Physical Activity, Stress and Quality Of Life among Community-Dwelling Older Adults in Shenzhen during the Post-COVID-19 Pandemic Period

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Abstract

Background: The COVID-19 pandemic and the associated preventive measures resulted in a substantial disruption of daily life. To date, almost 2 years after the initial outbreak, there has been no specific investigation of the effects of COVID-19 on community-dwelling older adults. Objectives: To investigate the levels of physical activity, stress and quality of life of community-dwelling older adults 2 years after the outbreak of COVID-19, and to quantify the relative contributions of physical activity and stress to their quality of life in the post-COVID-19-pandemic period. Methods: Two hundred and thirty-four community-dwelling older adults completed an online survey comprising a sociodemographic data sheet and questionnaires including the Chinese versions of the Physical Activity Scale for the Elderly (PASE-C), the Perceived Stress Scale (CPSS-10) and the European Quality of Life Questionnaire Five-Level Scale (EQ-5D-5L). Descriptive statistics, group comparisons and correlation coefficients were used to evaluate the levels of physical activity and stress and quality of life. Multiple linear regression was used to determine the relative power of the independent variables to predict the EQ-5D-5L index value. Results: When compared with a previous local study before the outbreak of COVID-19 pandemic, the level of physical activity decreased by approximately 12% in community-dwelling older adults during the post-COVID-19-pandemic period. Our final regression model predicted 51.0% of the variance in the Chinese version of the EQ-5D-5L index. Conclusion: The levels of physical activity and perceived stress were found to be significantly correlated with the quality of life of community-dwelling older adults during the post-COVID-19 period. Future studies should focus on developing and testing strategies to promote physical activity and stress management in this cohort during future pandemics.

Introduction

COVID-19 is a deadly infectious disease that has caused a total of 318 million cases and 5.5 million deaths as of 14 Jan 2022.[1] The first confirmed case of COVID-19 was reported on the literature MedRxiv in Mar 3, 2020.[2] To control the spread of COVID-19, a series of preventive measures, such as border restrictions, quarantine and isolation, and social distancing, were implemented by the government. The COVID-19 pandemic and the associated preventive measures resulted in a substantial disruption of daily life, which, in turn, led to reduced physical activity, increased stress and compromised quality of life (QoL). Previous studies reported that the long-term isolation or home-confinement may have negative effects on psychosocial and mental health, especially causing stress, negative emotions, and impaired cognition,[3] and immune system and physiological functions suppress from prolonged isolation may increase the risk of exposure to SARS-CoV-2.[4] WHO strongly suggested that people stay physically active at home in order to optimize their health status, decrease the negative psychosocial consequences of confinement, and maintain their immune system function during the COVID-19 pandemic.

Shenzhen, adjacent to Hong Kong, jointly forms the most developed international metropolitan circle in the world, with a huge population and economic aggregate. The quality of life of residents is crucial to economic and social development. Especially under the environment of the large-scale SARS-CoV-2

pandemic, how to balance and reduce the impact of the prevention and control policies on the quality of life is a very important proposition. Physical activity is important for healthy aging.[5] It is associated with various health-related outcomes, including health status and functional capacity,[6] chronic illnesses (e.g., type 2 diabetes mellitus and coronary heart disease),[7] cognitive functions (e.g., executive function and memory),[8] physical performance of daily activities,[9] the risk of falling,[10] mortality[11] and quality of life.[12] Notably, decreased levels of physical activity (PA) in people of different age groups have been reported globally during the COVID-19 pandemic. In a systematic review of 66 studies, Stockwell et al.[13] reported that during the COVID-19 pandemic, children, healthy adults and patients across the globe had decreased levels of physical activity and increased sedentary behaviour.

Worldwide, the general public have been facing the fear of being infected, and experiencing stress associated with infringed personal freedoms, disrupted normal living activities and economic turbulence resulting from the imposition of these preventive measures and the COVID-19 pandemic. Krishnamoorthy et al.[14] conducted a systematic review and meta-analysis of 50 studies from different countries and found that the prevalence of stress and psychological distress (e.g., post-traumatic stress symptoms and poor sleep quality) among the general population amid the COVID-19 pandemic was 36% and 26%, respectively. The prevalence of stress in the general public was found to be even higher than its prevalence in healthcare workers (33%). Moreover, Goularte et al.[15] reported that other psychiatric symptoms, such as anger and somatic symptoms, are remarkably high among the general population.

