Different Levels of Physical Activity, Physical Health, Happiness, and Depression among Older Adults with Diabetes

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Abstract

The purpose of this study was to investigate the relationship between different levels of physical activity (light, moderate, and vigorous), physical health, happiness, and depression among older adults with diabetes. Using data from the National Social Life, Health and Aging Project (NSHAP) Wave 3, the results indicate that moderate and/ or vigorous physical activity is more effective than light physical activity for promoting physical health and happiness and lowering depression of older adults with diabetes. This study suggests that activity professionals and therapists working with older adults with diabetes need to encourage their participation in physical activity as well as adjust a level of physical activity intensity that is tailored to participants' needs and expectations.

Diabetes among the adult population within the United States continues to increase with over 26.8% of adults aged 65 years or older living with this diagnosis (American Diabetes Association, 2018). Becoming more common within the adult population, diabetes can compromise health outcomes in various ways ultimately impacting one's quality of life. Research has shown that older adults with diabetes experience a variety of adverse health issues, such as geriatric syndrome (e.g., depression, cognitive decline, risk of falls, and physical pain), impaired physical functions, and premature death (American Diabetes Association, 2018). In particular, Rodrigues et al. (2016) has found that older adults with diabetes-related health issues were at elevated risks for depression, anxiety, and social isolation. These health complications have increased with the current onset of COVID-19 among those living with Diabetes, including the ability to engage in psychosocial experiences as well as engagement in preventative measures, such as physical activity.

A growing body of literature has suggested that increasing physical activity as an effective and preventative strategy to enhance physical and mental health of older adults (Scarmeas et al., 2001; Wilson et al., 2002). Feldman et al. (2015) demonstrated that regular physical activity has been associated with improved physical strength and functions, a lower mortality risk, and better health outcomes (e.g., longevity). For example, a meta-analysis of 36 studies (Netz et al., 2005) found that older adults who participated in physical activity programs reported higher levels of psychological wellbeing (e.g., emotional health, self-perceptions, and life satisfaction) than those who did not.

Recently, evidence has been accumulated that the importance of physical activity for physical and mental health in the general population of older adults also applies to older adults with diabetes (Chudyk & Petrella, 2011; Colberg et al., 2016). Studies have shown that participation in physical activity resulted in physical health improvements such as blood pressure reduction, increased insulin sensitivity, and improved glycemic control (Chudyk & Petrella, 2011; Colberg et al., 2016). Accordingly, the American Diabetes Association recommends that adults with diabetes to engage in aerobic exercise for at least 150 minutes per week and resistance exercise at least twice a week (Yardley et al., 2014). While the physical health benefits of physical activity

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for older adults with diabetes have been established, however, little information exists on how physical activity is associated with their mental health.

In addition, some studies have addressed the effects of different levels of intensity of physical activity on the health of people with diabetes (Ekelund et al., 2009; Lee et al., 2005) and found that moderately-intense physical activity increased metabolism. On the other hand, Jelleyman et al. (2015) found that high-intensity physical activity was more effective for improving cardiovascular symptoms and glycemic control of older adults with diabetes than continuous moderate intensity physical activity. These contradictory findings in the literature may be due in part to differences in study design, inquiry methods, representativeness of the sample, and sample size and related statistical power. These mixed findings indicate the need for further research to reach consensus on recommended intensity levels of physical activity for physical and mental health of older adults with diabetes.

To help closing this gap in the literature, the present study is an investigation of how different levels of physical activity are associated with the physical and mental health of older adults with diabetes. Toward this end, we compared measures of physical and mental health among three groups of older adults with diabetes who engaged in different levels of physical activity (light, moderate, and vigorous).

Physical Activity and Diabetes

It is well documented that physical activity has a positive effect on preventing diabetes as well as promoting physical health (e.g., increased stamina and improved glycemic control, reduction of blood pressure, and maintenance of weight loss) among people with diabetes (Chudyk & Petrella, 2011). Some studies have found that participation in moderate levels of physical activity (e.g., walking, meditative exercises, Tai Chi, and yoga) decreased the risk of diabetes and reduced the risk of cardiovascular events and mortality rates of people with diabetes. For example, Koska et al. (2018) conducted a randomized clinical trial to investigate the effects of walking as a form of moderate physical activity on diabetes among older adults and found that it reduced the prevalence of diabetes. In a review of the literature on the effects of Tai Chi on balance improvement, Palermi et al. (2020) found that people with diabetes improved their physical balance through Tai Chi exercise.

