

## ORIGINAL ARTICLE

# Impact of physical activity on response to stress in people aged 65 and over during COVID-19 pandemic lockdown

Antonio RADINO and Vincenza TARANTINO 

Department of Psychology, Educational Science and Human Movement, University of Palermo, Palermo, Italy

*Correspondence:* Dr Vincenza Tarantino, PhD, Department of Psychology, Educational Science and Human Movement, University of Palermo, Viale delle Scienze Ed. 15, 90128 Palermo, Italy, Email: vincenza.tarantino03@unipa.it

*Disclosure:* The authors declare they have no conflicts of interest in the research.

*Received 4 August 2021; revision received 20 November 2021; accepted 18 December 2021.*

## Abstract

**Background:** The outbreak of the COVID-19 pandemic has negatively affected the lives of many people. In particular, restrictions of physical activity (PA) due to pandemic-related lockdown have impacted their psychological status. The aim of this work was to investigate the relationship between PA habits, before the pandemic and during the lockdown, and responses to stress due to home isolation during the lockdown, in older people.

**Methods:** To this aim, an online survey addressed to people aged 65 years and over was conducted during the first pandemic wave in Italy (Study 1). To explore the effect of PA restrictions on responses to stress over time, the survey was replicated during the second wave (Study 2). A group of 72 and 43 participants, from 65 to 88 years, completed the two studies, respectively. The survey required the completion of the International Physical Activity Questionnaire, and of two questionnaires on stress response, namely, the Impact of Event Scale-Revised and the Perceived Stress Scale. The correlation between the questionnaires' scores was examined.

**Results:** Study 1 demonstrated that higher levels of PA during the lockdown, related to working and walking activities, were associated with fewer stress-related symptoms and lower stress perception. In parallel, greater reduction of PA, during lockdown compared to the pre-pandemic period, was associated with more stress-related symptoms. People who spent more time at rest (sitting) before and during the pandemic lockdown were those who showed higher psychological impact. Study 2 confirmed the benefits of maintaining working activities during lockdown, but also showed that during the second pandemic wave people were more resilient to PA restrictions and home isolation, even if conducting a sedentary lifestyle.

**Conclusions:** Maintaining good levels of PA during lockdown was a protective factor against developing stress-related symptoms in older people. On the other hand, more resilient response to stress emerged in this population during the second wave.

**Key words:** ageing, COVID-19, home isolation, lockdown, physical activity, stress.

## INTRODUCTION

The coronavirus (COVID-19) pandemic has affected and still affects the entire world population. The advent of this event has changed our lives, sometimes dramatically. Movements and social interactions have been limited as much as possible; work, for most people, has been suspended or continues remotely at home. Although duration and type of lockdown restrictions varied in relation to measures

taken in one's home country and to the period of the pandemic, the need to stay at home for prolonged times and to mainly carry out sedentary activities was common to all around the world. This forced situation increased the load of psychological distress and decreased the quality of life.<sup>1-4</sup>

Greater concern has been devoted to more vulnerable people, such as adults over the age of 65, who have been reported to have the highest risk of

developing severe complications due to COVID-19 infection. Older adults, who were already the most exposed to diseases, loneliness, and limited autonomy, were also the most impacted by isolation, social distancing, and quarantine, and showed higher risk of developing psychological distress.<sup>5,6</sup> This has led to heightened anxiety and stress symptoms among this population.<sup>7,8</sup> In particular, home isolation and reduction of physical activity (PA) have been shown to increase the risk for depression and anxiety symptoms as well as the risk of relapses and general medical conditions.<sup>9</sup>

During the lockdown due to the first COVID-19 pandemic wave, the reduction of PA, especially vigorous activity and walking, adversely impacted psychological wellbeing, as documented in a study conducted on a population of adults from 18 to over 60 years.<sup>10</sup> Another study, conducted on a sample of adults in a similar range of age, showed that people who have maintained the same PA habits, or have started training activity during the first weeks of lockdown, experienced lower levels of negative emotions (fear and anxiety) and less stress-related symptoms (headache and fatigue).<sup>11</sup> Both studies concluded that PA was a protective factor against physical as well as psychological symptoms of stress. In line with these Italian studies, a negative association between moderate-to-vigorous PA and moderate-to-severe anxiety and depressive symptoms during the pandemic was found in people aged 35 to 64 years in the UK.<sup>12</sup> Moreover, negative PA changes were associated with higher depression, anxiety and stress symptoms in an Australian population of adults of 50 years of mean age<sup>13</sup> and in an UK population over the age of 50.<sup>14</sup> Even light PA during COVID-19 pandemic was shown to help alleviate depressive reactions to social restrictions in individuals over the age of 50 in North America.<sup>15</sup>

All these findings are in line with pre-COVID-19 literature, which documents that PA protects against anxiety and depressive symptoms and improves the ability to face stressful events,<sup>16,17</sup> in older adults especially.<sup>18,19</sup> Namely, moderate-to-vigorous PA was found to decrease the level of perceived stress in older people and indirectly positively affect quality of life.<sup>20</sup> Furthermore, numerous evidence showed that PA can be used as an additional or alternative treatment to relieve symptoms of anxiety and

depression in elderly subjects<sup>21,22</sup> and to maintain good cognitive functioning.<sup>23</sup>

