General Hospital Psychiatry 59 (2019) 30–36

Contents lists available at ScienceDirect

General Hospital Psychiatry

journal homepage: www.elsevier.com/locate/genhospsych

Physical activity correlates among older adults with probable generalized anxiety disorder: Results from The Irish Longitudinal Study on Ageing

C.P. McDowell*, B.R. Gordon, C. MacDonncha, M.P. Herring

Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland
Physical Activity for Health Research Cluster, Health Research Institute, University of Limerick, Limerick, Ireland

ARTICLE INFO

Keywords:
Mental health
Cross-sectional
Worry
Elderly
Generalized anxiety

ABSTRACT

Objectives: This study assessed physical activity (PA) correlates among 1237 (69.0% female; age ≥ 50 years) community-dwelling adults with probable-generalized anxiety disorder (GAD).
Methods: Wave 1 data from The Irish Longitudinal Study on Ageing were analysed. PA was measured using the short-form International PA Questionnaire. Probable-GAD caseness was indicated by a score of ≥23 on the abbreviated Penn State Worry Questionnaire. Potential correlates were analysed using binomial logistic regression. Hierarchical logistic regression consisting of three blocks (sociodemographic variables; quality of life (QoL) variables; physical health and performance variables) examined the proportion of the variance for PA that was explained at each step of the regression model.
Results: Five hundred thirty-five participants (43.2%) met PA guidelines. After adjustment for age and sex, younger age and being male were associated with increased likelihood of meeting PA guidelines. Significant correlates of PA were in employment, higher QoL (CASP-19), social connectedness, and grip-strength. Additionally, polypharmacy (i.e., taking ≥five medications), antidepressant use, at-risk waist circumference (i.e., Males: > 94 cm; Females > 80 cm), up-and-go time, and number of self-reported physical limitations were significantly negatively associated with meeting PA guidelines. Physical health and performance variables explained significant variation (8.4%) in meeting physical activity guidelines beyond that of sociodemographics, and QoL variables.
Conclusions: This study identified a range of sociodemographic, physical, and psychological variables that were associated with meeting or not meeting PA guidelines among older adults with probable-GAD.

1. Background

Generalized anxiety disorder (GAD) is characterized by recurrent or persistent excessive worry about every day, routine life events and activities, occurring most days for at least six months [1]. GAD is prevalent among 3.4% of adults aged ≥66 years and it is estimated that GAD affects 8.9 million people in Europe in a given twelve-month period [2]. Further, as the population in Europe continually ages, this number is expected to increase. GAD is highly comorbid with all other psychiatric disorders, except alcohol abuse, [2–4], and is associated with a high economic [5] and personal burden, including heightened medical comorbidity [6,7], increased healthcare costs [8], and premature mortality [9].

There is an abundance of evidence that adherence with World Health Organization (WHO) physical activity guidelines (i.e., ≥150 min weekly of moderate physical activity, or ≥75 min weekly of vigorous physical activity, or ≥600 metabolic equivalent (MET)·mins of weekly moderate-to-vigorous physical activity; [10]) has important physical and mental health benefits among the general population [11]. However, there may be further benefits to promoting physical activity specifically among people with GAD for several reasons. Specifically, 1) selective serotonin reuptake inhibitors [12], a first-line treatment for GAD, are associated with physical side-effects such as weight gain [13], which could potentially be attenuated or prevented by physical activity; f exercise, a structured form of physical activity intended to improve or maintain one or more components of fitness [14], is an accessible and effective treatment for GAD with minimal risk of negative side effects. For example, in the only exercise randomised controlled trial conducted to date among people with GAD, exercise training improved clinical severity (i.e., remission based on diagnostic interview; [15]), associated signs and symptoms (e.g., tension, fatigue, irritability; [16]), sleep initiation and continuity [17], and health-related quality of life (QoL;

* Corresponding author at: PESS 1039, Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland.
E-mail address: cillian.mcdowell@ul.ie (C.P. McDowell).

https://doi.org/10.1016/j.genhosppsych.2019.04.012
Received 26 September 2018; Received in revised form 16 April 2019; Accepted 17 April 2019

[18]).