Quality of life is a socially relevant construct and should be understood through the lens of contemporary social circumstances. The COVID-19 pandemic and its associated preventive strategies are influential worldwide and may induce a vicious cycle of ‘restricted physical activities–chronic stress’.[16] This vicious cycle, in turn, may further suppress the immune system and increase the risk of contracting COVID-19. In Shenzhen, the effect of the COVID-19 pandemic on physical activity and stress is largely unknown, especially among the older general population who are vulnerable to infection and at a higher risk of severe complications from COVID-19.[17] To date, 2 year after the initial outbreak, there has been no specific investigation of the effects of COVID-19 on physical activity, stress and quality of life among community-dwelling older adults. Thus, the objectives of this study were to investigate the levels of physical activity and stress and quality of life of community-dwelling older adults during the post-COVID-19-pandemic period; determine whether physical activity and stress independently contribute to their quality of life and to quantify the relative contributions of physical activity and stress to their quality of life when sociodemographic variables are also considered.

Material And Methods

Study Design

In this study, a cross-sectional online survey (by Internet App: Questionnaire Star, https://www.wjx.cn) was used to gather information from community-dwelling older adults in Shenzhen. In this survey, the

QoL questionnaire was designed according the self-administered WHO Quality of Life Instrument-Short Form (WHOQOL-BREF). It comprised 26 items including domains and facets (or sub-domains). The first two items assessed the “overall rating of QoL (OQOL)” and subjective satisfaction with health. The other 24 items measured four domains, namely, physical health (seven items), psychological health (six items), social relations (three items), and environment (eight items). The participants marked a response using a 5-point Likert scale [ranging from 1 (very dissatisfied/very poor) to 5 (very satisfied/very good)]. The domain scores of the WHOQOL-Bref were computed according to the guideline of the WHO. In 2021, 234 subjects were recruited if they were Shenzhen residents aged ≥ 60 years (elderly people with cognitive deficits, illiterates, vision problems can be also included under the help of their kinsfolk), besides, they were also eligible to meet the following inclusion criteria: 1) not using alcohol, drugs, or other substances; 2) no comorbidities and/or orthopedic limitations. Subjects were excluded if they were living in nursing care homes or institutions, and those who were not compliant to government guidelines at home during the COVID-19 epidemic were also excluded. Subjects completed the online questionnaires after signed a free and informed consent form. Local institutional ethical approval was provided for this study, which was conducted in accordance with the Declaration of Helsinki. Data were collected using online questionnaires and a sociodemographic data sheet (detailed information are available on https://www.wjx.cn).

Outcomes

The Physical Activity Scale for the Elderly (PASE)[18] was used to assess the level of physical activity during the past 7 days. The PASE uses a 10-item 4-point Likert scale to assess 12 categories of activities in three domains, including leisure time activities, household activities and work-related activities. The total score ranges from 0 to > 400, with a higher score indicating a higher level of physical activity. The Chinese version of PASE (PASE-C) has been shown to demonstrate excellent test-retest reliability (intraclass correlation coefficient [ICC] = 0.98) and acceptable internal consistency (Cronbach’s α = 0.71) among older adults with chronic obstructive pulmonary disease.[19]

The Perceived Stress Scale (CPSS-10)[20] was used to assess the level of self-perceived stress. It is a 10-item 5-point Likert scale with two factors: perceived helplessness and perceived self-efficacy. The total score ranges from 0 to 40, with higher scores indicating greater perceived stress. Scores ≤ 13, from 14 to 26, and ≥ 27 reflect low, moderate and high levels of perceived stress, respectively. The Chinese version of PSS-10 (CPSS-10) has been shown to demonstrate good internal consistency (Cronbach’s α = 0.86) and test-retest reliability (ICC = 0.68).[21]