In the light of the literature on PA benefits and on more recent COVID-19-related studies, we aimed the present investigation at elucidating the effect of PA habits on the impact of stress induced by the lockdown due to the pandemic, in people aged 65 years and over. We hypothesised that higher levels of PA performed before the pandemic outbreak and/or during the lockdown would protect against higher levels of psychological distress, whereas sedentary habits would adversely affect these levels. To this aim, an online survey was conducted during the national lockdown due to the first pandemic wave in Italy. The survey required the completion of the International Physical Activity Questionnaire (IPAQ),<sup>24,25</sup> to assess frequency and duration of PA. To quantify individual changes in PA habits after the pandemic outbreak, the IPAQ was duplicated: the first part referred to the pre-COVID-19 period, while the second part referred to the lockdown period. In addition, two questionnaires on stress, namely, the Impact of Event Scale-Revised (IES-R)<sup>26,27</sup> and the Perceived Stress Scale (PSS)<sup>28,29</sup> were completed, to quantify the presence of stress symptoms related to home isolation and the levels of perceived stress during the lockdown. Compared to previous studies on the effect of PA on psychological distress during the pandemic in older adults,<sup>13,14</sup> we focused on ages of 65 years and over and we adapted the IPAQ for the retrospective estimation of intensity and type of PA. Furthermore, to explore the effect of PA changes on stress over time, we conducted the survey a second time, during the national lockdown due to the second pandemic wave.

## STUDY 1

### Methods

#### Procedure

The survey was presented in an online format, implemented in Google Forms. Data collection lasted from May 4 to May 15, 2020. Participants were recruited among personal contacts and volunteer associations, which work throughout the Italian territory with and for older adults. The study was performed in accordance with the Declaration of Helsinki and approved by the local Ethics Committee of the

University of Palermo (protocol n. 32/2020). All participants gave their consent before participation and after being informed about the research purposes and procedure, and the anonymous data collection and processing.

### Participants

A total of 76 participants were enrolled and completed the online survey. Four of them were excluded from statistical analyses because of more than five inconsistencies in their answers to the IPAQ (see below), which denoted poor data reliability. All 72 participants of the final sample were at least 65 years old. The mean age was 67.8 years (range: 65 to 76 years,  $SD = 2.7$ ). Forty participants (55.6%) were women while the remaining 32 were men (44.4%). Mean years of education was 11.9 ( $SD = 4.4$ ). Forty-five participants lived with one person only (62.5%), usually husband or wife, 15 participants lived with more than one person (20.8%), usually the family, 10 participants lived alone (13.9%), whereas two participants did not provide information (2.8%). Forty-two participants reported to suffer from medical conditions (e.g., hypertension, hypercholesterolemia).

### Questionnaires

**IPAQ.** The questionnaire evaluates frequency (days per week) and duration (hours per day) of active as well as sedentary behaviours. The long version of the IPAQ<sup>24,25</sup> was slightly adapted to improve the suitability for an online self-administration modality. Likewise with the original version, the number of items was 27 and activities were grouped in five domains: domestic and gardening (yard) activities (thereafter abbreviated as ‘home’), leisure time PA (‘leisure’), transport-related PA (‘transport’), work-related PA (‘work’), and sitting (‘rest’). The items of home, leisure, and work domains were further grouped into ‘moderate’ (e.g., bicycling or working in the garden) and ‘vigorous’ (e.g. heavy lifting and other intense exercises) activities. In addition, the leisure and work domains provide a separate score for ‘walking’ activity. For each item, an answer for frequency and duration was requested. Unlike the original version, the items were presented on a Likert scale. Namely, for each activity, the days in a week (from 0 to 7) and the minutes/hours in a day (0 min, 30 min, 1 h, 2 h, 3 h, 5 h, >5 h) were required. Each item was duplicated: the first item referred to ‘pre-COVID’ period, and the

second one referred to ‘the last week’. For example, the items investigating walking in leisure time asked ‘In a typical week before pandemic/In the last week, how many days did you walk for at least 10 minutes at a time in your leisure time?’ for frequency, and ‘How much time did you usually spend on one of those days walking in your leisure time?’ for duration. Data were preprocessed according to IPAQ guidelines ([www.ipaq.ki.se](http://www.ipaq.ki.se)). Items were scored by multiplying the time in minutes spent in a specific activity by the number of days per week the subject spent in that activity. This quantity represents the Metabolic Equivalent Task minutes per week measure (MET min/week), that is, the physical expenditure of a subject during that specific activity. In order to compute a weighted value of this measure, the MET was multiplied by an average MET score for each type of activity derived from previous studies, in line with the IPAQ guidelines. Before entering data into analysis, inconsistencies across answers on frequency and duration were screened and removed, for instance the answer ‘0 days per week’ together with ‘1 hour per day’ for walking in leisure time.