Despite these known benefits, people with anxiety disorders are less likely to engage in regular physical activity and display decreasing physical activity levels over time [19,20]. Therefore, in order to optimise the potential benefits of increased physical activity participation for individuals with GAD, it is imperative that the factors which promote or inhibit physical activity participation be better understood. The identification of these key factors which account for variation in physical activity behaviour will increase the efficacy of existing and new policy initiatives and GAD intervention and management programmes. Extant research has identified a range of correlates which potentially may impact physical activity behaviour among the general population [21,22], people with anxiety symptoms assessed by a single question [23,24], and people with depression [25]. These include a wide range of sociodemographic, physical and mental health, and lifestyle factors; however, little information exists on whether correlates that are relevant for increasing physical activity levels in healthy individuals are also relevant to people with anxiety disorders. Therefore, the present study assessed physical activity correlates, selected based on logical, theoretical, and/or prior empirical associations with physical activity [21–25], associated with meeting physical activity guidelines among community-dwelling adults with probable-GAD.

2. Methods

This study used STROBE recommendations to guide reporting [26].

2.1. The Irish Longitudinal Study on Ageing

Data from The Irish Longitudinal Study on Ageing (TILDA) were analysed. TILDA is an ongoing cohort study that contains a nationally representative sample of community dwelling adults aged ≥fifty years, and their partners of any age, resident in the Republic of Ireland. An initial multi-stage probability sample of addresses was chosen by means of the RANSAM sampling procedure [27], with District Electoral Divisions selected at the first stage and household addresses selected at the second stage. The response rate was 62.0%. Wave 1 (2009–2010; [28]) data for adults with GAD aged ≥fifty years who completed the short form International Physical Activity Questionnaire ($n = 1237$) were analysed. Participants missing data for a specific variable(s) were excluded from analyses involving that variable(s) but included in the rest of the analyses. Participants provided full informed consent to participate in the study and ethical approval was obtained from the Trinity College Dublin Faculty of Health Sciences Research Ethics Committee.

2.2. Physical activity

Respondents self-reported the number of days and duration of the vigorous, moderate, and walking activities that they had engaged in during the previous seven days using the short form International Physical Activity Questionnaire [29]. Respondents who reported walking or moderate-to-vigorous physical activity greater than a combined 16 h/day were excluded ($n = 2$). The remaining respondents were classified according to whether they met WHO physical activity guidelines [10].

2.3. Probable-generalized anxiety disorder

At Wave 1, symptoms of worry were assessed using an abbreviated Penn State Worry Questionnaire (PSWQ-A; [30]). In the present sample, the PSWQ-A demonstrated excellent internal consistency (Cronbach's $\alpha = 0.94$). A cut-off score of ≥23 has been shown to correctly predict a GAD diagnosis among older adults with 76–82% sensitivity, 80–93% specificity, and 91% positive predictive value [31,32].

2.4. Sociodemographic variables

Sociodemographic variables included age, sex, highest level of education achieved (completed secondary or less), marital status (married/cohabiting, never married, separated/divorced, or widowed), household size (one, two, or ≥three), household location (urban or rural), and employment status (employed/self-employed vs other).

2.5. Health variables

Health behaviours included alcohol use (weekly vs. less than weekly), smoking (current vs. past/never), and polypharmacy (taking ≥five medications vs not; [33]). Anxiety symptoms were assessed using the anxiety subscale of the Hospital Anxiety and Depression Scale (HADS-A) which has previously been validated in a sample of elderly subjects selected from the general population [34,35]. Caseness of anxiety was indicated by scores ≥8, which has been associated with good sensitivity and specificity [36]. Depression was assessed using the Center for Epidemiological Studies Depression Scale (CES-D; [37]). A cut-off score of ≥16 determined caseness of depression [37]. This cut-score demonstrates 100% sensitivity and 87.6% specificity in older populations [38]. Positive predictive values can be low (13.2%) and negative predictive values can be high (99–100%; [38]). Antidepressant use was self-reported. The Mini-Mental State Examination (MMSE) was used to screen for dementia [39]. A cut-off score of < 21 for those with a primary school education, < 23 for those with a secondary school education, and < 24 for those with graduate/university education determined dementia [40]. QoL was assessed using the CASP-19 [41]. Social connectedness was assessed by four questions: member of a church, married/living with a partner as if married, member of organization excluding the church, and has at least one close relative or friend. Participants were given a score ranging zero to four, with one point added for each criteria they met.

Waist circumference was classified as low- or increased-risk according to WHO guidelines (i.e., Males: > 94 cm; Females > 80 cm; [42,43]). The presence of bodily pain (Y/N) and falls in the last year (Y/N) were self-reported. Participants reported whether a doctor had ever told them that they have angina, asthma, cancer/a malignant tumour, diabetes/high blood sugar, osteoporosis, or a stroke. Respondent's seated blood pressure was measured twice; hypertension was defined as an average systolic score > 140 mm Hg or an average diastolic score greater than 90 mm Hg.

