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# Relationships between physical activity, social isolation, and depression among older adults during COVID-19: A path analysis



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## ABSTRACT

**Background:** There are known significant relationships between greater physical activity and less depression, and greater social isolation and greater depression; therefore, it is important to understand these relationships among older adults during COVID-19.

**Methods:** The Physical Activity Scale for Elders, Geriatric Depression Scale, and PROMIS Social Isolation were administered. Path analysis was performed to evaluate the relationship between physical activity, social isolation, and depression.

**Results:** 803 surveys were received. Consistent with our a-priori model, higher social isolation predicted greater depression. ( $p < 0.001$ ).

**Conclusion:** Older adults may suffer a high emotional price during times of imposed social distancing.

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## Introduction

The negative consequences of social isolation and physical inactivity as they relate to mental health in older adults are well known.<sup>1,2,3</sup> During the COVID-19 pandemic, a new phenomenon occurred in terms of imposed social isolation.<sup>4</sup> It is possible that increased social isolation as a result of public policies to shelter in place and personal concerns about exposure, created an environment of loneliness for older adults.<sup>4,5</sup> This pandemic-imposed social isolation may be more prevalent in older adults than in the general population given the higher risk of depression, and morbidity and mortality from COVID-19 in this population.<sup>6</sup> Further, reduced physical activity and its ramifications during COVID-19 has been widely reported in the literature.<sup>6,7,8,9,10</sup> Hence, it was recognized that a greater understanding of physical activity and social isolation and their relationship to depression among older adults was needed.

## Social isolation

Prior to the COVID-19 pandemic, social isolation was already recognized as a correlate of decreased physical activity<sup>11</sup> and higher

levels of depression, especially when social isolation was subjectively perceived.<sup>3</sup> Researchers previously posited that pandemic-related social distancing would result in increased feelings of social isolation among older adults.<sup>5</sup> Evidence has demonstrated that older adults who are isolated tend to do less physical activity,<sup>12</sup> which has been associated with higher risk of depression.<sup>6</sup> Thus, healthcare professionals have raised concerns about social isolation (limited relationships and contact with others) and loneliness (perceived isolation) stemming from the COVID-19 pandemic.<sup>5</sup> Older age, low income, and low education have also been identified as important correlates of social isolation<sup>13</sup>; however less is known about these factors as they relate to imposed social isolation in the setting of COVID-19.

## Physical activity

As adults age, physical activity tends to decrease.<sup>14</sup> Sedentary behavior, which was previously found to be associated with higher depression,<sup>1</sup> increased significantly during the early months of the COVID-19 pandemic.<sup>8</sup> At the same time, moderate to vigorous physical activity decreased.<sup>10</sup> In earlier work, higher intensity physical activity was found to be an important correlate of lower levels of depression.<sup>2</sup> Qualitative researchers indicated that social isolation due to self-imposed sheltering in place during COVID-19 was a potential reason for this reduction in physical activity.<sup>8</sup> Research

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showed that physical activity had a moderate inverse relationship to depression in older adults ( $r=-0.35$ ,  $p<0.001$ ),<sup>15</sup> therefore it is important to consider the role of physical activity and its relationship to depression in the setting of COVID-19 lockdowns and social distancing. However, much of the research on physical activity behaviors during COVID-19 focused on adults who were less than 65 years old, leaving a gap in the literature for physical activity among older adults.<sup>10,16</sup> In addition to age, other factors have been associated with physical activity levels. An inverse relationship between socioeconomic status<sup>11</sup> and education,<sup>17</sup> and physical activity among isolated older adults has been described, indicating that higher income and better education are related to a more active lifestyle.

### Significance and purpose

During the COVID-19 pandemic, the nature of social isolation changed for many older adults, providing an opportunity to expand our understanding of the relationship between physical activity, social isolation, and depression. Prior to the current study it was not known how physical activity and social isolation in the setting of imposed social distancing were related to each other, and to depression symptoms in older adults. The purpose of this study was to examine the relationship between physical activity and depression, and social isolation and depression in community-dwelling older adults during a period of pandemic-related imposed social distancing. Our hypotheses were that; (a) higher social isolation will predict higher depression; (b) lower physical activity will predict higher depression; (c) higher social isolation will predict lower physical activity; (d) personal factors (older age, lower income, and lower education) will be directly associated with reduced physical activity; (e) personal factors (older age, lower income, and lower education) will be directly associated with increased social isolation; and (f) physical activity will mediate the relationship between social isolation and depression (Fig. 1).

