Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Mental Health and Physical Activity 19 (2020) 100361

Contents lists available at ScienceDirect

Mental Health and Physical Activity

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

Resilience and physical activity in people under home isolation due to COVID-19: A preliminary evaluation

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ARTICLE INFO

Keywords:
Confinement
Quarantine
Coronavirus
Vigorous physical activity
Psychological effects

ABSTRACT

Background: The recent shelter-in-place order issued by the Spanish government (due to the outbreak of the COVID-19) forced the Spanish population to self-isolate at home. The psychological and social effects of this new situation are unknown. Therefore, this study aimed to examine the impact of such scenario on citizens' resilience, as well as the connections between resilience, physical activity (PA), gender, weight and body mass index (BMI) before and after confinement, and COVID-19-related information.

Methods: A total of 1795 people answered an online questionnaire conducted on March 21st, 2020, seven days after the mandatory shelter-in-place health order was issued.

Results: Results showed that individuals who regularly engaged in Vigorous PA during the first week of confinement reported higher resilience in terms of higher locus of control, higher self-efficacy, and higher optimism. Moreover, inter-personal resilience differences were observed based on gender, age groups, BMI, weight, and people living with dependent persons or under health risk conditions.

Conclusion: To the best of our knowledge, these findings are the first quantitative evidence pointing towards a link between engagement in Vigorous PA and resilience within the COVID-19 restrictions in Spain. These findings may have important implications for general population during the course of this pandemic, or future ones.

1. Introduction

On January 30, 2020, the World Health Organization (WHO) warned that the new coronavirus (COVID-19) outbreak was an international public health emergency. Forty-four days later, the Spanish government ruled a nationwide lockdown. It is considered a vital protective measure, but it may have considerable psychological impact (Brooks et al., 2020).

Various studies have assessed the psychological and social consequences of being confined in different scenarios, such as hospitals (Purssell, Gould, & Chudleigh, 2020) or prisons (Haney, 2018). Many studies have shown negative psychological effects including post-traumatic stress symptoms, confusion, anger, emotional disturbance, depression, stress, low mood, irritability, insomnia, anxiety, and irritability (See Brooks et al., 2020). Thus, the understanding of the psychological consequences of self-isolation during the COVID-19 pandemic is needed (Duan & Zhu, 2020).

Resilience explains how individuals' use coping resources in the face of stressors, and their ability to effectively adapt those resources to manage stressful situations (Rutter, 2007). Researchers have theorized during the first days of the pandemic that psychological problems, including individuals' anxiety, depression, and stress, could increase (Duan & Zhu, 2020). In order to overcome this extraordinary state of confinement, it seems important for individuals to use stress prevention techniques or behavioural coping strategies (Pagel & Choukèr, 2016). Resilience has been identified as an indicator of successful stress-coping ability (Connor & Davidson, 2003) that could provide citizens under confinement an advantage for overcoming such situation (Pagel & Choukèr, 2016). Higher levels of resilience have been found positively related to mental and physical health in the general population (Schure, Odden, & Goins, 2013; Wermelinger et al., 2018), and might be a protective factor for chronically ill populations (McGowna et al., 2018).

The aim of minimizing mental and physical problems caused by COVID-19 restrictions has also given rise to new psychological questions. For instance, was the population facing their confinement properly? What strategies could help them minimize physical and mental health problems? Physical Activity (PA) has been named as one of them. Unfortunately, the shelter-in-place health order may have led to a reduction in individuals' PA. This is a serious concern because negative

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https://doi.org/10.1016/j.mhpa.2020.100361
Received 17 May 2020; Received in revised form 29 September 2020; Accepted 30 September 2020
Available online 2 October 2020
1755-2966/

psychological effects of prolonged periods of physical inactivity have been reported (Dolenc & Pišot, 2011; Dolenc, Pišot, Tušak, & Dimec, 2008). Moreover, PA has been recently proposed as an important strategy for healthy living during the coronavirus crisis (Chen et al., 2020). The benefits of regular participation in PA have been well documented, showing inverse relationships between PA and cardiovascular risk, diabetes, and some types of cancer, and beneficial effects on a number of mental health outcomes (Penedo & Dahn, 2005; WHO, 2010). Likewise, physical exercise has been related to beneficial effects in terms of more balanced mood while in isolation (Abeln et al., 2015). Therefore, it is important to understand how the preventive measures against the outbreak of the COVID-19 may be related to different psychological and social aspects of individuals that remained home isolated during the quarantine. This study aimed to assess general Spanish population resilience and PA levels after the first week of the shelter-in-place health order issued, and to evaluate the relationship between resilience and PA levels.