Grip strength was measured with a Baseline (Fabrication Enterprises Inc., White Plains, NY) hydraulic hand dynamometer. The handle was set ensuring that the grip rested on the middle phalanx of the four fingers. The upper arm was kept tight against the trunk and the forearm was kept at a right angle to the upper arm, and the respondent was asked to squeeze the handle with maximum force for a few seconds. The value to the nearest whole number in kilograms was recorded by viewing the scale when held at nose level. Two values were recorded for the dominant hand. Standardised grip strength was derived by dividing a respondent's mean grip score by the sex-specific sample standard deviation.

The timed up-and-go test was performed once [44]. Participants were asked to stand from a seated position, walk 3 m at their usual pace, turn around, walk back to the chair, and sit down. The chair had armrests and the seat was 46 cm high. Walking aids were allowed, and no instructions were given about the use of arms. The time taken from the command “Go” to when the participant was sitting with their back resting against the back of the chair was recorded using a stopwatch. Participants were instructed to walk at their usual pace. Participants were asked whether they had difficulties with walking, running, sitting, sit-to-stand, stair climbing, reaching overhead, stooping, kneeling, crouching, lifting heavy weights, pushing or pulling large objects and picking small coins from table, and the number of reported physical limitations summed.

2.6. Statistical analysis

Statistical analyses were conducted using SPSS Version 22.0 (Armonk, NY: IBM Corp.). Adjusted associations between each correlate and physical activity were assessed with binomial logistic regression adjusting for age and sex. All variables were included in the models as categorical variables except for QoL, timed up-and-go, and grip strength (continuous variables). As 29 logistic regressions were run, the cut-off for statistical significance was set at $P < 0.00172$ (i.e., 0.05/29). P-values between 0.05 and 0.00172 are referred to as nominally significant.

Statistically significant correlates were added to a hierarchical logistic regression model consisting of three blocks: sociodemographic variables; QoL variables; physical health and performance variables. R-square represented the proportion of the variance for meeting the physical activity guidelines that was explained by the regression model at each step. R-square change indicated the improvement in R-square when the second and third blocks were added to the model.

3. Results

A total of 1237 (69.0% female) individuals with probable-GAD were included in analyses. Of these, 43.2% ($n = 535$) met physical activity guidelines. After adjustment for age and sex, significant correlates of physical activity were age (50–59 and 60–69 vs ≥80 years; adjusted for sex, only), being male (adjusted for age, only), and being employed (Table 1). Being married/cohabiting was nominally significant. Additionally, taking less than five medications and having a normal waist circumference, were significantly associated with meeting physical activity guidelines (Table 2). Further, higher MMSE, QoL, social connectedness, and strength, and lower up-and-go time and number of physical limitations were significantly associated with meeting physical activity guidelines. Not taking anti-depressants and not experiencing bodily pain, and not having diabetes or a stroke were nominally significantly associated with meeting physical activity guidelines (Table 2).

Significant correlates in the full hierarchical logistic regression model were sex, waist-circumference, and physical limitations (Table 3). The full model accounted for 17.2% of the variance for meeting the physical activity guidelines. Physical health and performance variables significantly accounted for the greatest proportion of this (R-square change = 0.084; $P < 0.001$).

Table 1
Sociodemographic correlates of PA estimated by multiple logistic regression.

Characteristic	Category	Odds ratio[a]	95% confidence interval	P-value
Age (years)	≥80	REF		
	70–79	2.200	0.919 to 5.266	0.077
	60–69	4.478	1.949 to 10.287	< **0.001**
	50–59	5.185	2.284 to 11.768	< **0.001**
Sex	Female (vs male)	0.560	0.435 to 0.720	< **0.001**
Education	≥Secondary completed (vs less)	1.175	0.921 to 1.498	0.194
Marital status	Married/cohabiting	REF		
	Never married	0.528	0.341 to 0.818	**0.004**
	Divorced/separated	0.724	0.461 to 1.135	0.159
	Widowed	1.215	0.815 to 1.813	0.339
Household size	1	REF		
	2	1.007	0.725 to 1.398	0.968
	≥3	1.110	0.787 to 1.566	0.553
Household location	Rural (vs urban)	1.176	0.927 to 1.493	0.183
Employed	Yes (vs no)	1.578	1.210 to 2.057	< **0.001**

Bold values indicates statisticaly significant at $p < 0.05$.
[a] Model adjusted for age and/or sex.