Other studies suggest that high intensity physical activity produces health benefits among people with diabetes. In a meta-analysis, Liubaoerjijin et al. (2016) found that as compared to lower-intensity exercise, higher-intensity exercise had a higher association with a reduction of glycated hemoglobin of people with type 2 diabetes. In addition, epidemiological studies based on cohort data provide statistical evidence on the benefits of high intensity physical activity, which is not only more effective than low intensity physical activity to

reduce the risk of diabetes but also positively affects the incidence of cardiovascular and mortality events (Yates et al., 2014).

As noted, in light of these mixed findings, one purpose of the present study was to examine the effects of different intensity levels (light, moderate, and vigorous) of physical activity on the physical health of older adults with diabetes. In addition, as no previous study has investigated the associations between different levels of intensity of physical activity and mental health outcomes among older adults with diabetes, another purpose was to examine the effects of different levels of intensity of physical activity on their mental health measures including happiness and depression.

Methods

Sample

Data was from the National Social Life, Health and Aging Project (NSHAP) Wave 3, which published in 2016. NSHAP is a population-based study which collected data on self-rated health perception, diseases/disorders, psychological status, and activities of older adults in the United States. The total number of interviews in NSHAP wave 3 was 4,777. From this sample, we extracted 709 respondents who were diagnosed with diabetes and included such variables as health perception, self-rated happiness, scores on the Center for Epidemiologic Studies Depression Scale (CES-D), and physical activity participation.

Measures

Physical activity. Intensity of physical activity was measured by one question: "On average over the last 12 months, how often have you participated in vigorous physical activity or exercise? By vigorous physical activity, we mean 30 minutes or more of things like sports, exercise classes, heavy housework, or a job that involves physical labor." Respondents rated the intensity of their activity on a five-point scale (0 = "never," 1 = "less than 1 time per month," 2 = "1-3 times per month," 3 = "1-2 times per week," 4 = "3-4 times per week," 5 = "5 or more times per week"). In line with the recommendations of the Physical Activity Scale for Elderly (PASE), respondents were classified into three groups based on the frequency of their participation in physical activity: a light intensity group (1-2 times a week), a moderate group (3-4 times/a week), and a vigorous group (5 or more times/a week).

Physical health. Physical health was measured by a single item: "This section is about your physical health. First, we would like to ask you some general questions. Would you say your health is excellent, very good, good, fair, or poor? (Use hand card)" The respondents rated their self-assessed general physical health on a five-point scale

(1 = "poor," 2 = "fair," 3 = "good," 4 = "very good," 5 = "excellent"), with higher scores indicating better perceived physical health. This measurement has been widely applied to health studies.

Happiness. Happiness was measured by a single item: "If you were to consider your life in general these days, how happy or unhappy would you say you are, on the whole. . .?" The respondents rated their general happiness with a five-point scale (1 = "unhappy usually," 2 = "unhappy sometimes," 3 = "pretty happy," 4 = "very happy," 5 = "extremely happy"), with higher scores indicating greater happiness. Pavot (2018) found that measuring happiness by a single item was reliable, valid, and viable in health studies.

Depression. To measure a level of depression, the Center for Epidemiologic Studies Depression Scale (CES-D) was used. This revised 8-item version was recommended for older adults rather than the original 20-item version because the original version was considered taxing for older adults and a revised 8-item version is strongly correlated (Pearson $r = 0.95$, $n = 2,339$) with the original version (Kohout et al., 1993). The eight items we used covered the topics "appetite," "depression," "effort," "sleep," "unfriendliness," "sadness," "dislike," and "get-go." For instance, the item for "depression" was "During the past week, I felt depressed." The items were rated on a four-point scale (0 = "rarely or none of time," 1 = "some of the time," 2 = "occasionally," 3 = "most of the time"), and higher scores indicated more severe depression. The Cronbach's alpha for all eight items on depression was 0.78.

Covariance, Age, and Gender

This study adjusted for the effects of age and gender. Demographic factors such as age and gender are significant covariates in examining the health status of older people and evaluating their chronic diseases. For example, activity limitations among women were greater than among men, as well as among all elderly persons. The extent of activity limitations has a negative relationship with physical activity participation and social participation (World Health Organization, 2001). Accordingly, to control the demographic effect, in this study age and gender variables were set as covariates.

Data Analysis

Prior to the main analysis, a descriptive analysis, a Pearson's correlation analysis, and scale reliability tests were conducted. Next, a covariance analysis was performed to initially verify the association between covariance and dependent variables. In the last phase, to control the leverage of the covariate, a Multivariate Analysis of Covariance (MANCOVA) ($\alpha = 0.5$) was conducted to examine differences in the dependent

Table 1. Frequencies of Participant Characteristics.