### Methodology

This was a cross sectional, descriptive, correlational design utilizing survey methodology. Convenience sampling was used to select participants. This study included older adults (aged 65 or older) who had previously attended at least one provider appointment at the main campus of a large quaternary care center in Northeast Ohio during 2020. No exclusion criteria were applied; however, surveys were provided in English only. In addition, potential participants had to have access to a computer and internet in order to complete the surveys.

### Variables and outcome measurements

Depression was the outcome variable and was measured using the 15-item Geriatric Depression Scale (GDS-15).<sup>18</sup> The scale is used

in older adult populations and takes approximately 10 minutes to complete. It may be used in individuals who are healthy or have mild to moderate cognitive and physical impairment. The GDS showed good sensitivity (92%) and specificity (89%) when compared to diagnostic criteria.<sup>18</sup> The GDS for self-rating of symptoms of depression was able to differentiate depressed from non-depressed adults ( $r = .84$ ,  $p < .001$ ).<sup>18</sup> Scores are from 0-15 and are categorized as follows: 0-4 (normal); 5-8 (mild depression); 9-11 (moderate depression); and 12-15 (severe depression).

Social Isolation was defined as limited relationships and contact with others, including friends and family.<sup>11</sup> Social isolation was measured with the PROMIS Short Form v2.0 – Social Isolation 8a.<sup>19</sup> This instrument consists of 8 short questions which are answered on a 1 (never) to 5 (always) Likert scale. The instrument uses T-scores (Mean[M]=50, Standard Deviation [SD]=10) with higher scores indicating worse social isolation. Therefore, a social isolation T-score of 60 is worse than the average of 50. Strong internal consistency with Cronbach's alpha of .86 was reported in a population of caregivers.<sup>20</sup> Strong convergent validity (Spearman's rho = 0.76,  $p < 0.001$ ) was reported in a sample of community dwelling older adults.<sup>21</sup>

Physical activity was defined as bodily movement resulting from skeletal muscle contractions, requiring energy expenditure; not necessarily planned as in the case of exercise.<sup>22</sup> Physical activity was measured by the Physical Activity Scale for the Elders (PASE). The PASE assesses participants' current activities, including walking, recreational activities, exercise, housework, yard work, and caring for others.<sup>23</sup> Developed in the early 1990's, the PASE was originally validated for older adult populations.<sup>24</sup> The questionnaire is based on the F.I.T.T. principal (frequency, intensity, time, and type of activity) and measures activity in the previous week. It contains 10 questions answered on a LIKERT scale from 0 (never) to 3 (often) and sub-questions regarding the length of time for each activity. Scores range from 0 to 793 and are computed by multiplying a weight for a given activity by the duration. Higher scores indicate greater physical activity.<sup>25</sup> Among rural, community dwelling older adults, PASE showed good stability and convergent validity (Spearman correlation coefficient of 0.43 ( $p<0.01$ ) between Actigraph data and total PASE scores.<sup>26</sup> The PASE intraclass correlation coefficient was 0.65,<sup>27</sup> indicating moderate reliability.

A demographic questionnaire was included for the purposes of describing the population and for determining the role of participant characteristics as they relate to physical activity and social isolation. Age (in years), race/ethnicity (Caucasian, non-Caucasian/Hispanic, non-Hispanic, other, prefer not to answer), sex (male, female, other), household income (<\$50,000, \$50-100,000, >\$100,000, prefer not to answer), and education (< high school, high school/GED, some college, college degree or higher, prefer not to answer) were collected. Since it was possible that participants might seek help in reading or

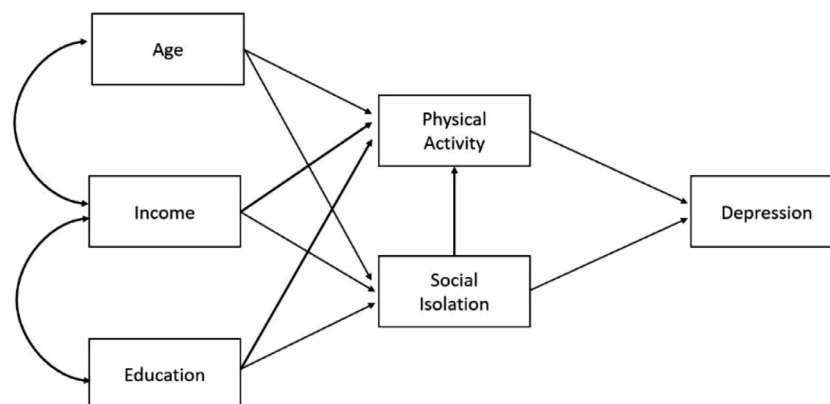


Fig. 1. Hypothesized model for relationships between social isolation, physical activity, personal factors and depression.

completing the surveys, one question was added regarding who completed the survey: the participant (independently), with the assistance of a friend/family member, or someone else. Additionally, participants were asked if they lived alone or with others.