The European Quality of Life Questionnaire Five-Level Scale (EQ-5D-5L)[22] was used to assess health-related quality of life. The EQ-5D-5L consists of two parts: the EQ-5D descriptive system and the EQ visual analogue scale (EQVAS). The EQ-5D descriptive system comprises five subscales (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression). It was converted to an EQ-5D-5L index value based on the Chinese version EQ-5D-5L value set in the present study.[23] The index values range from − 1 (negative values represent a condition worse than death) to 1 (full health). The EQVAS values indicate the

overall health status and range from 0 to 100 (100 indicates the best imaginable health). The Chinese version of the EQ-5D-5L has been shown to demonstrate good internal consistency (Cronbach's α = 0.78) and test-retest reliability (ICC = 0.777) among people with idiopathic scoliosis.[24]

Data analysis

Statistical analyses were performed using the Statistical Package for Social Sciences version 26.0 (IBM, Armonk, NY, USA). The significance level was set at 0.05. Data normality was assessed using the Kolmogorov-Smirnov test. Sociodemographic data and variables of interests were summarised using descriptive statistics. An independent Student's t-test or an analysis of variance was used to compare PASE-C, CPSS-10 and EQ-5D-5L index values and EQVAS scores between groups when appropriate.

The relationships between the sociodemographic data and PASE-C, CPSS-10, EQ-5D-5L index and EQVAS mean scores were examined using Pearson's correlation coefficients. To control for sociodemographic differences, partial correlation coefficients were calculated for the PASE-C and CPSS-10 scores. Multiple linear regression (forced entry mode) was used to determine the relative power of the independent variables to predict the EQ-5D-5L index value.

Results

Participants' characteristics

In total, 109 male (46.4%) and 125 female (53.6%) participants who completed the online survey (Table 1). Their mean age was 71.82 years (standard deviation [SD] = 7.07), ranging from 60 to 93 years. Most participants were living with others (67.2%), while the remaining were living alone (32.8%). Half of the participants had received a primary education or below (49.6%), whereas 10.3%, 31.6% and 8.5% of the participants had received no education, a secondary-level education or below, or an undergraduate-level education or above, respectively.

Table 1
Sample characteristics

	n = 234	Percentage
Age (mean ± SD)	71.82 ± 7.07	
Gender		
Male	109	46.4
Female	125	53.6
Living condition		
Living Alone	77	32.9
Living with Others	157	67.1
Educational Level		
Not educated	24	10.3
Primary level or below	116	49.6
Secondary level	74	31.6
Undergraduate or above	20	8.5

Levels of physical activity, perceived stress and quality of life

Table 2 summarises the variables of interest. Based on data from the PASE-C, the most frequent physical activity was light housework (mean [M] ± SD = 19.98 ± 10.04) and the least frequent physical activity was muscle strength and endurance activities (M ± SD = 1.03 ± 3.52). Stratified comparisons (Appendix 1) revealed that there were no significant differences in the PASE-C, CPSS-10, EQ-5D-5L utility and EQVAS mean scores between men and women. For participants with different living status, there were no significant differences in PACE-C household activity and work-related activity subscales, CPSS-C and EQ-5D-5L utility mean scores. However, there were significant in the PASE-C leisure time activity subscale and EQVAS mean scores.

For the participants with different educational level, there were significant differences in the PACS-C leisure time activity domain, the CPSS-10, EQ-5D-5L utility and EQVAS mean scores. Our post hoc analysis revealed that participants who had received primary level or below education were significantly different from those of participants who had received a secondary-level education. Moreover, our post hoc analysis revealed that there were significant differences in mean EQ-5D-5L utility scores between those who had received no education (0.49 ± 0.46) and those who had received a secondary-level education or below (MD -0.37; CI -0.57, -0.17; $p < 0.001$) or an undergraduate-level education or above (MD -0.34; CI -0.60, -0.81; $p < 0.01$).

Table 2
Mean and standard deviation of PASE-C, CPSS-10, EQVAS and EQ-5D-5L

	Mean	SD
PASE-C overall score	91.77	60.92
Leisure time activity	24.91	27.40
Walk outside home	13.70	13.39
Light sports and recreational activities	3.85	7.54
Moderate sports and recreational activities	3.57	8.31
Severe sports and recreational activities	2.76	11.53
Muscle's strength and endurance activities	1.03	3.52
Household activity	56.57	34.62
Light housework	19.98	10.04
Heavy housework	15.71	12.11
Home repairs	1.41	6.36
Lawn work and yard care	2.62	9.36
Outdoor gardening	3.85	7.90
Caring for another person	13.01	16.95
Work-related activity		
Paid work	7.40	26.80
CPSS-10	15.97	7.19
EQVAS	74.34	10.30
EQ-5D-5L index	0.73	0.34

PASE-C, Chinese version of Physical Activity Scale for the Elderly; CPSS-10, Chinese version of the Perceived Stress Scale; EQVAS, European quality of life visual analogue scale; EQ-5D-5L, European Quality of Life Questionnaire 5 level scale.