4. Discussion

4.1. General findings

To the authors' knowledge, this is the first report of physical activity correlates in people with probable-GAD. In this sample of 1237 adults, 43.2% ($n = 535$) of whom met the physical activity guidelines. This is slightly less than that previously reported in older adults [24], potentially due to the use of a stronger measure of GAD in the current study. After adjustment, younger age, being employed, and improved QoL, social connectedness, and grip strength were all positively correlated with meeting physical activity guidelines. Being male or married, taking less than five medications and not taking antidepressants, a normal waist circumference, an absence of pain, diabetes, and stroke, quicker timed up-and-go, and less physical limitations were all correlated with meeting physical activity guidelines.

The present findings that younger age, being male, having a normal waist circumference, and being free of illness were associated with physical activity participation have previously been observed in the general population [45,46]. Similarly, positive associations between social connectedness and meeting physical activity guidelines have previously been reported among older adults [47]. These established associations of social support and meeting guidelines also potentially explain the positive association between employment and physical activity engagement, as employment in older age may provide opportunities for social interaction and engagement [48]. Similarly, marriage may offer a valuable source of social support, potentially explaining the finding that study individuals who were never married were less likely to meet physical activity guidelines, respectively.

The findings that decreased physical limitations, quicker timed up-and-go, and increased grip strength were associated with meeting physical activity guidelines supports previously observed inverse associations between mobility and physical performance and physical activity among older adults with depression and anxiety [23,25]. Furthermore, the finding that increased QoL was associated with meeting physical activity guidelines is consistent with previous evidence that showed improved QoL among people with GAD following a structured exercise intervention (Herring et al., 2016).

Similar to findings among people with schizophrenia, bipolar disorder, and major depressive disorder [49], respondents who took antidepressants were less likely to engage in physical activity. This may be partially explained by poor sleep and fatigue as side effects of medication; however, antidepressant prescription may also serve as a proxy measure for GAD severity. The inverse association between polypharmacy and meeting physical activity guidelines may also be due to adverse effects of the medications; however, it seems more likely that polypharmacy is more common among those with poorer health that may limit physical activity engagement.

There is a substantial body of literature to support the anxiolytic and antidepressant effect of physical activity. In the current study, those who met cut-offs for anxiety and depression were less likely to meet physical activity guidelines; however, differences were not statistically significant. In the current population of people with probable-GAD, those not meeting cut-offs for depression and anxiety still reported higher anxiety and depressive symptoms than those in the general TILDA population without probable-GAD. It is therefore possible that the differences in physical activity participation were smaller than typically observed in the general population, and the current study was not sufficiently powered to provide good precision of this smaller estimated difference.

4.2. Implications

Social support was associated with meeting physical activity guidelines among older adults with probable-GAD. Social support has been shown to play a key role in recovery from affective disorders [50],

Table 2
Health correlates of PA estimated by multiple logistic regression.

Characteristic	Category	Odds ratio[a]	95% confidence interval	P-value
Health behaviours				
Alcohol consumption	Weekly (vs less)	0.912	0.681 to 1.222	0.538
Smoking	Current (vs past/never)	0.871	0.656 to 1.157	0.340
Polypharmacy (i.e., taking ≥5 medications)	Yes (vs no)	0.562	0.415 to 0.763	< **0.001**
Mental health				
Anxiety	Yes (vs no)	0.902	0.686 to 1.187	0.462
Depression	Yes (vs no)	0.795	0.606 to 1.044	0.099
Taking antidepressant	Yes (vs no)	0.679	0.479 to 0.962	**0.029**
Dementia	Yes (vs no)	0.771	0.373 to 1.590	0.481
Quality of life				
Quality of Life Scale	Per unit increase	1.040	1.024 to 1.057	< **0.001**
Social connectedness	Per unit increase	1.331	1.160 to 1.527	< **0.001**
Physical health				
Waist circumference	At risk (vs normal)	0.532	0.391 to 0.724	< **0.001**
Bodily pain	Yes (vs no)	0.679	0.534 to 0.863	**0.002**
Fallen in last year	Yes (vs no)	0.905	0.683 to 1.200	0.488
Angina	Yes (vs no)	0.626	0.343 to 1.142	0.127
Asthma	Yes (vs no)	1.097	0.750 to 1.605	0.634
Cancer	Yes (vs no)	0.890	0.536 to 1.476	0.652
Diabetes	Yes (vs no)	0.585	0.365 to 0.938	**0.026**
Hypertension	Yes (vs no)	0.763	0.573 to 1.017	0.065
Osteoporosis	Yes (vs no)	1.209	0.837 to 1.744	0.312
Stroke	Yes (vs no)	0.065	0.009 to 0.492	**0.008**
Physical performance				
Timed up-and-go (s)	Per unit increase	0.844	0.783 to 0.909	< **0.001**
Grip strength	Per sex-specific SD increase	1.326	1.153 to 1.525	< **0.001**
Number of physical limitations	Per unit increase	0.826	0.782 to 0.872	< **0.001**

