al., 2012). However, participation in higher intensity physical activity has been found to confer an additional reduction in depression symptoms compared to lower intensity activities in women with depression (Chu et al., 2009).

Our third key finding was that HRQoL was an important predictor of depression symptoms; although, HRQoL only partially mediated the relation between physical activity and depression with a negligible effect. This result is not robust enough to confirm that a reduction in depression symptoms is partly explained by improvements in HRQoL that are conferred by physical activity. However, the importance of HRQoL as a predictor of depression symptoms is supported by findings of a meta-analysis showing the largest reductions in depression symptoms occur when function-related health outcomes (such as function-related quality of life) are improved (Herring et al., 2012). A sub-study from the Australian Longitudinal Study on Women's Health (ALSWH) has also reported that higher amounts of physical activity (accounting for intensity) were associated with better HRQoL in middle-aged and older women with depression symptoms (Heesch et al., 2015, 2016). Heesch and colleagues (2016) also found that the amount of physical activity engaged in declined over time as did all HRQoL domains, except mental health related quality of life providing further evidence for the need to understand other factors in addition to physical activity that may improve HRQoL in women with chronic illness.

Our research demonstrated that both HRQoL and health-related hardiness are important predictors of depression symptoms when controlling for potential confounding factors. Previous research suggests that health-related factors (e.g. physical activity, smoking, sleep quality) interact with psychological factors (e.g. health-related hardiness) to influence HRQoL (Eschleman et al., 2010; Nicholas, 1993; Smith et al., 2004)—such findings are supported in our study. Consistent with our findings, a sub-study from the ALSWH found that health-related hardiness was an important predictor of HRQoL in older women (Smith et al., 2004). This association has also been found in a number of smaller studies reporting that those higher in health-related hardiness had higher HRQoL scores (Brooks, 2008; Nicholas, 1993). The perceived control dimension of health-related hardiness used in our study is associated with “active coping” and increased participation in health-promoting behaviours, such as physical activity (Eschleman et al., 2010). Having a high amount of health-related hardiness may lead people with chronic illness to engage in health promoting behaviours, such as moderate to vigorous intensity physical activity, which in turn increases their HRQoL. This is an important consideration for future research.

Our findings emphasise the importance of improving HRQoL in women with chronic illness, in order to assist in the management of depression symptoms. Treatment of these women is complex as there are multiple interacting psychological and health-related variables that contribute to HRQoL. Our study also highlights the clinical challenges in managing depression in women with chronic illness. A patient centred approach to managing behavioural risks and effective self-care for depression and chronic physical illness is best achieved with multidisciplinary team-based care (Katon et al., 2010). Further research is needed to determine how to support general practitioners and other health care providers (e.g. psychologists, exercise physiologists) to include physical activity in the primary, secondary and tertiary management of chronic illness.

Limitations

The primary strength of this study was the large sample size. However, limitations of this study need to be noted. First, while the measures utilised in our study are widely used in large

survey designs with each measure demonstrating acceptable psychometric properties they were nevertheless self-report measures which may be affected by recall bias. The current study was restricted in the number of variables included in the mediation analyses. As [this was a cross-sectional study and](#) the relations between the variables included are likely to be more complex and often bidirectional, future studies should consider employing more sophisticated modelling techniques using [longitudinal designs with](#) larger sample sizes to ensure adequate power to provide a more comprehensive understanding of the factors involved in managing HRQoL and depression symptoms in this population.

Conclusion

This is the first known study to explore the relations between physical activity, psychological and health-related factors and depression symptoms in women with chronic illness. We found that engaging in more vigorous physical activity is associated with lower depression severity in women with chronic illness. The findings also suggest that improving HRQoL is a critical consideration for the prevention and management of depression symptoms in women with chronic illness, and psychological and health-related factors that influence quality of life require attention in addition to physical activity. As there is now a strong evidence-base for the benefits of physical activity in managing chronic illness, the next step is to determine the most effective ways of assisting women with chronic illness to improve their HRQoL with consideration of a range of psychological and health related factors.

Declarations of interest

None.