2. Material and methods

2.1. Participants and procedure

The sample comprised 1795 adults from Spain (656 males and 1150 females), aged 16–82 years (M_{age} = 40.54 years, SD = 15.68 years). All participants answered to an online questionnaire posted on March 21st, , 2020, seven days after the mandatory shelter-in-place health order was issued. The survey was online for four days. However, the participants' responses indicated that some of them might self-isolated themselves before the mandatory order was issued, while others (by unknown reasons) started their confinement one or two days after the mandatory order took effect. Table 2 shows personal and demographic characteristics.

Permission to conduct the study was obtained from the researchers' State Ethics Research Committee. The research team developed an online questionnaire that was distributed via e-mail, press, WhatsApp, Twitter, and Facebook. Participants could read on the first page that their responses would be kept anonymous and they could withdraw at any time. Thus, informed consent was obtained from all participants.

2.2. Instruments and measures

2.2.1. Resilience

It was assessed using a Spanish version of *The Connor-Davidson CD-RISC resilience scale* (Connor & Davidson, 2003). In this study, 15 items were used with a Likert Scale ranged from 1 (*completely disagree*) to 4 (*completely agree*). These allow measuring the ability to face adversity and comprise three resilience factors: Locus of Control and commitment, challenge of behaviour orientated towards action and Self-efficacy, and Optimism. Participants responded to the stem: "Indicate to what extent you feel right now". The original instrument has shown adequate psychometric properties in general population (Connor & Davidson, 2003).

Table 1
Means, Standard Deviations, and bivariate correlations between different physical activity intensities and different factors of resilience.

	M	*SD*	1	2	3	4	5
1. VPA	59.14	118.18	1				
2. MPA	96.38	162.24	.2	1			
3. LPA	334.38	547.08	.00	.27**	1		
4. Locus	2.92	0.61	.09**	.08**	.05*	1	
5. Self-efficacy	3.00	0.53	.09**	.07**	.02	.78**	1
6. Optimism	2.92	0.59	.08**	.06**	.04	.71**	.77**

Note. **$p < .01$, *$p < .05$. VPA = Vigorous Physical Activity; MPA = Moderate Physical Activity; LPA = Light Physical Activity.

2.2.2. Physical activity

The international PA Questionnaire (IPAQ; Booth, 2000) is an instrument developed for cross-national monitoring of PA and inactivity. In this study, the Spanish validated version (obtained at www.ipaq.ki.se) of the short form, 7-day recall, was used (Craig et al., 2003). This is the most appropriate outcome measure for clinical and research use (Craig et al., 2003) and its measurement properties have been found acceptable for monitoring PA levels in populations above 15 years of age. This version provides information about the time spent involved in three PA intensity levels: (a) walking (LPA), (b) moderate (MPA), and (c) vigorous (VPA).

2.2.3. Other measures

To obtain information about the participants' personal and demographic factors of their confinement, additional questions were included in the survey: age; gender; participant's BMI = weight (kg)/[height (m)]^2 (underweight: < 18.5, normal weight: 18.5–24.9, overweight: 25.0–29.9, obese: ≥ 30.0); and weight (Kg) before and after the first week of confinement. COVID-19-related information was also obtained: "*Do you live with someone diagnosed with a COVID-19 risk condition or related disease*?", "*Do you live with any dependent person*?", and "*How many days have you been shelter-in-place*?"