Relationship between sociodemographic data and PASE-C, CPSS-10, EQ-5D-5L index and EQVAS scores

Table 3 presents the correlations of sociodemographic data with the PASE-C, CPSS-10 and EQ-5D-5L scores. Among the chosen sociodemographic data, age had significantly negative weak to moderate correlations with PASE-C, EQ-5D-5L index and EQVAS mean scores, and significantly negative weak correlation CPSS-10 mean scores. While living status was found to have significantly positive weak

correlations with EQ-5D-5L index and EQVAS, educational level showed significantly positive weak correlations with EQ-5D-5L index, EQVAS and CPSS-10 mean scores. There were no significant correlations between sex with PASE-C, CPSS-10, EQ-5D-5L index and EQVAS mean scores, and no significant correlations between PASE-C and CPSS-10 mean scores. Nonetheless, there were significant partial correlations between the PASE-C ($r = 0.292$, $p < 0.001$), CPSS-10 ($r = -0.56$, $p < 0.001$) and EQ-5D-5L index scores after controlling for the age, living status and educational level (Table 4).

Table 3
Correlations between sociodemographics, PASE-C, CPSS-10 and EQ-5D-5L scores

	Age	Sex	Living status	Educational level	PASE-C	CPSS-10
PASE-C	r=-0.25, p < 0.001	r = 0.06, p = 0.33	r = 0.09, p = 0.17	r = 0.08, p = 0.26	-	r=-0.09, p = 0.16
CPSS-10	r = 0.19, p = 0.004	r = 0.04, p = 0.53	r=-0.14, p = 0.04	r=-2.4, p < 0.001	r=-0.09, p = 0.16	-
EQ-5D-5L index	r=-0.39, p < 0.001	r = 0.09, p = 0.17	r = 0.23, p = 0.001	r = 0.32, p < 0.001	r = 0.43, p < 0.001	r= -0.41, p < 0.001
EQVAS	r=-0.23, p < 0.001	r=-0.01, p = 0.84	r = 0.10, p = 0.12	r = 0.19, p = 0.005	r = 0.27, p < 0.001	r=-0.41, p < 0.001

PASE-C, Chinese version of Physical Activity Scale for the Elderly; CPSS-10, Chinese version of the Perceived Stress Scale; EQVAS, European quality of life visual analogue scale; EQ-5D-5L, European Quality of Life Questionnaire 5 level scale.

Table 4
Partial correlation coefficients (controlling for age, living status and educational level) between EQ-5D-5L index and other variables

Variables	Partial Correlation Coefficients with EQ-5D-5L index	P
PASE-C	0.292	< 0.001
CPSS-10	-0.56	< 0.001

PASE-C, Chinese version of Physical Activity Scale for the Elderly; CPSS-10, Chinese version of the Perceived Stress Scale

Physical activity, stress and EQ-5D-5L index values

Multiple linear regression analysis that included age, living status, educational level, PASE-C scores and CPSS-10 scores predicted 51.0% ($F_{5, 228} = 47.423$, $p < 0.001$) of the variance in EQ-5D-5L index values (Table 5). After adjusting for the other variables, the PASE-C and CPSS-10 scores remained independently associated with the EQ-5D-5L index value, accounting for 30.6% of the variance, and the model prediction significantly improved (F change, 110.686; $p < 0.001$). The CPSS-10 scores were the best predictor of the EQ-5D-5L index value, as indicated by the magnitude of the standardised regression coefficient (β =

-0.508, see model 3 in Table 4) and Pearson's correlation coefficient (r = 0.190, p = 0.004) of the predictive model (Table 3).