#### Data collection procedures

Medical records numbers (MRNs) of potential participants who met inclusion criteria were obtained from the health system administrative database (n=63,353). The dataset was merged with a user database for the health system patient portal (EPIC MyChart) to identify potential participants who were enrolled in the platform. Survey invitations (n=6,548) were sent a total of two times through MyChart, along with a survey link, and completion of the survey indicated consent to participate. The survey itself was administered through the web-based application, REDCap (Research Electronic Data Capture).

#### Sample size

Sample size was calculated using G\*Power software for two-sided correlation (bivariate normal model) and an adjusted significance level of 0.0125. A sample of 365 patients would have at least 80% power to detect a statistically significant correlation between surveys, assuming the true correlation of < 0.2. We anticipated a 10% response rate and at least 5% incomplete surveys, thus needing to send a minimum of 3,850 survey invitations. For the path analysis, a sample size of at least 20 responders per parameter in the model is recommended, so with the planned sample size of 365, there would be adequate sample to fit all hypothesized parameters.<sup>28</sup>

#### Analysis

Categorical variables were described using frequencies and percentages. Continuous variables were described using means and standard deviations, as well as medians and inter-quartile range (IQR). A path analysis was performed to evaluate the relationships between physical activity and social isolation along with covariates of age, income, and education on depression. Standardized regression coefficients were calculated, and  $R^2$  measures for each exogenous variable were estimated. Goodness-of-fit criteria were calculated to assess model fit with comparative fit index (CFI)  $\geq 0.90$ , Tucker-Lewis index (TLI)  $\geq 0.90$ , root mean square error of approximation (RMSEA)  $< 0.10$ , and standardized root mean residual (SRMR)  $\leq 0.09$  indicating acceptable model fit.<sup>29,30</sup> Analysis was performed using the lavaan package (version 0.6-9) in R software (version 4.0; Vienna, Austria).<sup>31</sup>

## Results

#### Sample characteristics

Of 6,548 invitations to participate, 803 surveys were received for a response rate of 12.3%. For analysis, 326 incomplete surveys were removed, leaving 477 in the final sample. The mean ( $\pm$  SD) age of the sample was  $71.6 \pm 5.4$ , half were male (51.3%), and 80% were Caucasian/non-Hispanic. For the sample, the mean ( $\pm$  SD) physical activity score was  $134.1 \pm 88.2$  out of a possible 793 points, representing low exercise levels; mean ( $\pm$  SD) social isolation scores were  $45.3 \pm 7.8$ , which is below the average T-score of 50. The overall mean ( $\pm$  SD) depression score was  $2.9 \pm 2.8$ , indicating a low level of depression, or normal according to the tool's creators.<sup>18</sup> A summary of participant characteristics and survey scores can be found in Table 1.

**Table 1**

A summary of participant characteristics and survey scores

Factor	Total (N=477)	
	N	Statistics
Sex, n (%)	470	
Male		241 (51.3)
Race, n (%)	469	
Hispanic		44 (9.4)
Caucasian, non-Hispanic		375 (80.0)
Non-Caucasian, non-Hispanic		30 (6.4)
Other		20 (4.3)
age, mean $\pm$ sd	477	$71.6 \pm 5.4$
Income, n (%)	477	
less than \$50,000 per year		140 (29.4)
\$50-100,000 per year		151 (31.7)
greater than \$100,000 per year		129 (27.0)
prefer not to answer		57 (11.9)
Education, n (%)	477	
high school/GED		72 (15.1)
some college		100 (21.0)
college degree or higher		305 (63.9)
Physical Activity, mean $\pm$ sd	477	$134.1 \pm 88.2$
Social Isolation, mean $\pm$ sd	477	$45.3 \pm 7.8$
Depression, mean $\pm$ sd	477	$2.9 \pm 2.8$

Statistics presented as Mean  $\pm$  SD, Median [P25, P75], N (column %).