2.3. Data analysis

All data were analysed using SPSS version 24.0 (IBM Co. LTD, Chicago, IL, USA). Lilliefors-corrected Kolmogorov-Smirnov test showed that data was not normally distributed. Therefore, the Mann-Whitney *U* test was used to assess between-group differences. Descriptive statistics included size (*n*) and frequency (%) for categorical variables. Different Generalized Lineal Models (GLM) were built. The dependent variables were all the resilience factors, while the predictor variables were: VPA, MPA, LPA, and the remaining categorical variables. To build the GLM, all PA intensities were included, because this study aimed to analyze the links between resilience parameters and PA levels. Likewise, the covariates were incorporated until no additional improvement of the model was obtained. Only the interactions between the variables that were significant were included in the different models. Non-significant variables were removed to avoid over-parameterization (Hocking, 1976), which could dilute other effects. The model that minimized the variance of the residuals was chosen as the most appropriate, and robust estimation was considered when there was suspicion of heteroscedasticity. Then, the Omnibus test was used to interpret the results. Finally, the goodness of fit was assessed by deviance and Akaike's Information Criterion (AIC). Results were considered significant at $p < .05$.

3. Results

3.1. Descriptive statistics and bivariate correlations

Table 1 shows means, standard deviations and correlations for all the variables. Participants got involved in 1 h per week of VPA and MPA. Likewise, individuals spent more than 5 h per week on LPA. Regarding resilience, participants showed intermediate values. VPA and MPA were positively correlated with all resilience factors. Regarding LPA, it was only correlated with locus of control.

3.2. Personal and contextual differences

Descriptive statistics of the observed variables are shown in Table 2. This table also includes differences between the three resilience factors according to categorical variables. Results showed significant: a) gender differences among the three resilience factors (i.e., males scored higher than females in Locus: $z = -6.18$, $p < 001$, Self-efficacy: $z = -6.59$, $p < .001$ and Optimism: $z = -7.96$, $p < .001$; b) age group differences among the three resilience factors (i.e., citizens between 25 and 54 years old

Table 2
Means and Standard Deviations of all variables under study regarding Locus of Control, Self-efficacy, and Optimism.

			Locus of control		Self-efficacy		Optimism	
	n	%	*M*	*SD*	*M*	*SD*	*M*	*SD*
Gender								
Male	656	75.4	3.03[a]	0.62	3.09[a]	0.54	3.04[a]	0.60
Female	1139	24,6	2.87[b]	0.59	2.95[b]	0.51	2.84[b]	0.58
Age								
<25	442	24.7	2.90[a]	0.59	2.99[a]	0.44	2.88[a]	0.57
25-39	406	22.6	3.00[b]	0.57	3.08[b]	0.47	2.96[b]	0.56
40-54	539	30.1	2.95[ab]	0.63	3.02[ab]	0.57	2.95[b]	0.62
>54	408	22.7	2.90[a]	0.62	2.91[a]	0.61	2.86[a]	0.63
BMI								
Underweight	63	3.5	2.81[a]	0.53	2.97[a]	0.46	2.74[a]	0.52
Normal or Healthy Weight	1050	58	2.95[b]	0.60	3.00[a]	0.53	2.91[b]	0.59
Overweight	444	24,5	2,93[ab]	0.62	3.01[a]	0.57	2.93[b]	0.60
Obese	173	9.6	2.96[b]	0.64	3.02[a]	0.53	3.02[b]	0.61
Weight difference								
Weight gain (>1 Kg)	88	4.9	2.78[a]	0.73	2.91[a]	0.63	2.82[a]	0.65
Weight gain (0.1 -1 Kg)	295	16.3	2.82[a]	0.65	2.94[a]	0.58	2.85[a]	0.63
No difference	982	54.3	2.99[b]	0.61	3.03[a]	0.53	2.94[b]	0.59
Weight loss (0.1 Kg – 1 Kg)	276	15.3	2.96[b]	0.55	3.03[a]	0.47	2.96[b]	0.57
Weight loss (>1 Kg)	33	1.8	3.01[b]	0.54	3.24[b]	0.44	3.07[b]	0.57
Living with someone at risk								
No	1364	75.4	2.95[a]	0.62	3.02[a]	0.54	2.94[a]	0.60
YES	445	24.6	2.89[a]	0.59	2.96[b]	0.51	2.86[b]	0.59
Living with dependent								
NO	1607		2.93[a]	0.61	3.00[a]	0.52	2.92[a]	0.59
YES	202		2.93[a]	0.64	2.96[a]	0.59	2.85[b]	0.67
Days shelter-in-place								
5 days	616	34.1	2.92[a]	0.62	2.98[a]	0.55	2.89[a]	0.62
6 days	577	31.9	2.95[a]	0.58	3.03[a]	0.49	2.93[a]	0.55
7 days	424	23.4	2.94[a]	0.64	2.99[a]	0.52	2.92[a]	0.62
8 or more days	192	10.6	2.93[a]	0.60	3.01[a]	0.56	2.94[a]	0.60