Table 5
Multiple linear regression analyses (forced entry) relating EQ-5D-5L index with the other variables

Model No.	Independent variables	R^2 (R^2 Adjusted)	R^2 Change	B(SE)	β	P
Model 1		0.204 (0.193)	0.204			
	Age			-0.15(0.003)	-0.312	< 0.001
	Living status			0.083(0.045)	0.114	0.069
	Educational level			0.079(0.028)	0.182	0.005
Model 2		0.272 (0.259)	0.068			
	Age			-0.12(0.003)	-0.247	< 0.001
	Living status			0.072(0.043)	0.099	0.100
	Educational level			0.081(0.027)	0.187	0.003
	PASE-C			0.002(0.000)	0.269	< 0.001
Model 3		0.510(0.499)	0.238			
	Age			-0.009(0.002)	-0.190	< 0.001
	Living status			0.052(0.036)	0.072	0.146
	Educational level			0.040(0.022)	0.093	0.074
	PASE-C			0.001(0.000)	0.246	< 0.001
	CPSS-10			-0.024(0.002)	-0.508	< 0.001

PASE-C, Chinese version of Physical Activity Scale for the Elderly; CPSS-10, Chinese version of the Perceived Stress Scale

Discussion

In this cross-sectional survey, we investigated the levels of physical activity and stress and quality of life of community-dwelling older adults in Shenzhen during the post-COVID-19-pandemic period. To the best of our knowledge, no other study has investigated the contribution of physical activity and stress to the quality of life of community-dwelling older adults during this period.

Physical activity of community-dwelling older adults during the post-COVID-19-pandemic period

The PASE-C scores (M = 91.8; SD = 60.9) suggested an approximately 12% decrease in the level of physical activity of community-dwelling older adults during the post-COVID-19-pandemic period compared with the results of another local study by Ngai et al[25] (M = 104.4; SD 47.1) 10 years ago. These findings are consistent with those of Yamada et al,[26] who reported a 26.5% decrease in the physical activity of community-dwelling older adults, as measured using the International Physical Activity Questionnaire.[27] However, the decrease in the level of physical activity in the present study was less than that reported by Yamada et al.[26] One possible reason is that the present study was conducted 1 year after the initial outbreak of COVID-19, while the study reported by Yamada et al[26] was conducted approximately 3 months after the initial outbreak. Older adults may be less prepared to live with the outbreak (e.g., shortage of masks) and thus may experience a greater reduction in the level of physical activity. Our findings also suggest that older adults living with others engaged in physical activities, such as walking outside the home, repairing the home and caring for another person, more than those living alone.

Stratified group analyses suggested that older adults with a higher educational level and who lived with others were more likely to perform leisure-time activity, such as light sports, recreational activities and walk outside the home, and had less perceived stress and a higher quality of life than those with a lower educational level. One possible explanation for this phenomenon is that older adults with a higher educational level who live with others perceived less stress as the number of COVID-19 cases remained at a low level, and their daily lifestyle was less disrupted by adopting preventive measures, such as wearing masks and maintaining social distancing. Thus, their leisure-time activities, stress levels and quality of life were less affected during the post-COVID-19-pandemic period. Additional support, such as the promotion of light indoor sports activities through social media, may be needed in the post-COVID-19-pandemic period for older adults with a low educational level who are living alone.

Relationships between quality of life and other variables

Correlation analyses revealed that younger study participants living with others and having a higher educational level, a higher physical activity level and a lower stress level had a better quality of life, as measured using the EQ-5D-5L index and EQVAS mean scores. These findings echo those of Zaninotto et al[28] and Gouveia et al,[29] who showed that age, educational level, living status, physical activity and emotional disturbances, such as depression, are significantly correlated with quality of life in older adults.

Although living status was found to be correlated with quality of life, as measured using the EQ-5D-5L index, no such correlation was observed when the EQVAS score was used to quantify quality of life. This discrepancy may be due to the use of different measures of quality of life captured by the EQ-5D-5L index and the EQVAS. While the EQ-5D-5L index reflects the quality of life based on mobility, self-care, usual activities and mood disturbances (anxiety or depression), assessment via the EQVAS requires subjects to

project their overall quality of life on a visual analogue scale. It is possible that the study participants interpreted ‘overall quality of life’ to include some issues not limited to the five domains covered in the EQ-5D-5L dimensions. For example, based on a needs satisfaction model, Hyde et al[30] developed a quality of life measure known as ‘CASP-19’, which focuses on domains of control, autonomy, pleasure and satisfaction. These needs satisfaction domains may have been considered by the study participants when being asked to rate their quality of life on the EQVAS. Study participants may or may not be satisfied with living alone; thus, living status or social isolation were not necessarily associated with a needs satisfaction-based quality of life assessment.