Abbreviations: kg: kilograms; s: seconds; SD: standard deviation.
[a] Model adjusted for age and sex.

is inversely associated with mental health in older adults [51], and may, therefore, play an important role in the physical activity–mental health relationship. Policy makers should focus on increasing social support, and reducing social isolation, to help increase physical activity of older adults with GAD.

Secondly, physical activity interventions targeting those who have been prescribed antidepressant medication could prove valuable. Respondents who reported taking antidepressants were less likely to meet the physical activity guidelines. This is a concern because, as previously highlighted, serious side-effects of antidepressant use include weight gain [13] and disturbed sleep (Herring et al., 2015), which can benefit from physical activity and exercise. Additionally, antidepressant use may serve as a proxy for symptom severity, meaning individuals taking antidepressants may further benefit from the established benefits of physical activity for signs and symptoms of GAD.

Thirdly, adults with physical health and performance barriers were less likely to be physically activity. In particular, pain [52] and obesity [53] are highly comorbid with anxiety symptoms and disorders and, in the present study, were associated with 33%–47% lower odds of meeting the guidelines. Hierarchical logistic regression indicated that physical health and performance variables explained significant variation in meeting physical activity guidelines beyond that of sociodemographics and QoL variables. These findings have important implications because physical activity may also improve physical health and performance variables. Improvements in these factors have been associated with improved mental health, but could also substantially reduce the personal burden, including heightened medical comorbidity [6,7] of GAD. Therefore, collaborative interventions for older adults with probable-GAD should not only consider increasing physical activity and improving worry symptoms, but also reductions in weight and pain, and improved physical function. One particularly beneficial form of exercise may be resistance training, which has been shown to improve physical function [54], as well as anxiety [55] and depressive [56] symptoms, in older adults.

4.3. Limitations

Firstly, the cross-sectional design of the study limits the identification of causal inferences, and future prospective research is warranted to investigate these relationships. Secondly, the IPAQ-SF can be predisposed to over-reporting [57] and device-measured physical activity may provide a more reliable estimate [58]. Thirdly, although the PSWQ-A is a useful measure of worry symptoms for epidemiological studies, its low specificity makes it a suboptimal measure of clinical GAD status and likely resulted in an overestimation of the prevalence of GAD. Similarly, anxiety and depression were measured using self-reported symptoms. Although the HADS-A and CES-D are widely used in epidemiological research, clinician administered assessments would offer stronger appraisals. Finally, as previously mentioned, GAD is highly comorbid with many psychiatric disorders. The influence of these comorbidities on the present findings remains unclear and should be further examined in future research.

4.4. Conclusion

Notwithstanding the aforementioned limitations, the present findings support that a range of sociodemographic and physical and psychological factors are associated with meeting or not meeting physical activity guidelines among older adults with GAD. Interventions targeting at-risk groups identified by these correlates are recommended to encourage and facilitate increased physical activity in older adults with GAD.

Acknowledgements

The TILDA study was supported by the Irish Government, the Atlantic Philanthropies, and Irish Life PLC. This work was also supported by the Health Research Board of Ireland (Grant reference: HRA_PHS/2012/30). The sponsors played no role in study design, methods, subject recruitment, data collection, analysis or preparation of the paper.

Table 3
Correlates of meeting physical activity guidelines estimated by logistic regression.