#### Path Analysis

The model (Fig. 2), which was based on current evidence related to social isolation, physical activity, and depression, adequately fit the data based on goodness-of-fit indices:  $\chi^2 (15, 477) = 373.37$ ,  $p < 0.001$  (CFI/TLI=0.97/0.95; RMSEA=0.05; SRMR=0.03). From the results of the path analysis, six of the nine direct paths were significant at the  $\leq 0.05$  level (see Table 2). The overall  $R^2$  for the model was 0.44, indicating that 44% of the variability in the depression measure is explained using social isolation and physical activity. Social isolation was positively associated with depression, and the standardized effect was more than twice that of physical activity on depression. Social isolation was negatively associated with physical activity, and physical activity was negatively associated with depression, however the magnitude of the standardized effect for both paths was small. Personal factors of age, income, and education were directly related to physical activity ( $R^2 = 0.07$ ), but not social isolation ( $R^2 = 0.01$ ). A small, indirect effect was noted for social isolation on depression through physical activity ( $\beta = 0.038$ , 95% CI [0.020, 0.056],  $p < 0.001$ ).

## Discussion

We explored the associations between personal factors, physical activity, social isolation, and depression in a population of community dwelling older adults during the COVID-19 pandemic. The current findings contribute to the understanding of the behavioral and socio-demographic pathways that help to explain depression among older adults during times of pandemic-related social distancing. Consistent with our a-priori model, higher social isolation predicted greater depression. Our results are also in accordance with recent work in which older adults were more sedentary and depressed as a result of social distancing which was also consistent with the a-priori model.<sup>6</sup> We hypothesized that personal factors (age, income, and education) were related to lower physical activity, which predicted greater depression. Additionally, we hypothesized that personal factors would be related to social isolation; however, none of these factors reached significance. Contextual factors, such as social distancing and sheltering in place during COVID-19 may have played a role in social isolation, reduced physical activity, and depression in our sample, thus interfering with older adults' ability to connect with others socially.

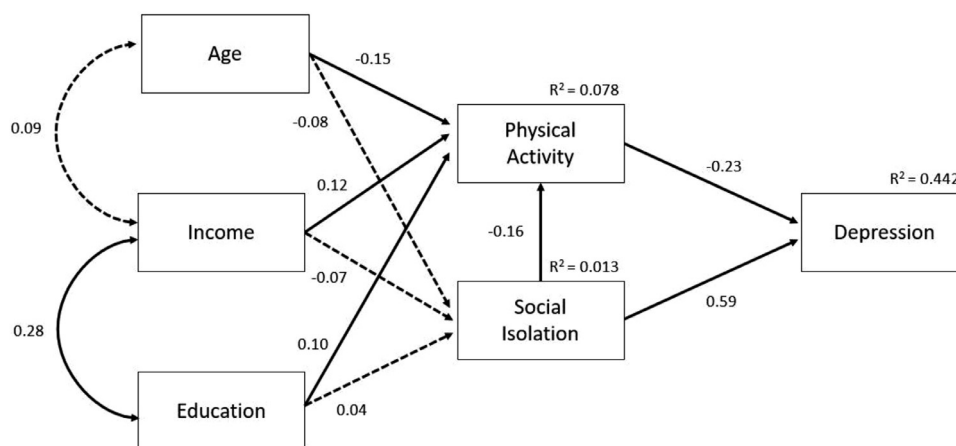


Fig. 2. Final path analysis model of physical activity, social isolation, and depression. Dotted lines indicate non-significant pathways ( $p > 0.05$ ).

Table 2  
Path Model: Direct Effects

Path	b (SE)	Z-value	p	$\beta$
Social Isolation→ Depression	0.214(0.015)	14.254	<0.001	0.588
Physical Activity→Depression	-0.007(0.001)	-6.639	<0.001	-0.230
Social Isolation→Physical Activity	-1.84(0.480)	-3.836	<0.001	-0.163
Age→ Physical Activity	-2.502(0.712)	-3.512	<0.001	-0.154
Income→ Physical Activity	10.631(3.999)	2.658	0.008	0.121
Education→ Physical Activity	12.257(5.084)	2.411	0.016	0.103
Age→ Social Isolation	-0.113(0.065)	-1.733	0.083	-0.078
Income→ Social Isolation	-0.565(0.369)	-1.532	0.126	-0.072
Education→Social Isolation	0.467(0.515)	0.907	0.365	0.044

b = Unstandardized path coefficient; SE = standard error;  $\beta$  = Standardized path coefficient

Social isolation and depression

Social isolation from COVID-19 was recently dubbed “lockdown loneliness” and was recognized as an important public health issue.<sup>4</sup> Participants in our study reported slightly lower than average social isolation which had a large effect on depression, and was consistent with pre-COVID-19 research findings.<sup>3</sup> Yet the magnitude of the emotional ramifications of social distancing and sheltering in place during COVID-19 must be considered. A recent study showed that older adults who reported reduced social connectivity during COVID-19 had a 17.24 times (95% CI 13.20, 22.50) higher risk of depression symptoms.<sup>32</sup> We found a similar large effect of social isolation on depression symptoms during a period of pandemic-related imposed social distancing. In contrast to previous literature,<sup>13</sup> the personal factors in our sample, including age, were not associated with social isolation. This may reflect the unique nature of imposed social isolation during the COVID-19 pandemic.