Note: Different superscripts in the same column show statistically significant differences at $p < .05$ when comparing two or more groups. The same superscript means that there are not statistically significant differences; BMI = Body Mass Index.

scored higher than participants from other age groups): >25 years: Locus: $z = -2.28$, $p < .05$, Self-efficacy: $z = -2.78$, $p < .01$ and Optimism: $z = -2.22$, $p < .05$; <50 years: Locus: $z = -2.24$, $p < .05$, Self-efficacy: $z = -4.62$, $p < .001$ and Optimism: $z = -2.08$, $p < .05$; c) BMI during confinement differences: underweight citizens scored lower on Locus than normal or healthy weight: $z = -2.11$, $p < .05$ or obese: z

Table 3
GLM including the three factors of resilience as dependent variables.

	B	DE	Wald	*p*	Exp(B)	95% CI	
						Lower	Upper
Model 1	Locus de Control						
VPA	.040	.015	7.32	.007	1.041	1.011	1.072
MPA	.026	.015	2.88	.090	1.026	.996	1.058
LPA	.031	.015	4.42	.036	1.032	1.002	1.062
Gender	-.154	.030	26.54	.000	.715	.602	.848
Model 2	Self-efficacy						
VPA	.028	.014	4.22	.040	1.028	1.001	1.056
MPA	.017	.014	1.51	.219	1.017	,990	1.046
LPA	.014	.014	.95	.331	1.014	.986	1.042
Age	-.003	.001	14.37	.000	,997	.995	.998
Gender	-.151	.027	30.42	.000	.8600	.815	.907
Weight differences							
Weight gain (>1 Kg)	-.322	.107	8.93	.003	.725	.587	.895
Weight gain (0.1 Kg - 1 Kg)	-.275	.097	8.06	.003	.659	.628	.918
No difference	-.176	.094	3.52	.061	.839	.698	1.008
Weight loss (0.1 Kg – 1 Kg)	-.196	.097	4.06	.044	.822	.679	.995
Weight loss (>1 Kg)	1	–	–	–	–	–	–
Model 3	Optimism						
VPA	-.008	.003	5.90	.015	.992	.986	.999
MPA	-.344	.084	16.41	.000	.709	.600	.837
LPA	.004	.002	4.61	.032	1.004	1.000	1.008
Gender	.042	.015	8.28	.004	1.043	1.013	1.073
BMI							
Underweight	-.245	.092	7.08	.008	.783	.654	.938
Normal or Healthy Weight	-.082	.050	2.64	.104	.922	.835	1.017
Overweight	-.096	.053	3.19	.074	.909	.818	.1.009
Obese	1	–	–	–	–	–	–

Note. VPA= Vigorous Physical Activity; MPA = Moderate Physical Activity; LPA = Light Physical Activity; BMI = Body Mass Index.