Characteristics	*n* (%)
Age	
50–59	186 (26.2)
60–69	262 (37.0)
70–79	175 (24.7)
80–89	78 (11.0)
90–93	8 (1.1)
Gender	
Male	357 (50.4)
Female	352 (49.6)
Marital status	
Married	432 (60.9)
Living with a partner	29 (4.1)
Separated	18 (2.5)
Divorced	92 (13.0)
Widowed	91 (12.8)
Never married	47 (6.6)
Physical activity	
Light	263 (37.1)
Moderate	185 (26.1)
Vigorous	261 (36.8)

Note. Total $n = 709$.

variables. In summary, we investigated the difference in the result variables (i.e., physical health, happiness, depression) according to the frequency of physical activity participation under conditions of controlling for age and gender. All statistical procedures were performed using SPSS 25.0 statistical package.

Results

Descriptive Statistics

Table 1 provides an overview of the participants' basic characteristics. The respondents' age range was categorized into 10-year generations from 50 to 93 years old ($M = 66.5$ $SD = 9.85$). Genders were represented in similar proportions in the respondent pool: 50.4% male and 49.6% female. Over half of the participants were married (60.9%), 4.1% were living with a partner, 2.5% were separated, 13.0% were divorced, 12.8% were widowed, and 6.6% were never married. Of the participants' physical activity frequency, 37.1% were low frequency (less than one time per week), 26.1% were mid frequency (less than three times per week), and 36.8% were high frequency (more than five times per week).

Table 2 provides the mean and standard deviations of the independent variables and dependent variables. Measures of physical health, happiness, and depression were self-rated method. Physical health ($M = 2.76$, $SD = 1.00$) and happiness ($M = 3.35$, $SD = 1.0$) variables were measured with a six-point Likert scale. Depression was measured by the brief CES-D scale. The respondents' depression was measured with the CES-D's four-point Likert scale ($M = 13.41$, $SD = 4.52$).

Table 2. Descriptive Statistics.

Variables	Mean	SD
Physical health		
Low	2.34	0.91
Mid	2.86	0.89
High	3.11	0.91
Happiness		
Low	3.16	1.05
Mid	3.35	0.99
High	3.54	0.91
Total	3.35	1.00
Depression		
Low	14.73	5.03
Mid	13.03	4.08
High	12.34	3.91
Total	13.41	4.52

Note. Total $n = 709$.

The correlation coefficient matrix (Table 3) shows that all of the variables were significantly correlated with each other, excluding the relationship between age and gender. The correlation coefficients of physical activity and all dependent variables ranged from −0.470 to 0.348. All the magnitude of correlation coefficients on Table 3 satisfied the subsequent statistical assumptions and indicated no problems associated with multicollinearity.

The MANCOVA results (Table 4) present significant differences among the levels of physical activity participation with reference to the outcome variables, physical health, happiness, and depression (Pillai's Trace = 0.132, $F = 16.528$, $p < .01$). Both age (Pillai's Trace = 0.032, $F = 7.754$, $p < .01$) and gender (Pillai's Trace = 0.017, $F = 4.001$, $p < .01$), which showed covariance, showed significant differences in physical health, happiness, and depression. Because there were significant differences in the three dependent variables depending on the level of physical activity participation, a univariate analysis (MANCOVA) and post hoc test (Bonferroni) were computed.

Table 5 shows the mean and standard deviations, which were adjusted by covariance. The age and gender factor as covariance presented significant differences in physical health, happiness, and depression (Table 4) and strongly correlated with all dependent variables (Table 3). The results of the adjusted mean and standard deviation were controlled by the covariate. In the happiness and depression measurements, the mean increased and the standard deviation decreased when age and gender factors were adjusted. The standard deviation of physical health increased, although the mean was only slightly affected by covariance control.

Table 6 shows the covariance effect of age and gender as well as the main effect of physical activity participation. The covariate effect of age was significant on all dependent variables, physical health ($F = 12.07$, $p < .01$, $\eta^2 = 0.02$), happiness ($F = 11.93$, $p < .01$, $\eta^2 = 0.02$), and depression ($F = 16.40$, $p < .01$, $\eta^2 = 0.02$). The covariate effect of gender was significant only on depression ($F = 9.50$, $p < .01$, $\eta^2 = 0.01$). The main effect of physical activity was significant to all dependent variables. Participants who engaged in different levels of physical activity showed commensurate levels of physical health ($F = 47.02$, $p < .01$, $\eta^2 = 0.12$), happiness ($F = 9.706$, $p < .01$, $\eta^2 = 0.03$), and depression ($F = 20.51$, $p < .01$, $\eta^2 = 0.06$).