Acknowledgments

This research was completed using data collected through the 45 and Up Study (www.saxinstitute.org.au). The 45 and Up Study is managed by the Sax Institute in collaboration with major partner Cancer Council NSW; and partners: The National Heart Foundation of Australia (NSW Division); NSW Ministry of Health; NSW Government Family & Community Services – Ageing, Carers

and the Disability Council NSW; and the Australian Red Cross Blood Service. We thank the many thousands of people participating in the 45 and Up Study. This study was supported by an Australian Research Council (ARC) Discovery Project (DP140100238), and the ARC supported Distinguished Professor Jon Adams via a Professorial Future Fellowship (FT140100195) while working on this manuscript.

References

- 45 and Up Study Collaborators, 2008. Cohort Profile: The 45 and Up Study. *International Journal of Epidemiology* 37, 941-947.
- Andresen, E.M., Malmgren, J.A., Carter, W.B., Patrick, D.L., 1994. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). *American Journal of Preventive Medicine* 10, 77-84.
- Astell-Burt, T., Feng, X., Kolt, G.S., 2014. Green space is associated with walking and moderate-to-vigorous physical activity (MVPA) in middle-to-older-aged adults: Findings from 203 883 Australians in the 45 and Up Study. *British Journal of Sports Medicine* 48, 404-406.
- Australian Bureau of Statistics, 2007. National Survey of Mental Health and Wellbeing: Summary of Results. Australian Bureau of Statistics, Canberra, Australia.
- Australian Institute of Health and Welfare, 2003. The Active Australia Survey, A guide and manual for implementation, analysis and reporting. Australian Institute of Health and Welfare, Canberra: Australia.
- Balchin, R., Linde, J., Blackhurst, D., Rauch, H.G.L., Schönbacher, G., 2016. Sweating away depression? The impact of intensive exercise on depression. *Journal of Affective Disorders* 200, 218-221.
- Brooks, M.V., 2008. Health-related hardiness in individuals with chronic illnesses. *Clinical Nursing Research* 17, 98-117.
- Brown, W., Bauman, A., Chey, T., Trost, S., Mummery, K., 2004. Method: Comparison of surveys used to measure physical activity. *Australian and New Zealand Journal of Public Health* 28, 128-134.
- Brown, W.J., Ford, J.H., Burton, N.W., Marshall, A.L., Dobson, A.J., 2005. Prospective study of physical activity and depressive symptoms in middle-aged women. *American Journal of Preventive Medicine* 29, 265-272.

- Chu, I.H., Buckworth, J., Kirby, T.E., Emery, C.F., 2009. Effect of exercise intensity on depressive symptoms in women. *Mental Health and Physical Activity* 2, 37-43.
- Clemens, S., Begum, N., Harper, C., Whitty, J.A., Scuffham, P.A., 2014. A comparison of EQ-5D-3L population norms in Queensland, Australia, estimated using utility value sets from Australia, the UK and USA. *Quality Of Life Research* 23, 2375-2381.
- Eschleman, K.J., Bowling, N.A., Alarcon, G.M., 2010. A meta-analytic examination of hardiness. *International Journal of Stress Management* 17, 277-307.
- Furihata, R., Uchiyama, M., Takahashi, S., Suzuki, M., Konno, C., Osaki, K., Konno, M., Kaneita, Y., Ohida, T., Akaoshi, T., Hashimoto, S., Akashiba, T., 2012. The association between sleep problems and perceived health status: A Japanese nationwide general population survey. *Sleep Medicine* 13, 831-837.
- Gebel, K., Ding, D., Chey, T., Stamatakis, E., Brown, W.J., Bauman, A.E., 2015. Effect of moderate to vigorous physical activity on all-cause mortality in middle-aged and older australians. *JAMA Internal Medicine* 175, 970-977.
- George, E.S., Jorm, L., Kolt, G.S., Bambrick, H., Lujic, S., 2012. Physical activity and psychological distress in older men: Findings from the new south wales 45 and Up Study. *Journal of Aging and Physical Activity* 20, 300-316.
- Global Burden of Disease Study 2013 Collaborators, 2015. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 386, 743-800.
- Goldney, R.D., Phillips, P.J., Fisher, L.J., Wilson, D.H., 2004. Diabetes, depression, and quality of life. *Diabetes Care* 27, 1066.
- Greer, T.L., Trombello, J.M., Rethorst, C.D., Carmody, T.J., Jha, M.K., Liao, A., Grannemann, B.D., Chambliss, H.O., Church, T.S., Trivedi, M.H., 2016. Improvements in psychosocial functioning and health-related quality of life following exercise augmentation in patients with treatment response but nonremitted major depressive disorder: Results from the tread study. *Depression and Anxiety* 33, 870-881.
- Gunn, J.M., Ayton, D.R., Densley, K., Pallant, J.F., Chondros, P., Herrman, H.E., Dowrick, C.F., 2010. The association between chronic illness, multimorbidity and depressive symptoms in an Australian primary care cohort. *Social Psychiatry and Psychiatric Epidemiology* 47, 175-184.
- Hayes, A.F., 2009. Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs* 76, 408-420.