Moreover, we found no correlation between physical activity and perceived stress. Violant-Holz et al[31] systematically reviewed 15 studies published between 1 January 2019 and 15 July 2020 and reported that physical activity is associated with certain aspects of psychological well-being, including stress, and suggested to further investigate whether physical activity is an effective strategy for coping with the associated negative psychological consequences of the COVID-19 pandemic. As the studies reviewed by Violant-Holz et al[31] were published 6 months after the initial COVID-19 outbreak and the present study was conducted 1 year after, it is reasonable to hypothesise that community-dwelling older adults in Shenzhen had adapted to the preventive measures and minimised the associated negative effects on physical activity, such that there were no serious disruptions to their daily lifestyle. Thus, the stress level reported by the participants of this study may be a result of other issues not related to the COVID-19 pandemic and its associated preventive measures.

Physical activity and perceived stress independently predict quality of life during the post-COVID-19-pandemic period

The final regression model explained 51.0% of the quality of life of our participants. In view of the strength of their correlations with EQ-5D-5L index values (Table 5), the PASE-C score was included in model 2 and the CPSS-10 score was then added to model 2 to formulate the final model. Both physical activity and perceived stress were independent predictors of the EQ-5D-5L index value, and the PASE-C and CPSS-10 scores accounted for 30.6% of the variance in the final model. The PASE-C score accounted for 6.8% of the explained variance in model 2, and the CPSS-10 score accounted for 23.8% of the explained variance in model 3. Previous studies have investigated the roles of sociodemographics,[32] social participation,[33] perceived health status, perceived ability to cope financially, perception of poverty over time and loneliness[34] in determining quality of life. To investigate the quality of life of community-dwelling older adults during the post-COVID-19-pandemic period, we further considered the roles of physical activity and perceived stress. As expected, higher levels of physical inactivity and perceived stress predicted poorer quality of life in community-dwelling older adults.

From the viewpoint of public health, the current findings are highly relevant to the COVID-19 pandemic and other future pandemics, because they add to the current knowledge and provide evidence that decreased physical activity and increased stress levels induced by infectious pandemics and their associated preventive measures are independent factors influencing the quality of life of community-

dwelling older adults, especially those who are older, live alone and have a low educational level. Fortunately, COVID-19 vaccinations are available and the number of cases continues to be maintained at a low level as this report was written. To ensure a high quality of life in the post-COVID-19-pandemic era, it is important for healthcare workers and gerontologists to identify possible ways to promote physical activity and reduce the level of stress brought about by the pandemic and its associated preventive measures, to promote healthy aging.

Limitations

This study has several limitations. First, the participants were recruited from social media or online platforms on a convenience basis, which may limit the representativeness of the sample. Our findings should not be generalised to those who are not cognitively intact (e.g., those with mild cognitive impairment or dementia) or have poor coping skills. Second, our regression model only accounted for 51.0% of the total variance in the EQ-5D-5L index values. Approximately half of the variance remained unexplained, and therefore, future studies should also consider other elements, such as social support and the level of physical functioning. Third, all the variables analysed were measured by self-reported questionnaires, which may be subject to participants' bias.

Conclusions

During the COVID-19 pandemic, it is imperative to understand how the population is coping with such a major disaster. Here, we focused on several potentially serious consequences of the COVID-19 pandemic for older adults and, more specifically, on how preventive social measures aimed at mitigating the risk of infection have changed the way of life for community-dwelling older adults, with regard to their physical activities, perceived stress and quality of life. Our findings demonstrated that the COVID-19 pandemic and its associated restrictive measures have restricted physical activity and increased stress levels. These data also provide insights for the promotion of home-based leisure-time activity programmes that are suitable for older adults, so that they maintain a level of physical activity that helps diminish the adverse effects of COVID-19 on their physical and mental health.

Declarations

Ethics approval and informed consent

The present study protocol was approved by the Ethics Committees of the Chinese University of Hong Kong, Shenzhen (CUHKSZ-2021EA1120). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

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Competing interests

The authors declare no conflict of interest.

