

Physical Activity Frequency and Depression in Old Age: a Bidirectional Association

Juhendra
Faculty of Psychology
Universitas Negeri Yogyakarta
juhendra.2018@student.uny.ac.id

Rita Eka Izzaty
Faculty of Psychology
Universitas Negeri Yogyakarta
rita_ekaizzaty@uny.ac.id

Yoga Setyo Wibowo
Faculty of Psychology
Universitas Negeri Yogyakarta
yogasetyo.2018@student.uny.ac.id

Abstract

The association between physical activity and mental health has been found bidirectional in the literature. However, evidence of this bidirectional association is lacking from developing countries. This study was aimed at investigating the bidirectional relationship between physical activity frequency and mental health in old age using data from the Indonesia Family Life Survey with a sample of 8,323 old individuals aged between 45 and 90 years. The results revealed that the bidirectional association holds true in old age. Specifically, an increase of one unit in frequency of physical activity is associated with a decrease of 14% in depression after controlling for a set of confounding variables. Similarly, an increase of one unit in depression is associated with a decrease of 3.4% in frequency of physical activity. The results of this study suggest that health policies should take into account the importance of the frequency of physical activity.

Keywords: Frequency of physical activity, mental health, depression, old age, Indonesia.

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Introduction

The global population is aging given the increased life expectancy and the reduced fertility all around the world. In the year 2050, it is expected that the number of people aging 65 and older will be around 1.5 billion, representing 16% of the world population (World Health Organization (WHO, 2011). In the ASEAN region, it is estimated that in the same year, old people will account for 24.2% of the population (Adioetomo & Mujahid, 2014). Indonesia as the most populous country of the region will have around 74 million of old people in 2050 (Kadar, Francis, & Sellick, 2013). It is well known that old age presents a risk factor for developing mental health problems. In fact, the World Health Organization (WHO) (2016) have reported that 7% of the geriatric population suffer from depression.

Depression is a major problem in old age. Depression is defined as a mood disorder that alters people's capacity to think, to be motivated, and brings feelings of hopelessness and helplessness (Segal, Williams, & Teasdale, 2013). In later life, the symptoms of depression

are taken as a normal aging process because of its comorbidities with other illnesses (Mitchell & Vaze, 2010) which makes depression more dangerous in old age. Old individuals too underestimate depressive symptoms (Mui & Yang, 2005) and this is the reason why there are a great number of people living with undiagnosed depression. Depression has a negative effect on people's health. Cronin-Stubbs et al. (2000) found in a longitudinal study that depression increased the likelihood of being disable in a sample of old individuals. Depression has been also associated with suicide in old age. In a study by Snowdon (2001), it was found that depression was a risk factor for suicide attempts among older adults. Similarly, psychological autopsies revealed that the main risk factor of suicide was depression in later life (Conwell, Van Orden, & Caine, 2011). It is therefore important to investigate ways to promote active aging, which means that old adults are enabled to continue participating in activities and carrying out a good life (World Health Organization (WHO), 2002). One way that has been documented to promote active aging and mental health in old age is participating in physical activities (Basso & Suzuki, 2017).

The benefits of physical activity for physical health (Hu et al., 1999; Mandic, Wilson, Clark-grill, & Neill, 2017; Jung, Lee, & Lee, 2018) and mental health (Mikkelsen, Stojanovska, Polenakovic, Bosevski, & Apostolopoulos, 2017; Hosker, Elkins, & Potter, 2018) have been well studied in the literature. The World Health Organization (WHO) (2012) identifies physical activity as a key factor for mental health enhancement. Given that the burden of mental health globally and in old age is depression (Chang & Weng, 2013), several studies have sought to investigate the association between physical activity and depression. These studies report that physical activity reduces the odds of experiencing depression (Doré, Loughlin, Schnitzer, Datta, & Fournier, 2018; Mcphie & Rawana, 2012). There are two competing psychological theories when it comes to explaining the effects of exercise on mental health: the distraction theory and the self-efficacy hypothesis (Mikkelsen et al, 2017). The distraction theory stipulates that doing physical activity provides people with a distraction from negatives thoughts and ruminations of problems while the self-efficacy hypothesis posits that completing an effortful task such as sport provides people with a sense of accomplishment and mastery, which is more likely to enhance mood (Mikkelsen et al, 2017).

A reverse direction of this relationship may be possible as well. In fact, in a literature review analysis, Roshanaei-moghaddam, Katon, and Russo (2009) investigated the longitudinal

effects of depression on physical activity. They concluded that depression was associated with sedentary lifestyle and decreased physical activity. It can be stipulated that when people are depressed, they tend to keep themselves isolated and less energized to participate in physical activities (Kaplan, Lazarus, Cohen, & Leu, 1991). Another explanation may be that people suffering from depression tend to gain weight and meet the criteria for obesity (McElroy et al, 2004) which affect negatively physical fitness and performance.