- Hayes, A.F., 2013. Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. The Guilford Press, New York.
- Hays, R.D., Martin, S.A., Sesti, A.M., Spritzer, K.L., 2005. Psychometric properties of the Medical Outcomes Study Sleep measure. *Sleep Medicine* 6, 41-44.
- Heesch, K.C., van Gellecum, Y.R., Burton, N.W., van Uffelen, J.G.Z., Brown, W.J., 2015. Physical activity, walking, and quality of life in women with depressive symptoms. *American Journal of Preventive Medicine* 48, 281-291.
- Heesch, K.C., van Gellecum, Y.R., Burton, N.W., van Uffelen, J.G.Z., Brown, W.J., 2016. Physical activity and quality of life in older women with a history of depressive symptoms. *Preventive Medicine* 91, 299-305.
- Helgadóttir, B., Forsell, Y., Hallgren, M., Möller, J., Ekblom, Ö., 2017. Long-term effects of exercise at different intensity levels on depression: A randomized controlled trial. *Preventive Medicine* 105, 37-46.
- Herring, M.P., Puetz, T.W., O'Connor, P.J., Dishman, R.K., 2012. Effect of exercise training on depressive symptoms among patients with a chronic illness: A systematic review and meta-analysis of randomized controlled trials. *Archives of Internal Medicine* 172, 101-111.
- Irwin, M., Artin, K.H., Oxman, M.N., 1999. Screening for depression in the older adult: Criterion validity of the 10-item center for epidemiological studies depression scale (CES-D). *Archives of Internal Medicine* 159, 1701-1704.
- Katon, W.J., 2011. Epidemiology and treatment of depression in patients with chronic medical illness. *Dialogues in Clinical Neuroscience* 13, 7-23.
- Katon, W.J., Lin, E.H.B., Von Korff, M., Ciechanowski, P., Ludman, E.J., Young, B., Peterson, D., Rutter, C.M., McGregor, M., McCulloch, D., 2010. Collaborative care for patients with depression and chronic illnesses. *New England Journal of Medicine* 363, 2611-2620.
- Mayne, D.J., Morgan, G.G., Jalaludin, B.B., Bauman, A.E., 2017. The contribution of area-level walkability to geographic variation in physical activity: A spatial analysis of 95,837 participants from the 45 and Up Study living in Sydney, Australia. *Population Health Metrics* 15, 38.
- McAuley, E., Konopack, J.F., Motl, R.W., Morris, K.S., Doerksen, S.E., Rosengren, K.R., 2006. Physical activity and quality of life in older adults: Influence of health status and self-efficacy. *Annals of Behavioral Medicine* 31, 99-103.
- Mezuk, B., Eaton, W.W., Albrecht, S., Golden, S.H., 2008. Depression and type 2 diabetes over the lifespan: A meta-analysis. *Diabetes Care* 31, 2383-2390.