**IES-R.** The questionnaire<sup>26,27</sup> examines the presence of post-traumatic stress disorder (PTSD) symptoms, such as, intrusiveness, avoidance, and hyperarousal. Participants were asked to self-assess the psychological impact of home isolation during the COVID-19 pandemic, in the last week. The questionnaire consists of 22 items, scored on a Likert scale ranging from 0 to 4 (0 = not at all; 1 = a little bit; 2 = moderately; 3 = quite a bit; 4 = extremely). The final score is given by the sum of all answers. A total IES-R score of 33 or higher indicates the probable presence of PTSD symptoms. During the pandemic, the IES-R was probably one of the most widely used self-report measures to investigate subjective distress after the pandemic outbreak, since the beginning (e.g., references<sup>30–32</sup>). In the present study, we asked participants to refer all questions to the home isolation condition specifically.

**PSS.** The questionnaire<sup>28,29</sup> investigates emotional reactions to stress, namely, the degree to which events in life are perceived as uncontrollable, unpredictable, and overloaded. This scale consists of 10 items, scored on a Likert scale ranging from 0 to 4 (0 = never; 1 = almost never; 2 = sometimes; 3 = fairly often; 4 = very often). As in the IES-R, participants were asked to refer to the last week. The

final score is given by the sum of all answers, taking into account reversed items. A final score between 1 and 10 is below average; a score between 11 and 14 is average; a score between 15 and 18 indicates a medium to high risk of stress; 19 or higher can be an indicator of high stress.

### Data analysis

Given the non-normal distribution of the IPAQ scores, to statistically test the reduction of PA during lockdown relative to the pre-pandemic period, a non-parametric Wilcoxon analysis was conducted on the IPAQ scores (MET min/week), on each domain. To verify the correlation between IPAQ scores and scores on questionnaires on stress (i.e., IES-R and PSS), which were normally distributed instead, a non-parametric correlation was performed, obtaining the Spearman's Rho coefficient ( $r_s$ ). The difference between IPAQ scores before COVID-19 and during lockdown was quantified in a 'proportion of change' in PA by the formula (lockdown PA – pre-COVID-19 PA) / (lockdown PA + pre-COVID-19 PA). This proportion expresses how much each participant modified her/his PA habits during the lockdown relative to the pre-COVID-19 period. Negative values represent reduction of PA during the lockdown compared to the pre-COVID-19 period. To explore the sex effect on stress scores, we performed Mann-Whitney statistics. All statistical analysis were performed using the SPSS software (v.25, Statistical Package for the Social Sciences, IBM, Armonk, NY, USA). Statistical significance was set to  $\alpha = 5\%$ .

## RESULTS

The median of IPAQ scores (MET min/week) in the pre-pandemic period and in the lockdown period are graphically represented in Fig. S1 of Supporting information. Significant reduction of PA was observed during the lockdown period relative to pre-COVID-19 (all  $P$ s < 0.001), in all domains except home activities.

The correlations between the pre-pandemic IPAQ scores and the IES-R and PSS scores, referred to the last 7 days of lockdown, are reported in Table 1. Frequency and duration of time spent at rest positively correlated with IES-R ( $r_s(66) = 0.507$ ,  $P < 0.001$ ) and PSS ( $r_s(66) = 0.332$ ,  $P = 0.006$ ) scores. Namely, the longer the time spent at rest (i.e., sitting) the higher

the impact of home isolation and the level of perceived stress during the lockdown.

As regard to the relationship between scores on IPAQ during lockdown and scores on stress questionnaires, significant negative correlations were found between frequency and duration of PA related to work and IES-R ( $r_s(61) = -0.442$ ,  $P < 0.001$ ) as well as PSS ( $r_s(61) = -0.282$ ,  $P = 0.025$ ) scores. Moreover, negative correlations were found between IPAQ walking activity and IES-R scores ( $r_s(57) = -0.271$ ,  $P = 0.038$ ), and between IPAQ overall vigorous activities and IES-R scores ( $r_s(60) = -0.339$ ,  $P = 0.007$ ). In contrast, significant positive correlations emerged between time at rest and IES-R ( $r_s(66) = 0.467$ ,  $P < 0.001$ ) as well as PSS ( $r_s(66) = 0.312$ ,  $P = 0.009$ ) scores.

When the relationship between the proportion of change in PA and scores on IES-R questionnaire was assessed, significant correlations emerged between the change of frequency and duration in PAs related to work ( $r_s(56) = -0.268$ ,  $P = 0.042$ ) and to walking ( $r_s(53) = -0.339$ ,  $P = 0.011$ ).

Overall, an average score of 33.06 (SD = 12.19) on the IES-R and an average score of 16.47 on the PSS (SD = 5.24) was found. Forty participants (55%) obtained a score equal to or higher than the threshold of 33 on the IES-R, which is an index of risk for PTSD. Twenty-three participants (32%) obtained a score of 19 or higher on the PSS, which is an index of high level of stress. Female participants reported significantly higher scores than male participants (IES-R:  $Z = 3.28$ ,  $P = 0.001$ ; PSS:  $Z = 2.92$ ,  $P = 0.004$ ). The total scores on the two questionnaires on stress significantly and positively correlated ( $r_s(62) = 0.721$ ,  $P < 0.001$ ). No significant correlations emerged between age and questionnaire scores (IES-R:  $r_s(66) = -0.231$ ,  $P = 0.058$ ; PSS:  $r_s(66) = -0.095$ ,  $P = 0.439$ ).