These findings suggest a bidirectional association between physical activity and depression. A recent study by Azevedo, Silva, and Nabi (2012) investigated this bidirectional association by analyzing longitudinal data at three-time points in eight years. The findings revealed that physical activity and depression are inversely related. In addition, depressed individuals exhibited reduced levels of physical activity. Using latent growth curve analysis, Steinmo, Hagger-Johnson, & Shahab (2014) found that physical activity is a predictor of better mental health and better mental health is a predictor of increased physical activity. Nonetheless, these empirical studies are conducted in developed countries. This bidirectional relationship is understudied in developing countries. Does this bidirectional association hold true in developing countries? Moreover, the frequency of physical activity in relation with mental health is not yet addressed in the context of bidirectional association. Thus, this study is aimed at shining a light on this gap by investigating the bidirectional association between the frequency of physical activity and mental health in Indonesia, using national representative data.

Method

Data

The data come from Indonesian Family Life Survey (IFLS), the 5th wave which took place in the late 2014 and early 2015. IFLS is an ongoing longitudinal socioeconomic and health survey representing around 83% of the entire Indonesian population (Strauss, Witoelar,

& Sikoki, 2016). It provides data information on individuals, their families, households, communities, education as well as on health.

Sample

IFLS5 collected information on 16,204 households and 50,148 individuals (Strauss et al., 2016). The respondents were informed about the background, goals, procedure, risks, and benefits of the survey and were given an informed consent to read and sign (Strauss et al., 2016). In this study, the sample was restricted to individuals of 45 years old and over. After correcting missing data for depression and physical activity frequency, a sample of 8,323 old individuals was yielded.

Measures

Physical activity frequency

The frequency of physical activity served as the outcome and explanatory variable. The survey asked the following question: *Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure. Did you do that for at least 10 min continuously?* (Strauss et al., 2016). Those who answered yes to this question were asked a subsequent question: during the 7 days, how many days did you do that exercise? Possible answers range from 1 to 7. High scores indicate high frequency of physical activity. The mean score is 5.27 (SD=2.27, range= 1-7).

Depression

Depression served as the outcome and explanatory variable and was measured using Center for Epidemiologic Studies Depression Scale, short version with 10 items (e.g. I was bothered by things that usually don't bother me, I had trouble keeping my mind on what I was doing, I felt lonely with answers rarely or none of the time (less than 1 day), some or little of the time (1-2 days), occasionally or moderate amount of time (3-4 days), most or all of the time (5-7 days)) (Andresen, Malmgren, Carter, & Patrick, 1994). In previous studies, internal consistency for the CES-D-10 = (Cronbach's $\alpha=0.86$), Test-retest reliability for the CES-D-10 = (1 CC=0.85), Convergent validity = .91, Divergent validity = .89 (Miller, Anton, & Townson, 2008). The average score for depression is 5.69 (SD= 4.64, range=0-30).

Control variables

There has been evidence of the relationships between gender, marital status, age, level of education, personality, smoking behaviors, religiosity, physical health and mental health and physical activity (Halliday, Kern, & Turnbull, 2019; Kim & Cardinal, 2019; Elavsky & McAuley, 2007; Mehrtash & Ince, 2018; Ipekoglu, Taskin, & Senel, 2019; Ghorbaniamir, Ahmadigatab, & Shayan, 2011). Therefore, we intend to control for these potential confounders of the relationship between physical activity frequency and depression.

Gender is coded with dummy variable 1 for male and 0 for female. Forty-eight % of respondents are male and 52% are female. The mean age is 56.1 (SD= 8.83, range= 45-90). In this analysis, we coded 1 for married individuals and 0 for unmarried ones (single, widow and divorced). Seventy-nine % are married. Education was coded based on the level of education achieved by respondents; 1 for kindergarten (0%), 2 for elementary school and equivalents (61.9%), 3 for junior high school and equivalents (15.4%), 4 for senior high school and equivalents (19.4%) and 5 for high education (3.2%). Religious individuals were given dummy code 1 and 0 for not religious. 84% of respondents reported to be religious. Extraversion was used to account for personality traits of respondents. The average score is 7.12 (SD= 1.32, range= 2-10). Health status was entered into the analysis. Those who reported being healthy and somewhat healthy was given the dummy code 1, and those who reported being somewhat unhealthy and very unhealthy were given the dummy code 0. A measure of subjective poverty was entered as well. The survey asked the following question: Please imagine a six-step ladder where on the bottom (the first step), stand the poorest people, and on the highest step (the sixth step), stand the richest people. On which step are you today (Strauss et al., 2016). Possible answers range between 1 (the poorest) and 6 (the richest). The scores were then reversed; high score indicate high level of subjective poverty. The average score is 4.04 (SD= 1.03, range= 1-6).