Authors' contributions

Xiaoying Zhang, Xuchang Zhang, Zhongwei Lv and Jianshe Yang carried out the studies, participated in collecting data, and drafted the manuscript. Jianshe Yang designed the project and performed the statistical analysis. All authors read and approved the final manuscript.

References

1. World Health Organization. Weekly epidemiological update on COVID-19–14 Jan 2022. https://covid19.who.int/
2. Zhao JJ, Yuan Q, Wang HY, et al. Antibody responses to SARS-CoV-2 in patients of novel coronavirus disease 2019. medRxiv. 2020.03.02.20030189. doi:10.1101/2020.03.02.20030189
3. Hawkley LC, Capitanio JP. Perceived social isolation, evolutionary fitness and health outcomes: a lifespan approach. Philos Trans R Soc Lond B Biol Sci. 2015;370(1669):20140114. doi: 10.1098/rstb.2014.0114.
4. Kiecolt-Glaser JK, McGuire L, Robles TF, Glaser R. Emotions, morbidity, and mortality: new perspectives from psychoneuroimmunology. Annu Rev Psychol. 2002;53:83–107. doi: 10.1146/annurev.psych.53.100901.135217.
5. Daskalopoulou C, Stubbs B, Kralj C, Koukounari A, Prince M, Prina AM. Physical activity and healthy ageing: A systematic review and meta-analysis of longitudinal cohort studies. Ageing Res Rev. 2017;38:6–17. doi: 10.1016/j.arr.2017.06.003.
6. Tomás MT, Galán-Mercant A, Carnero EA, Fernandes B. Functional capacity and levels of physical activity in aging: A 3-year follow-up. Front Med (Lausanne). 2018;4:244. doi: 10.3389/fmed.2017.00244.
7. Vogel T, Brechat PH, Leprêtre PM, Kaltenbach G, Berthel M, Lonsdorfer J. Health benefits of physical activity in older patients: a review. Int J Clin Pract. 2009;63(2):303–320. doi: 10.1111/j.1742-1241.2008.01957.x.
8. Newson RS, Kemps EB. Cardiorespiratory fitness as a predictor of successful cognitive ageing. J Clin Exp Neuropsychol. 2006;28(6):949–967. doi: 10.1080/13803390591004356.
9. Roberts CE, Phillips LH, Cooper CL, Gray S, Allan JL. Effect of different types of physical activity on activities of daily living in older adults: systematic review and meta-analysis. J Aging Phys Act. 2017;25(4):653–670. doi: 10.1123/japa.2016-0201.
10. Soares WJS, Lopes AD, Nogueira E, Candido V, de Moraes SA, Perracini MR. Physical activity level and risk of falling in community-dwelling older adults: systematic review and meta-analysis. J Aging

Phys Act. 2018;27(1):34–43. doi: 10.1123/japa.2017-0413.