Overall, PA habits before the pandemic highly correlated with PA during the pandemic (all  $r > 0.302$ , all  $P < 0.2$ ).

## STUDY 2

### Methods

#### Procedure

This study was conducted during the lockdown caused by the second wave of COVID-19 pandemic, namely, between January 8, 2021 and February 9,

**Table 1** Correlations between frequency and duration of physical activity (PA), as assessed by the International Physical Activity Questionnaire (IPAQ), and stress responses, as assessed by the Impact of Event Scale- Revised (IES-R) and Perceived Stress Scale (PSS) questionnaires, in Study 1. Three IPAQ measures were collected: scores before COVID-19 pandemic (data collected retrospectively), scores during the lockdown caused by the first pandemic wave, and the proportion of change between these two scores.

	Home	Leisure	Transport	Work	Rest	Walking	Moderate	Vigorous	IES-R	PSS
<b>Before COVID-19</b>										
Home	1									
Leisure	-0.010	1								
Transport	0.142	0.332**	1							
Work	0.335**	0.149	0.107	1						
Rest	-0.052	-0.136	-0.063	0.017	1					
Walking	0.126	0.326**	0.553***	0.560***	-0.009	1				
Moderate	0.656***	0.272*	0.209	0.694***	-0.165	0.302*	1			
Vigorous	0.143	0.525***	0.176	0.598***	-0.088	0.268*	0.579***	1		
IES-R	0.133	-0.062	-0.099	-0.088	<b>0.507***</b>	0.009	-0.133	-0.240	1	
PSS	0.201	-0.099	-0.223	-0.033	<b>0.332**</b>	0.54	-0.091	-0.053	0.721***	1
<b>During lockdown</b>										
Home	1									
Leisure	-0.329*	1								
Transport	-0.013	0.268*	1							
Work	0.223	0.167	0.226	1						
Rest	-0.027	-0.340**	-0.024	-0.310*	1					
Walking	0.280*	0.341**	0.443***	0.581***	-0.262*	1				
Moderate	0.799***	0.066	0.226	0.542***	-0.266*	0.493***	1			
Vigorous	0.055	0.333**	0.086	0.626***	-0.264*	0.298*	0.317*	1		
IES-R	0.058	-0.193	-0.078	<b>-0.442***</b>	<b>0.467***</b>	<b>-0.271*</b>	-0.112	<b>-0.339**</b>	1	
PSS	0.191	-0.253	-0.159	<b>-0.282*</b>	<b>0.312**</b>	-0.177	-0.009	-0.165	0.721***	1
<b>Proportion of change</b>										
Home	1									
Leisure	-0.124	1								
Transport	0.162	0.095	1							
Work	0.013	0.113	0.031	1						
Rest	0.002	0.033	-0.117	-0.013	1					
Walking	0.093	0.236	0.476***	0.433**	0.115	1				
Moderate	0.332*	0.278*	0.125	0.469***	-0.067	0.349*	1			
Vigorous	0.000	0.333*	0.073	0.459***	-0.002	0.143	0.640***	1		
IES-R	-0.172	-0.168	-0.031	<b>-0.268*</b>	-0.166	<b>-0.339*</b>	-0.115	-0.011	1	
PSS	-0.187	-0.156	0.032	-0.097	-0.089	-0.161	-0.119	-0.046	0.721***	1

\* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ . Home = housework, house maintenance, and caring for family; Leisure = recreation, sport, and leisure-time; Transport = movements due to transportation; Work = job or volunteering; Rest = time spent sitting; Moderate = moderate intensity PA, such as carrying light loads, bicycling at a regular pace, gardening; Vigorous = strong intensity PA, such as carrying heavy loads, performing intense aerobic exercises. Higher IPAQ scores reflect higher levels of PA; higher IES-R and PSS scores reflect more stress-related symptoms; negative proportions of change reflect PA reduction after pandemic outbreak; negative correlations between proportion of change and scores on stress questionnaires reflect higher stress levels in relation to a greater reduction of PA. In bold correlations relevant to the aims of the study.

2021. The same questionnaires as Study 1 were presented in the online format (Google forms).

### Participants

A total of 47 participants completed the survey. Four participants were excluded because of answer inconsistencies (see Study 1). The remaining sample had a mean age of 70.56 years (range: 65 to 88 years,  $SD = 5.6$ ). Twenty-three participants (53.5%) were women and 20 were men (46.5%). The mean years of education was 13.35 ( $SD = 4.9$ ). Nineteen participants lived with only one person (44.2%), 18 lived

with more than one person (41.9%), and six lived alone (14%). Twenty-seven participants reported having at least one medical condition.

### Data analysis

The same statistical analysis as in Study 1 was performed.

## RESULTS

The median of IPAQ scores in the pre-pandemic period and in the lockdown period are graphically

represented in Fig. S1 of Supporting information. As in Study 1, a significant reduction of PA was observed during lockdown relative to the pre-COVID-19 period (all  $P < 0.047$ ), in all domains except home activities.