Physical activity and depression

There is a large body of evidence suggesting that higher physical activity is related to lower risk of depression. In a report prior to the COVID-19 pandemic, researchers tracked the physical activity of older adults for 3 years and found that when the activity was outside the home, it was negatively associated with depression.<sup>33</sup> Given the restrictions of the pandemic, it is possible that many in our sample left their homes less frequently, thus affecting activity outside of the home. Researchers also showed that older adults who were sedentary had higher depression and anxiety scores.<sup>15</sup> In accordance with these findings, researchers before and after the onset of COVID-19

reported that the higher the physical activity, the lower the depression.<sup>2,34</sup> In the current study, personal factors operated via physical activity to predict depression. Older age was negatively associated with physical activity, indicating that the older the person, the less physically active they were. Income and education were both positively associated with physical activity. Further, our participants reported low levels of physical activity on the PASE with mean scores that were well below the 50<sup>th</sup> percentile. Our findings and others suggest that addressing physical inactivity should be an important priority for those who care for older adults.

Our model provides evidence that social isolation and low physical activity are both predictors of depression among older adults. Herbolshheimer and others demonstrated an association between social isolation and lower out-of-home physical activity, which together predicted greater depression.<sup>33</sup> In a recent cross-sectional survey conducted in Spain, researchers revealed a decrease in physical activity among quarantined adults during COVID-19,<sup>10</sup> specifically those in the 18-44 and 55-64 year old age groups and those with chronic conditions.<sup>10</sup> Importantly, older adults who were isolated at home due to COVID-19 transmission mitigation policies and who had moderate to high levels of physical activity, reported lower depression.<sup>7</sup> Taken together, the literature supports the findings of the current study that both physical activity and lower perceived social isolation are important factors to consider in the treatment of depression among older adults.

Implications for practice

Although we did not measure physical activity before and after the onset of COVID-19, our participants had very low physical activity overall. As a result, we suggest that older adults will likely benefit from participating in virtual or outdoor activities to mitigate the psychological effects of social isolation and COVID-19 related inactivity. In an effort to combat depression in older adults, virtual physical activity and social connectedness are quickly becoming mainstream solutions for addressing social isolation and sedentary behavior.<sup>4</sup> Healthcare in general and nursing in particular can have an important impact on older adults’ physical and emotional health by simply encouraging an active lifestyle, especially one that socially engages the participant. Future research should further examine the relationships between physical activity, social isolation, and depression in older adults. Interventions are needed that accommodate older adults’ need for physical and social activities in the midst of pandemics and other situations that challenge our ability to socialize. Digital technology, socially distanced group activities, and outdoor activities for the purpose of decreasing sedentary and isolating behaviors, should be examined.

## Limitations

This study has several limitations. First, it included patients who had previously sought care at a single institution, possibly limiting generalizability. The population may also be different than other older adult populations since they needed to have access to computers and may have been more technologically savvy as a result. Further, we were not able to ensure that the population of older adults in this study was free of cognitive impairment, which was found to be related to low physical activity and high levels of depression in previous research.<sup>35</sup> This was a cross-sectional survey and results were based on individual perceptions. Therefore results are subject to the participants' interpretation of the questions. Lastly, we cannot conclude that imposed social distancing or sheltering in place caused perceived social isolation nor that it was the sole reason for low physical activity and depression. Due to the complex nature of depression, it is likely that unmeasured factors also played a role in depression scores.

## Conclusions

In conclusion, reduced physical activity and social isolation predicted greater depression in older adults during COVID-19. Nevertheless, depression is a complex problem that may have many contributing factors. However, older adults may suffer a high physical and emotional price during times of social distancing or sheltering in place. Nurses can play an important role in educating socially isolated older adults on the importance of exercise, supporting those who become depressed, and perhaps most importantly, advocating for programs and policies that promote ways to connect socially in the setting of imposed social distancing or sheltering in place. The results of this study may help healthcare professionals to more effectively treat older adults and help researchers design interventions to mitigate causal factors of depression in this vulnerable population.

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