11. Bellavia A, Bottai M, Wolk A, Orsini N. Physical activity and mortality in a prospective cohort of middle-aged and elderly men - a time perspective. Int J Behav Nutr Phys Act. 2013;10:94. doi: 10.1186/1479-5868-10-94.
12. Salguero A, Martínez-García R, Molinero O, Márquez S. Physical activity, quality of life and symptoms of depression in community-dwelling and institutionalized older adults. Arch Gerontol Geriatr. 2011;53(2):152–157. doi: 10.1016/j.archger.2010.10.005.
13. Stockwell S, Trott M, Tully M, et al. Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. BMJ Open Sport Exerc Med. 2021;7(1):e000960. doi: 10.1136/bmjsem-2020-000960.
14. Krishnamoorthy Y, Nagarajan R, Saya GK, Menon V. Prevalence of psychological morbidities among general population, healthcare workers and COVID-19 patients amidst the COVID-19 pandemic: A systematic review and meta-analysis. Psychiatry Res. 2020;293:113382. doi: 10.1016/j.psychres.2020.113382.
15. Goularte JF, Serafim SD, Colombo R, Hogg B, Caldieraro MA, Rosa AR. COVID-19 and mental health in Brazil: Psychiatric symptoms in the general population. J Psychiatr Res. 2021;132:32–37. doi: 10.1016/j.jpsychires.2020.09.021.
16. Burtscher J, Burtscher M, Millet GP. (Indoor) isolation, stress, and physical inactivity: Vicious circles accelerated by COVID-19? Scand J Med Sci Sports. 2020;30(8):1544–1545. doi: 10.1111/sms.13706.
17. Mueller AL, McNamara MS, Sinclair DA. Why does COVID-19 disproportionately affect older people? Aging (Albany NY). 2020;12(10):9959–9981. doi: 10.18632/aging.103344.
18. Washburn RA, Smith KW, Jette AM, Janney CA. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol. 1993;46(2):153–62. doi: 10.1016/0895-4356(93)90053-4.
19. Tao YX, Wang L, Dong XY, et al. Psychometric properties of the physical activity scale for the elderly in Chinese patients with COPD. Int J Chron Obstruct Pulmon Dis. 2016;12:105–114. doi: 10.2147/COPD.S120700.
20. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983;24(4):385–396. doi:10.2307/2136404.
21. Wang Z, Chen J, Boyd JE, et al. Psychometric properties of the Chinese version of the perceived stress scale in policewomen. PLoS One. 2011;6(12):e28610. doi: 10.1371/journal.pone.0028610.
22. EuroQol Research Foundation. EQ-5D-5L User Guide-Basic Information on How to Use the EQ-5D-5L Instrument. 2019; Version 3.0. https://euroqol.org/publications/user-guides/
23. Wong ELY, Xu RH, Cheung AWL. Health-related quality of life among patients with hypertension: population-based survey using EQ-5D-5L in Shenzhen SAR, China. BMJ Open. 2019;9(9):e032544. doi: 10.1136/bmjopen-2019-032544.

24. Cheung PWH, Wong CKH, Samartzis D, et al. Psychometric validation of the EuroQoL 5-Dimension 5-Level (EQ-5D-5L) in Chinese patients with adolescent idiopathic scoliosis. Scoliosis Spinal Disord. 2016;11:19. doi: 10.1186/s13013-016-0083-x.
25. Ngai SP, Cheung RT, Lam PL, Chiu JK, Fung EY. Validation and reliability of the physical activity scale for the elderly in Chinese population. J Rehabil Med. 2012;44(5):462–465. doi: 10.2340/16501977-0953.
26. Yamada M, Kimura Y, Ishiyama D, et al. Effect of the COVID-19 epidemic on physical activity in community-dwelling older adults in Japan: A cross-sectional online survey. J Nutr Health Aging. 2020;24(9):948–950. doi: 10.1007/s12603-020-1424-2.
27. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381–1395. doi: 10.1249/01.MSS.0000078924.61453.FB.
28. Zaninotto P, Falaschetti E, Sacker A. Age trajectories of quality of life among older adults: results from the English longitudinal study of ageing. Qual Life Res. 2009;18(10):1301–1309. doi: 10.1007/s11136-009-9543-6.
29. Gouveia ÉRQ, Gouveia BR, Ihle A, et al. Correlates of health-related quality of life in young-old and old-old community-dwelling older adults. Qual Life Res. 2017;26(6):1561–1569. doi: 10.1007/s11136-017-1502-z.
30. Hyde M, Wiggins RD, Higgs P, Blane DB. A measure of quality of life in early old age: the theory, development and properties of a needs satisfaction model (CASP-19). Aging Ment Health. 2003;7(3):186–194. doi: 10.1080/1360786031000101157.
31. Violant-Holz V, Gallego-Jiménez MG, González-González CS, et al. Psychological health and physical activity levels during the COVID-19 pandemic: A systematic review. Int J Environ Res Public Health. 2020;17(24):9419. doi: 10.3390/ijerph17249419.
32. Hoi le V, Chuc NT, Lindholm L. Health-related quality of life, and its determinants, among older people in rural Vietnam. BMC Public Health. 2010;10:549. doi: 10.1186/1471-2458-10-549.
33. Lodhi FS, Rabbani U, Khan AA, et al. Factors associated with quality of life among joint and nuclear families: a population-based study. BMC Public Health. 2021;21(1):234. doi: 10.1186/s12889-021-10265-2.
34. Smith, AE, Sim J, Scharf T, Phillipson C. Determinants of quality of life amongst older people in deprived neighbourhoods. Ageing & Society. 2004;24(5):793–814. doi:10.1017/S0144686X04002569

Appendix

Appendix 1 is not available with this version