The results of correlational analyses are reported in Table 2. Unlike Study 1, the time spent at rest before the pandemic negatively correlated with PSS scores ( $r_s(41) = -0.401$ ,  $P = 0.008$ ). No effects were observed when considering the correlation between the IPAQ scores and the IES-R. In line with the result observed before pandemic, the time spent at rest during the lockdown negatively correlated with the PSS scores ( $r_s(41) = -0.349$ ,  $P = 0.022$ ). A significant

positive correlation emerged between the proportion of change in PA related to working activities and PSS ( $r_s(37) = 0.341$ ,  $P = 0.034$ ).

An average score of 23.05 (SD = 12.95) on the IES-R and of 13.42 (SD = 4.83) on the PSS was observed. These values were significantly lower than the average scores found in Study 1 ( $t(109) = 4.11$ ,  $P < 0.001$ ;  $t(109) = 3.02$ ,  $P = 0.003$  respectively). A total score on IES-R of 33 or higher, which indicates the probable presence of PTSD symptoms, was obtained by eight participants (18.6%). A total score of 19 or higher, which indicates high level of stress, was obtained by nine participants (21%). The

**Table 2** Correlations between frequency and duration of physical activity (PA), as assessed by the International Physical Activity Questionnaire (IPAQ), and stress responses, as assessed by the Impact of Event Scale- Revised (IES-R) and Perceived Stress Scale (PSS) questionnaires, in Study 2. Three IPAQ measures were collected: scores before COVID-19 pandemic (data collected retrospectively), scores during the lockdown caused by the first pandemic wave, and the proportion of change between these two scores.

	Home	Leisure	Transport	Work	Rest	Walking	Moderate	Vigorous	IES-R	PSS
<b>Before COVID-19</b>										
Home	1									
Leisure	0.334*	1								
Transport	0.260	0.548***	1							
Work	0.218	0.466**	0.282	1						
Rest	-0.150	-0.129	-0.026	-0.013	1					
Walking	0.142	0.656***	0.620***	0.592***	-0.139	1				
Moderate	0.842***	0.569***	0.290	0.404*	-0.387*	0.267	1			
Vigorous	0.454**	0.607***	0.437**	0.689***	-0.089	0.331*	0.607***	1		
IES-R	-0.055	-0.035	-0.043	0.055	-0.175	-0.052	0.182	0.001	1	
PSS	0.109	-0.020	-0.076	-0.199	<b>-0.401**</b>	-0.113	0.310	-0.078	0.339*	1
<b>During lockdown</b>										
Home	1									
Leisure	0.177	1								
Transport	0.063	0.626***	1							
Work	0.164	0.660***	0.407*	1						
Rest	-0.129	-0.101	0.150	-0.087	1					
Walking	0.025	0.799***	0.765***	0.765***	-0.004	1				
Moderate	0.849***	0.430*	0.271	0.489**	-0.146	0.348*	1			
Vigorous	0.328*	0.668***	0.522**	0.661***	-0.189	0.571***	0.523**	1		
IES-R	-0.112	-0.232	-0.205	-0.042	-0.222	-0.121	-0.066	-0.075	1	
PSS	0.087	-0.276	-0.203	-0.119	<b>-0.349*</b>	-0.153	-0.053	-0.014	0.339*	1
<b>Proportion of change</b>										
Home	1									
Leisure	0.348*	1								
Transport	-0.080	0.580***	1							
Work	-0.113	-0.150	0.071	1						
Rest	-0.035	-0.105	0.213	-0.007	1					
Walking	0.045	0.652***	0.812***	0.060	-0.024	1				
Moderate	0.695***	0.345	0.095	-0.244	-0.155	0.095	1			
Vigorous	0.030	0.043	0.043	0.565***	-0.126	0.032	-0.020	1		
IES-R	0.108	-0.180	-0.181	-0.026	-0.150	-0.026	0.177	0.087	1	
PSS	-0.059	-0.067	-0.104	<b>0.341*</b>	0.038	0.084	-0.135	0.217	0.339*	1

\* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ . Home = housework, house maintenance, and caring for family; Leisure = recreation, sport, and leisure-time; Transport = movements due to transportation; Work = job or volunteering; Rest = time spent sitting; Moderate = moderate intensity PA, such as carrying light loads, bicycling at a regular pace, gardening; Vigorous = strong intensity PA, such as carrying heavy loads, performing intense aerobic exercises. Higher IPAQ scores reflect higher levels of PA; higher IES-R and PSS scores reflect more stress-related symptoms; negative proportions of change reflect PA reduction after pandemic outbreak; negative correlations between proportion of change and scores on stress questionnaires reflect higher stress levels in relation to a greater reduction of PA. In bold correlations relevant to the aims of the study.

percentages of IES-R scores above the cut-off in Study 2 was significantly lower than the percentages in Study 1 ( $\chi^2 = 15.11, P < 0.001$ ), whereas no differences emerged in PSS scores ( $\chi^2 = 1.62, P = 0.2$ ). Neither significant gender differences (IES-R:  $Z = 1.9, P = 0.057$ ; PSS:  $Z = 1.72, P = 0.085$ ) nor significant correlations between age and questionnaire scores (IES-R:  $r_s(41) = -0.005, P = 0.977$ , PSS:  $r_s(41) = -0.175, P = 0.261$ ) emerged. Participants in Study 2 were slightly older than participants in Study 1 ( $t(113) = 3.65, P < 0.001$ ) and reported to have a more sedentary lifestyle in the pre-COVID-19 time ( $t(113) = 3.17, P = 0.002$ ). Overall, PA habits before the pandemic highly correlated with PA during the pandemic (all  $r > 0.717$ , all  $P < 0.001$ ).