= 2.13, $p < .05$. Likewise, underweight citizens scored lower on Optimism than normal or healthy weight: $z = -2.96$, $p < .01$, overweight: $z = -3.25$, $p < .001$ or obese: $z = -3.44$, $p < .001$; d) weight differences after one week of confinement (i.e., participants who kept their weight or decreased more than one Kg. showed higher Self-efficacy than the other groups [see Table 2]); e) coexistence at living place differences: participants who lived with someone with risk condition scored lower in Self-efficacy: $z = -2.12$, $p < .05$ and Optimism: $z = -2.79$, $p < .01$, and participants who lived with a dependent person showed lower Optimism: $z = -2.03$, $p < .05$. Finally, number of self-ísolation days showed no significant differences in any of the three resilience factors.

3.3. Generalized linear models

Table 3 represents GLM analyses. The three resilience factors were included as dependent variables. Omnibus test resulted significant: Locus: $x^2 = 48.52$ (4), $p < .001$, Self-efficacy: $x^2 = 68.99$ (9), $p < .001$ and Optimism: $x^2 = 65.04$ (7), $p < .001$. Model 1 showed that VPA ($\beta = 0.040$, $p < .01$) and LPA ($\beta = 0.031$, $p < .05$) positively predicted Locus of control after controlling for gender (males scored higher than females). However, there was no significant predictive value for the categorical variables. Model 2 indicated that only VPA ($\beta = 0.028$, $p < .05$) positively predicted self-efficacy after controlling for gender (males scored higher than females) and age (older people scored higher). There was also a significant difference in weight changes (people who lost weight after the first week of confinement showed higher self-efficacy). Finally, model 3 showed that VPA ($\beta = 0.040$, $p < .01$) positively predicted Optimism after controlling for gender (males scored higher than females). In this model, BMI also showed a significant effect (obese people showed more optimism than underweight people).

4. Discussion

This study aimed to analyze the relationships between resilience and PA levels at the end of the first week of confinement due to coronavirus pandemic restrictions. Global results showed that resilience was dependent on personal factors such as gender, age or weight, but also contextual factors such as living with a dependent person or with someone at risk. For instance, it seemed that males were facing this first week of confinement with higher resilience than females. Likewise, people aged between 25 and 54 years also scored higher in resilience than people of other age groups. This is consistent with related research that has shown that males are more resilient and use more coping strategies than females (Hu, Zhang, & Wang, 2015) and that resilience improves with age (McGowan et al., 2018). However, in this specific scenario, it is understandable that people at risk (i.e., above 55 years old) would be less optimistic about how the pandemic will end. In this regard, people who were living with dependent people or someone at risk have shown lower optimism. Living with some at risk can also lead to less self-efficacy. These results suggest that this sector of population was very worried about the effects of this pandemic. Likewise, people living with someone at risk were also especially concerned about the challenging task that they must face during the confinement. This is consistent with previous research that found that having relatives infected with COVID-19 was a risk factor for increasing anxiety (Cao et al., 2020). Understanding those differences is important because resilience has been related with overall well-being (McGowan et al., 2017) and life satisfaction (Hu et al., 2015).

It was found that obese people showed higher scores in optimism than underweight people. In contrast, previous studies have found positive associations between optimism and low BMI and healthy diet (e.g., Kelloniemi & Laitinen, 2005). However, this is the first occasion that these links have been analysed in a scenario where the population was self-confined in their homes. It has been reported that time spent on cooking was perceived as one of the most effective strategies to cope with self-isolation (Taylor et al., 2020). Likewise, a stressful situation, such as the COVID-19 pandemic, can result in preferences for palatable food (Singh, 2014). In this regard, reward and gratification associated with food consumption leads to dopamine production (Singh, 2014) and a recent study concluded that dopamine enhances optimism in humans (Sharot et al., 2020). On the other hand, the consumption of palatable rewarding food reduces the acute stress response, uncovering a potential of "comfort eating" to relief stress (Singh, 2014). Evidence suggests that a significant number of obese people display food addiction behavior (Meule, Hermann, & Kübler, 2015). Therefore, since obese people could be more prone to over-eat in this scenario, they could have perceived such comfort and relieve while responding to the survey. Nevertheless, according to Pellegrin et al. (2020) individuals with obesity significantly gained weight one month after the beginning of the confinement, which was related with the adverse mental burden linked to the COVID-19. New scenarios (e.g., COVID-19 pandemic) could show unexpected patterns in people's behavior. Hence, more research is needed.