Analytical strategy

We first tested a simple model (model 1a) in which the frequency of physical activity is the predictor of depression. A set of other variables that have been shown to be associated with depression were entered (model 1b) to see whether controlling for these confounders

impacted upon the relationship between physical activity frequency and depression. After this, a simple model was modeled (model 2a) in which depression was a predictor of physical activity frequency. A set of confounding variables was entered in the model 2b to account for them. The management of data and analysis of data were performed using R statistical software (Fox & Leverage, 2016).

Results

Descriptive statistics for the outcome, explanatory and confounding variables are summarized in Table I. The test for multicollinearity indicated very small values for all the independent variables (VIF between 1.02 and 1.18) which suggests that there is no multicollinearity between them. Therefore, all the predictors were included in the multivariate analysis.

Results from multivariate analysis are shown in Table 2 for depression as outcome variable, and in Table 3 for frequency of physical activity as outcome variable. The model 1a indicates an inverse association between frequency of physical activity and depression ($\beta = -0.09$, $p < 0.001$). After controlling for potential cofounders, this relationship is still significant and even bigger as shown by the model 1b ($\beta = -0.14$, $p < 0.01$). The model 2a treats frequency of physical activity as the dependent variable and shows an inverse association with depression ($\beta = -0.02$, $p < 0.001$). Even after controlling for confounders, the negative association remain significant ($\beta = -0.02$, $p < 0.01$).

Table I
 Descriptive statistics of the sample

Variable	Min	Max	Mean	SD	%	Mean (SD) Dep	n
Depression	0	30	5.69	4.64			8,276
Phys activity	1	7	5.27	2.27			6,11
Age	45	90	56.1	8.83			8,318
Extraversion	2	10	7.12	1.32			8,278
Subjective poverty	1	6	4.04	1.03			8,257
Social trust	1	4	2.89	1.16			8,318
Gender							
Male					51.5	5.95(4.78)	4,279
Female					48.5	5.41(4.44)	4,039
Education							
Elementary					61.9	5.95(4.83)	4,054
Junior high					15.5	5.66(5.53)	1,013
Senior high					19.5	5.37(4.33)	1,275
High education					3.1	4.42(3.46)	207
Marital Status							
Married					79.7	5.59(4.59)	6,633
Unmarried					20.3	6.09 (4.83)	1,685
Smoking Behaviors							
Smoking					90	5.57(4.51)	3,106
No Smoking					10	6.15(5.18)	345
Religiosity							
Religious					84	5.58(4.60)	5,477
Non-Religious					16	6.30(4.69)	1,033
Self-Rated Health							
Healthy					69.9	5.02(4.26)	5,784
Unhealthy					30.1	7.25(5.10)	2,495

Table 2
Simple and multivariate regression models predicting depression

Variable	Model 1a		Model 1b	
	Coef.	SE	Coef.	SE
Constant	6.25***	0.15	12.8***	1.34
Phys activity frequency	-0.09***	0.02	-0.14**	0.04
Social trust				
Gender (ref. Female)				
Male			-1.30**	0.45
Age			-0.03*	0.01
Education (ref. elementary)				
Junior High School			0.00	0.31
Senior High School			-0.19	0.28
High Education			-0.68	0.68
Marital (ref. unmarried)				
Married			0.72*	0.36
Smoking (ref. non-smoking)				
Smoking			-0.28	0.38
Religiosity (re. non-religious)				
Religious			-0.50	0.27
Extraversion			-0.14	0.08
Self-Rated Health (ref. unhealthy)				
Healthy			-2.37***	0.24
Subjective poverty			0.25*	0.11
Adjusted R2	0.002		0.08	

* P<0.05,**p<0.01,***p<0.001;SE:StandardErrors;SRH:self-ratedhealth

Control variables exhibit significant association with depression and physical activity as well. Males seem to suffer less from depression than females ($\beta=-1.30$, $p< 0.01$) and more frequently do physical activity ($\beta=0.45$, $p< 0.05$). Age is found to be inversely associated with depression ($\beta=-0.03$, $p< 0.05$). Marriage seem to protect individuals from depression ($\beta=-0.72$, $p< 0.05$) but is not associated with physical activity frequency. Social trust and smoking behaviors are negatively associated with frequency of physical activity, ($\beta=-0.10$, $p< 0.05$) and ($\beta=-0.51$, $p< 0.01$) respectively. As it may be expected, healthy individuals suffer less from depression than unhealthy ($\beta=-2.37$, $p< 0.001$). Surprisingly, subjective poverty exhibits positive association with depression ($\beta=0.25$, $p< 0.05$).