	Characteristic	Category	Model 1			Model 2			Model 3		
			OR	95% CI	P-value	OR	95% CI	P-value	OR	95% CI	P-value
Block one	Sociodemographic										
	Age (years)	≥80	REF			REF			REF		
		70–79	1.387	0.452 to 4.254	0.568	1.215	0.391 to 3.774	0.736	1.104	0.335 to 3.634	0.871
		60–69	1.885	0.656 to 5.417	0.239	1.686	0.580 to 4.903	0.337	1.294	0.411 to 4.075	0.660
		50–59	2.271	0.792 to 6.511	0.127	2.360	0.814 to 6.843	0.114	1.355	0.422 to 4.350	0.610
	Sex	Female (vs male)	0.616	0.446 to 0.851	**0.003**	0.539	0.385 to 0.754	< **0.001**	0.478	0.324 to 0.704	< **0.001**
	Employed	Yes (vs no)	1.538	1.103 to 2.147	**0.011**	1.350	0.958 to 1.903	0.087	1.210	0.844 to 1.734	0.299
Block two	Quality of life										
	Quality of Life Scale	Per unit increase				1.029	1.009 to 1.049	**0.004**	1.011	0.991 to 1.033	0.280
	Social connectedness	Per unit increase				1.282	1.065 to 1.543	**0.009**	1.207	0.995 to 1.465	0.056
Block three	Health behaviours										
	Polypharmacy (i.e., taking ≥5 medications)	Yes (vs no)							0.950	0.611 to 1.477	0.819
	Physical health										
	Waist circumference	At risk (vs normal)							0.618	0.430 to 0.888	**0.009**
	Physical performance										
	Timed up-and-go (s)	Per unit increase							0.942	0.870 to 1.021	0.145
	Grip strength	Per sex-specific SD increase							1.174	0.992 to 1.389	0.061
	Number of physical limitations	Per unit increase							0.837	0.769 to 0.913	< **0.001**
Nagelkerke R square				0.053			0.088			0.172	
R square change (P-value)							0.035 (< **0.001**)			0.084 (< **0.001**)	

Abbreviations: kg: kilograms; s: seconds; SD: standard deviation.

Financial support

This research received no specific grant from any funding agency, commercial or not-for-profit sectors. Brett R. Gordon is funded by the Irish Research Council under the Government of Ireland Postgraduate Programme.

Conflict of interest

The authors have no financial disclosures. The authors disclose no conflicts of interest.

Ethical standard

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Availability of data and materials

Dataset files are publicly accessible and provided by The Irish Longitudinal Study on Ageing. Information on how to access these is available at www.tilda.tcd.ie.