## DISCUSSION

The aim of the present work was to clarify the relationship between PA habits, before and during lockdown due to the COVID-19 pandemic, and responses to stress in people aged 65 years and over. Specifically, the presence of symptoms related to stress due to home isolation was assessed. To this aim, two studies were conducted, one study during the first wave of the pandemic, and one study during the second wave of the pandemic, both in Italy. Given that physical exercise is a protective factor against psychological distress, we expected to find fewer stress-related symptoms in people with higher levels of PA before and/or during the pandemic, and higher stress-related symptoms in people with more sedentary habits.

The results of Study 1 supported our hypotheses. Specifically, higher levels of working and walking PAs performed during lockdown, in terms of frequency and duration, inversely correlated with the presence of post-traumatic symptoms, as assessed in the IES-R questionnaire. Overall, the execution of vigorous-intensity activity during lockdown was associated with lower IES-R scores. Moreover, working PAs performed during lockdown (e.g., volunteering) inversely correlated with the level of perceived stress, as assessed in the PSS questionnaire. In parallel, the significant reduction of PAs in the working and walking domains, during lockdown compared to the pre-pandemic period, negatively correlated with IES-R scores. These results confirmed that greater stress-related symptoms were observed in the presence of a greater reduction of PA during lockdown relative to the pre-pandemic period.

On the other hand, the time spent at rest (i.e., sitting) before the COVID-19 pandemic positively correlated with scores on the IES-R and PSS questionnaires. These findings revealed that older people with a more sedentary lifestyle before the pandemic were those who showed a higher psychological impact and higher levels of stress during the first-wave pandemic lockdown. Likewise, sedentary habits during the lockdown were correlated with higher psychological impact of the lockdown and higher levels of stress.

The present findings are in line with other studies conducted on adults during the COVID-19 pandemic,<sup>10,33,34</sup> which demonstrated the inverse association between PA and psychological impact of stress. In addition, our study documents that this association was true also for people aged 65 years and over, and that sedentary lifestyle before COVID-19 was a risk factor for abnormal responses to stress. Furthermore, our study supports previous findings showing that PA relieves the impact of stressful events<sup>17</sup> and that an increase from moderate-to-vigorous PA reduces the level of perceived stress in older people and to indirectly and positively affect quality of life.<sup>20</sup>

Similar to Study 1, in Study 2 the participants who reduced physical movements related to working activities during lockdown were more affected by stress-related symptoms. This finding suggested that the adverse effect of reducing PAs, during pandemic compared to pre-pandemic times, was still evident in the lockdown due to the second wave. Nevertheless, in the latter study, a negative correlation between resting time and stress was found. Namely, participants with a more sedentary life, before and during the lockdown, reported lower levels of stress. These results suggested that the psychological response to the lockdown of the second wave was different from the first lockdown, and that the adverse effect of sedentary habits was instead inverted. This result could be interpreted as the effect of resilience and adaptation to the new condition. We might speculate that participants more used to a sedentary life, who spend more time at home, could cope better with home isolation in the long term. This interpretation is consistent with recent studies that have shown that older people reported higher levels of resilience in response to adversities, such as the COVID-19 pandemic, than younger people<sup>35–37</sup> (see reference 38 for a review), perhaps also because of fewer concerns associated with job positions or to less

exposure to news on social media. Further studies are needed to investigate this hypothesis.

Of note, a very high percentage of participants ‘at risk’ of PTSD was found during the first wave of the pandemic (55% of above-threshold IES-R scores), which significantly decreased in the second wave (18.6%). This demonstrated a higher impact of home isolation during the first lockdown. Although these data were derived from two separate groups of participants, we might infer that overall, in the long term (the second wave was about 10 months after the COVID-19 outbreak), participants developed a better adaptation to the new condition. On the other hand, we must consider that lockdown restrictions in the second wave were not total as in the first one.

The study results must be interpreted after taking into account some limitations. First of all, the limited sample size, in Study 2 especially, which did not allow drawing of firm conclusions. Furthermore, the adoption of a cross-sectional instead of longitudinal design did not allow a straightforward comparison between the two studies. There might be the presence of a potential selection bias in the sample, given that only active participants, with competencies in the use of digital media, could fill-in the questionnaires. Lastly, no survey questions addressed stress and health issues specifically related to COVID-19 infection. Therefore, we could not quantify the direct or indirect contribution of COVID-19 infection on stress levels related to home isolation.