Table 3
Multivariate regression model predicting physical activity frequency

Variable	Model 2a		Model 2b	
	Coef.	SE	Coef.	SE
Constant	5.40***	0.04	5.18***	0.67
Phys activity frequency	0.02***	0.00	-0.034**	0.01
Social trust			-0.10*	0.04
Gender (ref. Female)				
Male			0.45*	0.22
Age			0.00	0.00
Education (ref. elementary)				
Junior High School			0.02	0.15
Senior High School			-0.32*	0.14
High Education			-0.46	0.33
Marital (ref. unmarried)				
Married			-0.07	0.18
Smoking (ref. non-smoking)				
Smoking			-0.52**	0.19
Religiosity (re. non-religious)				
Religious			-0.02	0.13
Extraversion			0.01	0.04
Self-Rated Health (ref. unhealthy)				
Healthy			-0.07	0.12
Subjective poverty			-0.03	0.05
Adjusted R2	0.002		0.01	

* P<0.05, **p<0.01, ***p<0.001; SE:StandardErrors; SRH:self-ratedhealth

Discussion

This cross-sectional study investigated the associations between frequency of physical activity and mental health in old age, using national representative data from the Indonesian Family Life Survey, 5th wave. The main results indicate that an increase of one unit in frequency of physical activity is associated with a decrease of 14% in depression after controlling for confounding variables. Parallels, an increase of one unit in depression is associated with a decrease of 3.4% in frequency of physical activity. It seems that the frequency of physical activity is a better predictor of depression than is depression for physical activity frequency.

The findings of this study confirm the existence of a bidirectional association between physical activity frequency and depression even in developing countries. Previous studies reported a bidirectional association in developed countries (Azevedo et al., 2012; Steinmo et al., 2014). This means that doing physical activity frequently leads to better mental health which in turn increases the frequency of physical activity.

The mechanisms by which physical activity benefit mental health are unclear, however, some explanations have been proposed. At the physiological level, physical activity allows endorphins to be secreted, which in turn creates feelings of calm and good mood (Basso & Suzuki, 2017). Another physiological explanation is the antidepressant effect of physical activity. In fact, physical activity is thought to allow the synaptic transmission of amines which have antidepressant effects (Ransford, 1982). In addition, physical activity is assumed to improve cognitive processes (Giorgio, Kuvacic, Milic, & Padulo, 2018). At the psychological level, it has been proposed that physical activity increases a sense of perceived mastery and self-efficacy by presenting challenging activities (North, McCullagh, & Tran, 1990). At the psychosocial level, physical activity increases social relationships by allowing individuals involved into it to interact with peers and receive social support from them (Smith, Banting, Eime, Sullivan, & Uffelen, 2017). Finally, why do depressed individuals do exercise less frequently? The explanation may be that depressed people tend to withdraw from social interactions and isolate themselves which may knock down the motivation for physical activity (Kaplan, Lazarus, Cohen, & Leu, 1991).

Other findings concern control variables. This study found that males suffer less from depression compared to females. It seems that marriage acts as a protective factor against depression. Married individuals exhibited negative association with depression. As expected, healthy individuals reported decreased levels depression. Previous studies found that marriage, gender and self-rated health were predictive of subjective wellbeing (Ndayambaje, Pierewan, Nizeyumukiza, Nkundimana, & Ayriza, 2020), and mental health (Nizeyumukiza, Pierewan, Ndayambaje, & Ayriza, 2021).

This study has several strengths. First, to our knowledge, it is the first to investigate the bidirectional association between physical activity and mental health in a developing country. Second, the data used has a national scope. Third, the multivariate analysis allowed to control for a set of potential confounders including self-rated health, personality, education, subjective poverty and marital status. However, it is not without limitations. First, the cross-sectional nature of this study limits it to assume any causation. Second, the sample is from the general population, thus, we cannot know whether this bidirectional association would hold true with a sample from clinical cases. Future research should use longitudinal designs on a clinical population.

Conclusion

Using national representative data, a bidirectional association is found between frequency of physical activity and mental health in old age. Doing physical activity frequently leads to better mental health which in turn leads to high frequency of physical activity. These findings are relevant especially in the field of policy making and geriatric health care. We stipulate that mental health in old age can be improved by increasing the frequency of physical activity.

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Conflicts of Interest

The authors declare no conflicts of interest.

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