- Nicholas, P.K., 1993. Hardiness, self-care practices and perceived health status in older adults. *Journal of Advanced Nursing* 18, 1085-1094.
- Perales, F., del Pozo-Cruz, J., del Pozo-Cruz, B., 2014. Impact of physical activity on psychological distress: A prospective analysis of an Australian national sample. *American Journal of Public Health* 104, e91-e97.
- Pollock, S.E., Duffy, M.E., 1990. The Health-Related Hardiness Scale: Development and psychometric analysis. *Nursing Research* 39, 218-222.
- Sawatzky, R., Liu-Ambrose, T., Miller, W.C., Marra, C.A., 2007. Physical activity as a mediator of the impact of chronic conditions on quality of life in older adults. *Health and Quality of Life Outcomes* 5, 68.
- Schuch, F.B., Vasconcelos-Moreno, M.P., Fleck, M.P., 2011. The impact of exercise on Quality of Life within exercise and depression trials: A systematic review. *Mental Health and Physical Activity* 4, 43-48.
- Short, C., E., Hayman, M., Rebar, A., L., Gunn, K., M., De Cocker, K., Duncan, M., J., Turnbull, D., Dollman, J., van Uffelen, J., G. Z., Vandelanotte, C., 2015. Physical activity recommendations from general practitioners in Australia. Results from a national survey. *Australian and New Zealand Journal of Public Health* 40, 83-90.
- Smith, N., Young, A., Lee, C., 2004. Optimism, health-related hardiness and well-being among older Australian women. *Journal of Health Psychology* 9, 741-752.
- Spritzer, K.L., Hays, R.D., 2003. MOS Sleep Scale: A manual for use and scoring, Version 1.0. RAND, Los Angeles, CA.
- Steel, Z., Marnane, C., Iranpour, C., Chey, T., Jackson, J.W., Patel, V., Silove, D., 2014. The global prevalence of common mental disorders: A systematic review and meta-analysis 1980–2013. *International Journal of Epidemiology* 43, 476-493.
- Strine, T.W., Chapman, D.P., 2005. Associations of frequent sleep insufficiency with health-related quality of life and health behaviors. *Sleep Medicine* 6, 23-27.
- van Uffelen, J.G., van Gellecum, Y.R., Burton, N.W., Peeters, G., Heesch, K.C., Brown, W.J., 2013. Sitting-time, physical activity, and depressive symptoms in mid-aged women. *American Journal of Preventative Medicine* 45, 276-281.
- World Health Organization, 2017. World Health Statistics 2017: Monitoring health for the SDGs, Sustainable Development Goals. World Health Organization, Geneva.
- World Health Organization, 2018. Depression. World Health Organization, Geneva.

Table 1.

Demographic characteristics reporting percentage and frequency for regional area, qualification level, marital status, and income management.

Total N = 1,864					
AREA Classification	n	%	Marital status	n	%
Major Cities	881	47.3	Single	146	7.8
Inner Regional Australia	719	38.6	Married	1057	56.7
Outer Regional Australia	208	11.2	De facto/living with partner	88	4.7
Remote	14	0.8	Widowed	309	16.6
Total	1822	97.7	Divorced	215	11.5
Missing	42	2.3	Separated	36	1.9
Highest qualification			Total	1851	99.3
No formal school	138	7.4	Missing	13	0.7
School only	600	32.2	Income management	n	%
Trade/apprentice/diploma	557	29.9	No or little difficulties	1243	66.7
University/higher degree	554	29.7	Some difficulties	413	22.2
Total	1849	99.2	Struggles with income	200	10.7
Missing	15	0.8	Total	1856	99.6
			Missing	8	0.4

Table 2.

Mean scores for depression symptom severity by chronic condition diagnosis.

Health condition	Depression symptom severity (CESD-10)		
	n	M (SD)	95% CI
Asthma	367	6.74 (5.12)	[6.22, 7.27]
Depression	350	10.24 (6.10)	[9.60, 10.88]
Diabetes	375	7.62 (5.48)	[7.06, 8.17]
Osteoarthritis	392	7.24 (5.20)	[6.72, 7.75]
Osteoporosis	380	6.29 (4.98)	[5.79, 6.79]
Total	1,864	7.59 (5.54)	[7.34, 7.84]

Note. The health condition categories were created from the number of respondents who reported a diagnosis of one of the conditions in the base-line 45 and Up Study.

Table 3.

Frequency and percentages for number of physical activity sessions and time spent participating in moderate to vigorous physical activity for each chronic health condition.