In the light of the results and of the abovementioned limitations, we might conclude that sedentary habits before as well as during the pandemic was a risk factor for developing stress-related symptoms during the first wave of the pandemic, whereas PA related to working and walking activity protects against them. In the second wave, a decrease in stress-related symptoms, even in people with sedentary lives, suggested the presence of a more adaptive response to restrictions in older adults. Overall, the study confirms the fundamental role of maintaining a good level of PA in old age, to prevent mental problems from the COVID-19 pandemic.<sup>39</sup>

## ACKNOWLEDGMENTS

We thank all the volunteer associations for their kind collaboration, especially Auser, Anteas, and Ancescao.

## AUTHOR CONTRIBUTIONS

AR and VT contributed substantially to the conception and design of the work, carried out data analysis and interpretation, and drafted the work. AR acquired the data; VT revised the work critically for important intellectual content. Both authors approved the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved.

## REFERENCES

- 1 Amerio A, Lugo A, Stival C *et al.* COVID-19 lockdown impact on mental health in a large representative sample of Italian adults. *J Affect Disord* 2021; **292**: 398–404.
- 2 World Health Organization. *Mental Health and Psychosocial Considerations During COVID-19 Outbreak*: World Health Organization, 2020. [Cited 04 Aug 2021]. Available from URL: <https://www.who.int/docs/default-source/coronaviruse/mental-health-considerations.pdf>
- 3 Wang Y, Kala MP, Jafar TH. Factors associated with psychological distress during the coronavirus disease 2019 (COVID-19) pandemic on the predominantly general population: a systematic review and meta-analysis. *PLoS One* 2020; **15**: e0244630.
- 4 Georgieva I, Lepping P, Bozev V *et al.* Prevalence, new incidence, course, and risk factors of PTSD, depression, anxiety, and panic disorder during the Covid-19 pandemic in 11 Countries. *Healthcare* 2021 Jun; **9**: 664.
- 5 Hwang T-J, Rabheru K, Peisah C, Reichman W, Ikeda M. Loneliness and social isolation during the COVID-19 pandemic. *Int Psychogeriatr* 2020; **32**: 1217–1220.
- 6 Santini ZI, Jose PE, York Cornwell E *et al.* Social disconnectedness, perceived isolation, and symptoms of depression and anxiety among older Americans (NSHAP): a longitudinal mediation analysis. *Lancet Public Health* 2020; **5**: e62–e70.
- 7 Jeste DV. Coronavirus, social distancing, and global geriatric mental health crisis: opportunities for promoting wisdom and resilience amid a pandemic. *Int Psychogeriatr* 2020; **32**: 1097–1099.
- 8 Bergman YS, Cohen-Fridel S, Shrira A, Bodner E, Palgi Y. COVID-19 health worries and anxiety symptoms among older adults: the moderating role of ageism. *Int Psychogeriatr* 2020; **32**: 1371–1375.
- 9 Woods JA, Hutchinson NT, Powers SK *et al.* The COVID-19 pandemic and physical activity. *Sports Med Health Sci* 2020; **2**: 55–64.
- 10 Maugeri G, Castrogiovanni P, Battaglia G *et al.* The impact of physical activity on psychological health during Covid-19 pandemic in Italy. *Heliyon* 2020; **6**: e04315.
- 11 Di Corrado D, Magnano P, Muzii B *et al.* Effects of social distancing on psychological state and physical activity routines during the COVID-19 pandemic. *Sport Sci Health* 2020; **16**: 619–624.
- 12 Jacob L, Tully MA, Barnett Y *et al.* The relationship between physical activity and mental health in a sample of the UK public: a cross-sectional study during the implementation of COVID-19 social distancing measures. *Ment Health Phys Act* 2020; **19**: 100345.