The results showed that participants' PA was associated with all resilience factors. Specifically, VPA and LPA levels predicted Locus of control, and only VPA predicted self-efficacy and optimism. In other words, people who engaged regularly in VPA during the first week of confinement were more likely to cope better with the demands of the shelter-in-place order. This is consistent with previous studies, which found that PA is positively related with resilience (Wermelinger et al., 2018) and Locus of Control (Coob-Clark et al., 2014), indicating that those individuals who were more resilient were more inclined to be physically active during the confinement. Compared with individuals with low resilience scores, people with high scores tend to have more positive emotions in stressful situations (Tugade & Fredrickson, 2004) and to have more emotional flexibility in response to a stressful psychological task (Waugh, Thomson, & Gotlib, 2011). Similar effects have been observed on PA (Yoshikawa, Nishi, & Matsuoka, 2016). It is thought that physical exercise might influence the stress-coping system (Klaperski, von Dawans, Heinrichs, & Fuchs, 2013). This assumption has been widely discussed in the scientific literature. For example, the "Cross-Stressor Adaptation hypothesis" (CSA hypothesis) suggests that regular exercise leads to biological adaptations which contribute to a reduced physiological reaction of the sympathetic nervous system (SNS) and the hypothalamic–pituitary–adrenal (HPA) axis to stressors in general (Tsatsoulis & Fountoulakis, 2006). Hence, PA can contribute to a health-protective lower physiological reactivity and faster physiological recovery from stressful events (Tsatsoulis & Fountoulakis, 2006). PA also increases brain-derived neurotropic factor, which protects neurons in regions of the brain that are related to the response in stressful situations (Holmes, 2014). It has also been demonstrated that PA of certain intensity activates the hippocampus, inactivates the prefrontal cortex, and reduce the cortisol response to an emotional task (Zschuke et al., 2015). Likewise, more physically active people seem to have improved emotion regulation and more adaptive stress coping by cognitive reappraisal (Perchtold-Stefan et al., 2020). Yoshikawe et al. (2016) suggested that PA might promote resilience. However, the present study did not assess any of these constructs and further research should provide a more comprehensive picture of these mechanisms.

In the present study, resilience was analysed focusing in locus of control, self-efficacy, and optimism. Traditionally, locus of control scales included dimensions of internal, external and chance in life general. In this regard, using a health locus of control scale would have been interesting since staying at home and not exercising may have been an expression of internal control, and getting involved in some form of PA may have also been an expression of internal control, if the individual thought that it strengthened the immune system. The results of this study are in line with works that have highlighted the need to maintain regular PA during the COVID-19 pandemic (Chen et al., 2020; Halabchi, Ahmadinejad, & Selk-Ghaffari, 2020).

5. Conclusion

Results pointed to the relevant role of VPA and that personal and contextual factors are related to resilience, and they should be considered. Experts have warned that mandatory shelter-in-place orders due to the COVID-19 could be repeated in the future. The present study should acknowledges some limitations. The first one is that data is preliminary and only involved Spanish citizens. Secondly, PA levels and weight were measured using a self-report questionnaire and a cross-section design. While self-reports of weight are generally considered a valid method of data collection, these information should be considered cautiously because previous studies showed that overweight individuals, women and younger individuals tend to underestimate their weight (Bonn, Lagerros, & Bälter, 2013). Regarding resilience, it would be interesting to use a scale to assess health locus of control, because it would provide a better understanding of the associations found in the present study. Moreover, since we adapted the administration of this scale, it is impossible to know what the results mean in relation to all other reports of the CD-RISC. Finally, the baseline of PA patterns could not be measured before the shelter-in-place order was issue and given the cross-sectional design, no causal relationships can be derived from the results. These limitations should be taken into consideration in future works.

Data availability statement

Data are available for research. Any further inquiries can be directed to the authors.

Declaration of competing interest

The authors report no conflict of interest.

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