Type of physical activity	Type of chronic health condition					Total	p
	Asthma	Depression	Diabetes	Osteoarthritis	Osteoporosis		
	<i>n (%)</i>						
Intensity of physical activity							.01
No physical activity	26 (8.1)	44 (14)	48 (14.4)	37 (10.8)	28 (8.5)	183 (11.2)	
Insufficient activity for health	84 (26.1)	98 (31.1)	100 (30)	104 (30.4)	80 (24.4)	466 (28.4)	
Sufficient activity for health	65 (20.2)	70 (22.2)	65 (19.5)	74 (21.6)	79 (24.1)	353 (21.5)	
Highly active	147 (45.7)	103 (32.7)	120 (36)	127 (37.1)	141 (43)	638 (38.9)	
Total	322 (19.6)	315 (19.2)	333 (20.3)	342 (20.9)	328 (20)	1640 (100)	
Number of physical activity sessions							.05
None	56 (15.6)	70 (20.2)	78 (21)	69 (18)	62 (16.9)	335 (18.3)	
1-2	30 (8.4)	49 (14.1)	50 (13.5)	39 (10.2)	34 (9.3)	202 (11.1)	
3-4	68 (19)	67 (19.3)	61 (16.4)	79 (20.6)	62 (16.9)	337 (18.5)	
5 or more	204 (57)	161 (46.4)	182 (49.1)	196 (51.2)	209 (56.9)	952 (52.1)	
Total	358 (19.6)	347 (19)	371 (20.3)	383 (21)	367 (20.1)	1826 (100)	

Table 4.

Multiple regression predicting depression symptom severity.

Variable	<i>B</i>	95%CI	<i>p</i>
Intercept	24.93	[21.94, 27.91]	<0.001
Age	-0.07	[-0.10, -0.04]	<0.001
Relationship status			
In a relationship	-0.39	[-0.85, 0.08]	0.10
Not in a relationship	0		
Income management			
Struggles with income	1.99	[1.22, 2.75]	<0.001
Some difficulties	0.47	[-0.08, 1.02]	0.10
No or little difficulties	0		
Health condition			
Osteoporosis	-1.70	[-2.42, -0.98]	<0.001
Asthma	-1.71	[-2.40, -1.01]	<0.001
Diabetes	-1.12	[-1.83, -0.42]	<0.001
Osteoarthritis	-2.01	[-2.70, -1.32]	<0.001
Depression	0		
Anxiety disorder diagnosis			
Yes	2.23	[1.64, 2.82]	<0.001
No	0		
BMI	-0.01	[-0.05, 0.02]	0.43
Smoking			
Yes	1.27	[0.31, 2.23]	0.01
No	0		
General health status	-10.00	[-11.34, -8.66]	<0.001
Health hardiness	-0.13	[-0.17, -0.09]	<0.001
Sleep quality			
Not optimal	1.04	[0.61, 1.48]	<0.001
Optimal	0		
Intensity of physical activity			
Highly active	-1.04	[-1.78, -0.30]	0.01
Sufficient activity for health	-0.74	[-1.47, -0.01]	0.05
Insufficient activity for health	-0.44	[-1.11, 0.23]	0.20
No physical activity	0		
Number of physical activity sessions	-0.02	[-0.05, 0.02]	0.34

Table 5.

Model path coefficients for mediation analysis of HRQoL (M) between physical activity (IV) and depression symptom severity (DV) including six covariates

Variable	HRQoL (M)			Depression symptoms (DV) (Direct effect)			Depression symptoms (DV) (Indirect effect)		
	b	SE	p	b	SE	p	b	SE	p
Physical activity (IV)	.0001	.00	< .0001	-.00	.00	< .0001	-.001	.00	.001
HRQoL (M)	-	-	-	-	-	-	-11.48	.59	< .0001
Health-related hardiness (CV)	.01	.00	< .0001	-.27	.02	< .0001	-.15	.02	< .0001
Age (CV)	-.001	.00	.02	-.08	.01	< .0001	-.10	.01	< .0001
Sleep quality (CV)	.05	.01	< .0001	-1.68	.24	< .0001	-1.09	.21	< .0001
Income management (CV)	-.10	.01	< .0001	2.40	.26	< .0001	1.26	.24	< .0001
Smoking (CV)	-.05	.02	.02	2.31	.52	< .0001	1.80	.47	< .0001
Constant	.50	.04	< .0001	21.60	1.18	< .0001	27.31	1.12	< .001

IV = independent variable; M = mediator; DV = dependent variable, CV = covariate.