- 13 Stanton R, To QG, Khalesi S *et al.* Depression, anxiety and stress during COVID-19: associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *Int J Environ Res Public Health* 2020; **17**: 4065.
- 14 Creese B, Khan Z, Henley W *et al.* Loneliness, physical activity, and mental health during COVID-19: a longitudinal analysis of depression and anxiety in adults over the age of 50 between 2015 and 2020. *Int Psychogeriatr* 2021; **33**: 505–514.
- 15 Callow DD, Arnold-Nedimala NA, Jordan LS *et al.* The mental health benefits of physical activity in older adults survive the COVID-19 pandemic. *Am J Geriatr Psychiatry* 2020; **28**: 1046–1057.
- 16 McDowell CP, Dishman RK, Gordon BR, Herring MP. Physical activity and anxiety: a systematic review and meta-analysis of prospective cohort studies. *Am J Prev Med* 2019; **57**: 545–556.
- 17 Stuults-Kolehmainen MA, Sinha R. The effects of stress on physical activity and exercise. *Sports Med* 2014; **44**: 81–121.
- 18 Rebar AL, Stanton R, Geard D, Short C, Duncan MJ, Vandelanotte C. A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychol Rev* 2015; **9**: 366–378.
- 19 Salmon P. Effects of physical exercise on anxiety, depression, and sensitivity to stress. *Clin Psychol Rev* 2001; **21**: 33–61.
- 20 Awick EA, Ehlers DK, Aguiñaga S, Daugherty AM, Kramer AF, McAuley E. Effects of a randomized exercise trial on physical activity, psychological distress and quality of life in older adults. *Gen Hosp Psychiatry* 2017; **49**: 44–50.
- 21 Bauman A, Merom D, Bull FC, Buchner DM, Fiatarone Singh MA. Updating the evidence for physical activity: summative reviews of the epidemiological evidence, prevalence, and interventions to promote “active aging”. *Gerontologist* 2016; **56**: S268–S280.
- 22 Zhang S, Xiang K, Li S, Pan H-F. Physical activity and depression in older adults: the knowns and unknowns. *Psychiatry Res* 2021; **297**: 113738.
- 23 Engeroff T, Ingmann T, Banzer W. Physical activity throughout the adult life span and domain-specific cognitive function in old age: a systematic review of cross-sectional and longitudinal data. *Sports Med* 2018; **48**: 1405–1436.
- 24 Craig CL, Marshall AL, Sjoström M *et al.* International Physical Activity Questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc* 2003; **35**: 1381–1395.
- 25 Mannocci A, Di Thiene D, Del Cimmuto A *et al.* International Physical Activity Questionnaire: validation and assessment in an Italian sample. *Ital J Public Health* 2010; **7**: 369–376.
- 26 Weiss DS, Marmar CR. The impact of event scale—revised. In: Wilson JP, TMK, eds. *Assessing Psychological Trauma and PTSD*. New York, NY: The Guilford Press; 1997; 399–411.
- 27 Craparo G, Faraci P, Rotondo G, Gori A. The Impact of Event Scale - Revised: psychometric properties of the Italian version in a sample of flood victims. *Neuropsychiatr Dis Treat* 2013; **9**: 1427–1432.
- 28 Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983; **24**: 385.
- 29 Mondo M, Sechi C, Cabras C. Psychometric evaluation of three versions of the Italian Perceived Stress Scale. *Curr Psychol* 2021; **40**: 1884–1892.
- 30 Aljaberi MA, Alareqe NA, Qasem MA *et al.* Rasch modeling and multilevel confirmatory factor analysis for the usability of the impact of event scale-revised (IES-R) during the COVID-19 pandemic. *SSRN Journal*. <https://doi.org/10.2139/ssrn.3815681>
- 31 Wang C, Pan R, Wan X *et al.* Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health* 2020; **17**: 1729.
- 32 Maggi G, Baldassarre I, Barbaro A *et al.* Mental health status of Italian elderly subjects during and after quarantine for the COVID-19 pandemic: a cross-sectional and longitudinal study. *Psychogeriatrics* 2021; **21**: 540–551.
- 33 Finlay JM, Kler JS, O’Shea BQ, Eastman MR, Vinson YR, Kobayashi LC. Coping during the COVID-19 pandemic: a qualitative study of older adults across the United States. *Front Public Health* 2021; **9**: 323.
- 34 Füzéki E, Groneberg DA, Banzer W. Physical activity during COVID-19 induced lockdown: recommendations. *J Occup Med Toxicol* 2020; **15**: 25.
- 35 Rossi R, Jannini TB, Soggi V, Pacitti F, Di Lorenzo G. Stressful life events and resilience during the COVID-19 lockdown measures in Italy: association with mental health outcomes and age. *Front Psychiatry* [Internet] 2021; **12**: 1–8. <https://doi.org/10.3389/fpsy.2021.635832/full>.
- 36 Nwachukwu I, Nkire N, Shalaby R *et al.* COVID-19 pandemic: age-related differences in measures of stress, anxiety and depression in Canada. *Int J Environ Res Public Health* [Internet] 2020; **17**: 1–10.
- 37 González-Sanguino C, Ausín B, Castellanos MÁ *et al.* Mental health consequences during the initial stage of the 2020 Coronavirus pandemic (COVID-19) in Spain. *Brain Behav Immun* [Internet] 2020; **87**: 172–176. <https://doi.org/10.1016/j.bbi.2020.05.040>.
- 38 Sterina E, Hermida AP, Gerber DJ, Lapid MI. Emotional resilience of older adults during COVID-19: a systematic review of studies of stress and well-being. *Clin Gerontol [Internet]* 2021: 1–16. <https://doi.org/10.1080/07317115.2021.1928355>.
- 39 Jiménez-Pavón D, Carbonell-Baeza A, Lavie CJ. Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: special focus in older people. *Prog Cardiovasc Dis* 2020; **63**: 386–388.

## SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher’s website: <http://onlinelibrary.wiley.com/doi/supinfo>.

**Figure S1.** Median of International Physical Activity Questionnaire (IPAQ) scores (expressed in Metabolic Equivalent Task activity minutes per week) across domains, in pre-COVID-19 pandemic and during lockdown in the first wave (Study 1, upper panel) and in the second wave (Study 2, lower panel). The lower and upper hinges correspond to the first and third quartiles. The upper whisker extends from the hinge to 1.5 \* interquartile range (IQR); the lower whisker extends from the hinge to 1.5 \* IQR.