Specifically, to examine the mean differences in physical activity, a Bonferroni post hoc test (Table 7) was conducted for the three dependent variables (i.e., physical health, happiness, and depression) to determine whether mean differences in physical health, happiness, and depression were significant depending on the level of participation in physical activity (light, moderate, and vigorous). First, participants who engaged in light levels of physical activity showed lower physical health than those who pursued moderate and vigorous levels of physical activity ($MD = -0.545$, $SE = 0.091$, $p < .05$; $MD = -0.792$, $SE = 0.083$, $p < .05$), and participants with vigorous levels of physical activity presented higher physical health scores than those who engaged in moderate physical activity ($MD = -0.247$, $SE = 0.091$, $p < .05$). Second, participants pursuing vigorous level physical activity had higher happiness scores than those who participated in physical activity at light levels ($MD = 0.381$, $SE = 0.00$, $p < .05$). Finally, participants reporting light levels of physical activity had higher depression scores than those who participated in physical activity at both a vigorous level ($MD = 1.768$, $SE = 0.00$, $p < .05$) and a moderate level ($MD = 2.377$, $SE = 0.00$, $p < .05$).

Discussion

The present study was an initial exploration of how different intensity levels of physical activity may be associated with levels of physical health, happiness, and depression of older adults with diabetes. The findings showed that different levels of intensity of physical activity are associated with physical and mental health of this population. Participants who engaged in moderate and vigorous physical activity reported higher levels of physical health than those who practiced light physical activity. In addition, participants who engaged in vigorous physical activity reported higher physical health than those engaging in moderate physical activity. In terms of the association between intensity levels of physical activity and mental health, participants who participated in vigorous physical activity reported higher levels of happiness and lower levels of depression than those who engaged in light physical activity. This study indicates that moderate and/or vigorous physical activity is more effective than light physical activity for promoting physical health and happiness and lowering depression of older adults with diabetes.

Table 3. Correlation Coefficient Matrix.

Variables	Age	Gender	Physical activity	Physical health	Happiness	Depression
Age	1					
Gender	−0.011	1				
Physical activity	−0.083*	−0.121**	1			
Physical health	0.091*	−0.031*	0.328**	1		
Happiness	0.115**	−0.092*	0.162**	0.348**	1	
Depression	0.00	0.00	0.00	−0.31**	−0.47**	1

$**p < .01$. $*p < .05$.

Table 4. Multivariate Test for Physical Health, Happiness, and Depression.

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's trace	0.459	198.13	3	702.00	.00**
Age	Pillai's trace	0.032	7.754	3	702.00	.00**
Gender	Pillai's trace	0.017	4.001	3	702.00	.00**
Physical activity	Pillai's trace	0.132	16.528	6	1,406.00	.00**

Note. Design: Intercept + age + gender + physical activity.
$**p < .01$.

Table 5. Adjusted and Unadjusted Means for Physical activity by Age and Gender covariates.

Variables	Unadjusted mean	Unadjusted SD	Adjusted mean	Adjusted SD
Physical health				
Light	2.34	0.91	2.32	0.06
Moderate	2.86	0.89	2.87	0.07
Vigorous	3.11	0.91	3.12	0.06
Happiness				
Light	2.76	1.00	3.15	0.06
Moderate	3.16	1.05	3.36	0.07
Vigorous	3.35	0.99	3.53	0.06
Depression				
Light	14.73	5.03	14.75	0.27
Moderate	13.03	4.08	12.98	0.32
Vigorous	12.34	4.52	12.37	0.27

Note. Covariates appearing in the model are evaluated at the following values.
Age = 66.55, Gender = 1.50.

Table 6. Summary of Univariate Analyses.

Source	Dependent variable	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Corrected model	Physical health	89.96[a]	4	22.49	25.38	.00**	0.13
	Happiness	33.84[b]	4	8.46	8.79	.00**	0.05
	Depression	1,280.64[c]	4	320.15	17.07	.00**	0.09
Age	Physical health	10.70	1	10.69	12.07	.00**	0.02
	Happiness	11.48	1	11.47	11.93	.00**	0.02
Gender	Depression	307.54	1	307.54	16.40	.00**	0.02
	Physical health	0.09	1	0.09	0.101	.751	0.00
	Happiness	3.49	1	3.49	3.63	.057	0.01
Physical activity	Depression	178.08	1	178.09	9.50	.00**	0.01
	Physical health	83.34	2	41.67	47.02	.00**	0.12
	Happiness	18.67	2	9.34	9.70	.00**	0.03
	Depression	769.07	2	384.53	20.51	.00**	0.06

Note. [a]$R^2 = 0.121$.
[b]$R^2 = 0.048$.
[c]$R^2 = 0.83$.
$**p < .01$.