References

[1] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Arlington: American Psychiatric Association; 2013.
[2] Wittchen HU, Jacobi F, Rehm J, Gustavsson A, Svensson M, Jönsson B, et al. The size and burden of mental disorders and other disorders of the brain in Europe 2010. Eur Neuropsychopharmacol 2011;21:655–79.
[3] Grant BF, Hasin DS, Stinson FS, Dawson DA, Ruan WJ, Goldstein RB, et al. Prevalence, correlates, co-morbidity, and comparative disability of DSM-IV generalized anxiety disorder in the USA: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Psychol Med 2005;35:1747–59.
[4] Hunt C, Slade T, Andrews G. Generalized anxiety disorder and major depressive disorder comorbidity in the National Survey of Mental Health and Well-Being. Depress Anxiety 2004;20:23–31.
[5] Bandelow B, Michaelis S. Epidemiology of anxiety disorders in the 21st century. Dialogues Clin Neurosci 2015;17:327.
[6] Roest AM, Zuidersma M, de Jonge P. Myocardial infarction and generalised anxiety disorder: 10-year follow-up. Br J Psychiatry 2012;200:324–9.
[7] Roy-Byrne PP, Davidson KW, Kessler RC, Asmundson GJ, Goodwin RD, Kubzansky L, et al. Anxiety disorders and comorbid medical illness. Gen Hosp Psychiatry 2008;30:208–25.
[8] Chisholm D, Sweeny K, Sheehan P, Rasmussen B, Smit F, Cuijpers P, et al. Scaling-up treatment of depression and anxiety: a global return on investment analysis. Lancet Psychiatry 2016;3:415–24.
[9] Walker ER, McGee RE, Druss BG. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. JAMA Psychiat 2015;72:334–41.
[10] World Health Organization. Global Physical Activity Questionnaire (GPAQ) analysis guide. http://www.who.int/ncds/surveillance/steps/resources/GPAQ_Analysis_Guide.pdf; 2010, Accessed date: 25 June 2018.
[11] Physical Activity Guidelines Advisory Committee. The 2018 Physical Activity Guidelines Advisory Committee scientific report. https://health.gov/paguidelines/second-edition/report.aspx; 2018, Accessed date: 25 June 2018.
[12] Hidalgo RB, Tupler LA, Davidson JR. An effect-size analysis of pharmacologic treatments for generalized anxiety disorder. J Psychopharmacol 2007;21:864–72.
[13] Ruetsch O, Viala A, Bardou H, Martin P, Vacheron M. Psychotropic drugs induced weight gain: a review of the literature concerning epidemiological data, mechanisms and management. Encephale 2005;31:507–16.
[14] Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep 1985;100:126.
[15] Herring MP, Jacob ML, Suveg C, Dishman RK, O'Connor PJ. Feasibility of exercise training for the short-term treatment of generalized anxiety disorder: a randomized controlled trial. Psychother Psychosom 2012;81:21–8.
[16] Herring MP, Jacob ML, Suveg C, O'Connor PJ. Effects of short-term exercise training on signs and symptoms of generalized anxiety disorder. Ment Health and Phys Act 2011;4:71–7.
[17] Herring MP, Kline CE, O'Connor PJ. Effects of exercise on sleep among young women with generalized anxiety disorder. Ment Health and Phys Act 2015;9:59–66.
[18] Herring MP, Johnson KE, O'Connor PJ. Exercise training and health-related quality of life in generalized anxiety disorder. Psychol Sport Exerc 2016;27:138–41.
[19] Hiles S, Lamers F, Milaneschi Y, Penninx B. Sit, step, sweat: longitudinal associations between physical activity patterns, anxiety and depression. Psychol Med 2017;47:1466–77.
[20] McDowell CP, Dishman RK, Vancampfort D, et al. Physical activity and generalized anxiety disorder: results from The Irish Longitudinal Study on Ageing (TILDA). Int J Epidemiol 2018;47(5):1443–53.
[21] Brug J, van der Ploeg HP, Loyen A, Ahrens W, Allais O, Andersen LF, et al. Determinants of Diet and Physical Activity (DEDIPAC): a summary of findings. Int J Behav Nutr Phys Act 2017;14:150.
[22] Sallis JF, Bull F, Guthold R, Heath GW, Inoue S, Kelly P, et al. Progress in physical activity over the Olympic quadrennium. The Lancet 2016;388:1325–36.
[23] Vancampfort D, Stubbs B, Hallgren M, Veronese N, Mugisha J, Probst M, et al. Correlates of physical activity among community-dwelling individuals aged 65 years or older with anxiety in six low-and middle-income countries. Int Psychogeriatr 2017:1–10.
[24] Vancampfort D, Stubbs B, Koyanagi A. Physical activity correlates in people with anxiety: data from 46 low-and middle-income countries. Gen Hosp Psychiatry 2017;49:26–31.
[25] Vancampfort D, Stubbs B, Veronese N, Mugisha J, Swinnen N, Koyanagi A. Correlates of physical activity among depressed older people in six low-income and middle-income countries: a community-based cross-sectional study. Int J Geriatr Psychiatry 2018;33.
[26] Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology [STROBE] statement: guidelines for reporting observational studies. Gac Sanit 2008;22:144–50.
[27] Whelan BJ. Ransam a random sample design for ireland. Econ Soc Rev 1979;10:169.
[28] Barrett A, Burke H, Cronin H, Hickey A, Kamiya Y, Kenny RA, et al. Fifty plus in Ireland 2011: first results from the Irish Longitudinal Study on Ageing (TILDA). https://epubs.rcsi.ie/psycholrep/45/; 2011, Accessed date: 25 June 2018.
[29] Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International Physical Activity Questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35:1381–95.
[30] Hopko DR, Reas DL, Beck JG, Stanley MA, Wetherell JL, Novy DM, et al. Assessing worry in older adults: confirmatory factor analysis of the Penn State Worry Questionnaire and psychometric properties of an abbreviated model. Psychol Assess 2003;15:173.
[31] Crittendon J, Hopko DR. Assessing worry in older and younger adults: psychometric properties of an abbreviated Penn State Worry Questionnaire (PSWQ-A). J Anxiety Disord 2006;20:1036–54.
[32] Wuthrich VM, Johnco C, Knight A. Comparison of the Penn State Worry Questionnaire (PSWQ) and abbreviated version (PSWQ-A) in a clinical and non-clinical population of older adults. J Anxiety Disord 2014;28:657–63.
[33] Gnjidic D, Hilmer SN, Blyth FM, Naganathan V, Waite L, Seibel MJ, et al. Polypharmacy cutoff and outcomes: five or more medicines were used to identify community-dwelling older men at risk of different adverse outcomes. J Clin Epidemiol 2012;65:989–95.
[34] Spinhoven P, Ormel J, Sloekers PPA, et al. A validation study of the Hospital Anxiety and Depression Scale (HADS) in different groups of Dutch subjects. Psychol Med 1997;27(2):363–70.
[35] Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361–70.
[36] Bjelland I, Dahl AA, Haug TT, Neckelmann D. The validity of the Hospital Anxiety and Depression Scale: an updated literature review. J Psychosom Res 2002;52:69–77.
[37] Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Measur 1977;1:385–401.
[38] Beekman A, Deeg D, Van Limbeek J, Braam A, De Vries M, Van Tilburg W. Criterion validity of the Center for Epidemiologic Studies Depression scale (CES-D): results from a community-based sample of older subjects in the Netherlands. Psychol Med 1997;27(1):231–5.
[39] Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–98.
[40] Mitchell AJ. The Mini-Mental State Examination (MMSE): update on its diagnostic accuracy and clinical utility for cognitive disorders. In: S. I. Publishingeditor. Cognitive screening instruments. Switzerland: Springer; 2017. p. 45.
[41] Hyde M, Wiggins RD, Higgs P, Blane DB. A measure of quality of life in early old age: the theory, development and properties of a needs satisfaction model (CASP-19). Aging Ment Health 2003;7:186–94.
[42] Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. Diagnosis and management of the metabolic syndrome. Circulation 2005;112:2735–52.
[43] World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: WHO Technical Report Series 894 vol. 2000. 2000. p. 252 Available at: http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/, Accessed date: 25 June 2017.
[44] Podsiadlo D, Richardson S. The timed "up & go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991;39(2):142–8.
[45] O'Donoghue G, Perchoux C, Mensah K, Lakerveld J, Van Der Ploeg H, Bernaards C, et al. A systematic review of correlates of sedentary behaviour in adults aged 18–65 years: a socio-ecological approach. BMC Public Health 2016;16:163.
[46] Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: review and update. Med Sci Sports Exerc 2002;34:1996–2001.
[47] Smith GL, Banting L, Eime R, O'Sullivan G, Van Uffelen JG. The association between