Table 7. Post Hoc Test for Group Means of Physical Activity.

Dependent variable	Physical activity (*I*)	Physical activity (*J*)	Mean difference (*I−J*)	Sig.	Bonferroni
Physical health	Light	Moderate	−0.545	.00*	Mode > light
		Vigorous	−0.792	.00*	Vigor > light
	Moderate	Vigorous	−0.247	.02*	Vigor > mode
Happiness	Light	Moderate	−0.209	.08	
		Vigorous	−0.381	.00*	Vigor > light
	Moderate	Vigorous	−0.172	.21	
Depression	Light	Moderate	1.768	.00*	Mode > light
		Vigorous	2.377	.00*	Vigor > light
	Moderate	Vigorous	−0.610	.43	

Note. Bonferroni post hoc test.
*$p < .05$.

It is well-documented that moderate-to-vigorous physical activity is effective in promoting physical health among people with diabetes (Chudyk & Petrella, 2011). Some studies suggest that moderate physical activity leads to better physical health outcomes than vigorous physical activity (Koska et al., 2018; Palermi et al., 2020); while others found that vigorous physical activity is more effective (Liubaoerjijin et al., 2016). This study supports the greater effectiveness of vigorous levels of physical activity for better physical health outcomes than moderate levels. Based on our exploration of the psychometrics of perceptions of physical health, our interpretation is that older adults with diabetes who frequently engage in vigorous physical activity tend to rate their physical health higher than do those who participate in moderate physical activity.

Prior investigations of the relationship between levels of physical activity and happiness in the general population within international contexts (Kye et al., 2014; Piqueras et al., 2011) demonstrated that physical activity levels are positively associated with happiness. Our study is consistent with these findings by showing that older adults with diabetes who engaged in vigorous intensity physical activity had higher happiness scores than those who reported light intensity physical activity. This finding suggests that the intensity levels of physical activity can play an important role in increasing a sense of happiness among older adults with diabetes.

In terms of the relationship between the intensity of physical activity and depression among older adults, previous studies yielded mixed findings. Some indicated that older adults who participated in vigorous activities reported low depressive symptoms (Chi et al., 2015; Joshi et al., 2016). Others demonstrated that light intensity physical activity had a protective effect against depressive symptoms (Heesch et al., 2011; Jung et al., 2018). They investigated the relationship between physical activity and depression among adults with diabetes, indicated that high intensity physical activity can generate physical and mental fatigue and increase depression and recommended the moderate levels of physical activity as ideal for this population.

Our study supports the claim that moderate intensity physical activity can be more effective than vigorous intensity physical activity in reducing depressive symptoms. However, our study also found that older adults with diabetes who engaged in vigorous physical activity reported lower depressive symptoms than those participating in light intensity physical activity. These mixed findings suggest that older adults' functional abilities and demographic variables may affect depressive symptoms as well as levels of physical activity participation.

Limitations and Future Studies

Some limitations need to be addressed in this study. First, this study mainly focused on the associations between different levels of physical activity and mental health among older adults with diabetes without specifying the nature of the activities. Different types of activities, such as sports, aquatics, aerobic exercise, and resistance exercise, may influence physical health perceptions and mental health among participants. Future studies might explore the relationship between types of physical activity and health benefits. Second, this secondary data did not include information about the main types of diabetes (e.g., type 1 and type 2) among older adults. The main types of diabetes may affect the frequency of physical activity participation among older adults and its effects on health benefits. Future studies are needed to investigate differences in health outcomes related to intensity of physical activity between the main types of diabetes. Also, this study is based on a cross-sectional design and longitudinal analysis is needed to examine the cause and effect relationship between physical activity participation and health benefits among people with diabetes. Last, other variables such as physical limitations, demographic variables (e.g., education backgrounds), and time of onset of diabetes may be additional factors influencing physical activity participation among older adults with diabetes. Understanding the relationships of these variables to physical activity participation and health benefits can

provide more insightful information to researchers and health care providers.

Conclusion

This study was an initial exploration of the differences in physical and mental health among older adults with diabetes participating in different intensity levels of physical activity. Overall, the results of this study show that different intensity levels of physical activity are associated with physical and mental health and suggest that moderate to vigorous intensity physical activity can be more effective in increasing physical health and happiness and reducing depressive symptoms among older adults with diabetes. This study suggests that activity professionals and therapists working with older adults with diabetes need to encourage their participation in physical activity as well as adjust a level of physical activity intensity that is tailored to participants' needs and expectations.

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