social support and physical activity in older adults: a systematic review. Int J Behav Nutr Phys Act 2017;14(1):56.
[48] Schwingel A, Niti MM, Tang C, Ng TP. Continued work employment and volunteerism and mental well-being of older adults: Singapore longitudinal ageing studies. Age Ageing 2009;38(5):531–7.
[49] Vancampfort D, Firth J, Schuch FB, Rosenbaum S, Mugisha J, Hallgren M, et al. Sedentary behavior and physical activity levels in people with schizophrenia, bipolar disorder and major depressive disorder: a global systematic review and meta-analysis. World Psychiatry 2017;16:308–15.
[50] Hallgren M, Lundin A, Tee FY, Burström B, Forsell Y. Somebody to lean on: social relationships predict post-treatment depression severity in adults. Psychiatry Res 2017;249:261–7.
[51] Liu L, Gou Z, Zuo J. Social support mediates loneliness and depression in elderly people. J Health Psychol 2016;21:750–8.
[52] McDowell C, Gordon B, Andrews K, MacDonncha C, Herring M. Associations of physical activity with anxiety symptoms and status: results from The Irish Longitudinal Study on Ageing. Epidemiol Psychiatr Sci 2018:1–10. https://doi.org/10.1017/S204579601800001X.
[53] Strine TW, Mokdad AH, Dube SR, Balluz LS, Gonzalez O, Berry JT, et al. The association of depression and anxiety with obesity and unhealthy behaviors among community-dwelling US adults. Gen Hosp Psychiatry 2008;30:127–37.
[54] Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. Cochrane Database Syst Rev 2009;3:CD002759.
[55] Gordon BR, McDowell CP, Lyons M, Herring MP. The effects of resistance exercise training on anxiety: a meta-analysis and meta-regression analysis of randomized controlled trials. Sports Med 2017;47:2521–32.
[56] Gordon B, McDowell C, Hallgren M, Meyer J, Lyons M, Herring M. Association of efficacy of resistance exercise training with depressive symptoms: meta-analysis and meta-regression analysis of randomized clinical trials. JAMA Psychiat 2018;75:566–76.
[57] Lee PH, MacFarlane DJ, Lam TH, Stewart SM. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. Int J Behav Nutr Phys Act 2011;8:115.
[58] Dowd KP, Szeklicki R, Minetto MA, Murphy MH, Polito A, Ghigo E, et al. A systematic literature review of reviews on techniques for physical activity measurement in adults: a DEDIPAC study. Int J Behav Nutr Phys Act 2018;15(1):15.