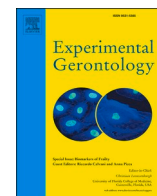




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Review

The trajectory of psychological well-being during the COVID-19 pandemic and its association with health-promoting coping behavior among Japanese community-dwelling older adults: The Otassha Study

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ABSTRACT

This study aims to identify the trajectory of psychological well-being during the COVID-19 pandemic among community-dwelling older adults and to clarify the association between coping behavior in the early stage of the pandemic and the trajectory of psychological well-being. The study was based on a cohort study, known as “the Otassha Study.” We administered three follow-up surveys to 720 older adults who participated in the survey in October 2019 (T0): T1: June 2020, T2: October 2020, and T3: October 2021. Furthermore, we assessed coping behavior in T1 via a self-developed questionnaire comprising 10 items. Psychological well-being was assessed by the WHO-5 Well-Being Index (score range: 0 to 25) in all surveys. The trajectories of psychological well-being were identified by group-based trajectory modeling. The association between coping behaviors and trajectory patterns was assessed using multinomial logistic regression analysis. Furthermore, among the 508 participants who participated in the follow-up survey two times or more, three patterns of the trajectory of psychological well-being were identified: heavily decreased group ($n = 39$), decreased group ($n = 352$), and increased group ($n = 39$). “Walking” as a coping behavior had a significantly higher odds ratio (OR) to be in the increased group (OR = 2.32, 95 % confidence interval (CI) 1.06–5.05, $p = 0.035$) compared to the heavily decreased group. “Conversations with family living together” had a slightly higher OR to become an increased group (OR = 1.96, 95 % CI: 0.87–4.41, $p = 0.106$), and “actively gathering information on COVID-19” had a slightly lower OR to become the decreased group (OR = 0.53, 95 % CI: 0.26–1.06, $p = 0.072$) compared to the heavily decreased group. The results of this study suggest how maintaining health in the early stage of the pandemic had a great influence on the long-term health status.

1. Introduction

More than two years have passed since the World Health Organization (WHO) declared COVID-19 a pandemic in March 2020. Meanwhile, numerous studies worldwide have reported deterioration of mental health among older adults as secondary damage caused by COVID-19 (Fujita et al., 2021; Maugeri et al., 2020; Park et al., 2021; Salari et al., 2020; Sepúlveda-Loyola et al., 2020). To consider measures to maintain health during the COVID-19 pandemic, it is necessary to understand in detail the change in mental health. Therefore, several studies have administered multiple surveys to evaluate the trajectories of

mental health. Piumatti et al. (2022) administered a monthly survey following the first wave of the pandemic, from August 2020 to May 2021, which showed that depression, anxiety, and stress increased among adults in Southern Switzerland (Piumatti et al., 2022). By contrast, Fluharty et al. (2021) reported that both depressive and anxiety symptoms decreased over time among adults during the first 21 weeks of the COVID-19 lockdown in the United Kingdom (Fluharty et al., 2021). Among older adults, Joseph et al. (2022) administered a monthly online survey from April 2020 to October 2020 and revealed that while physical isolation at home was associated with elevated depressive and anxiety symptoms at baseline, there was no meaningful

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variation in these mental health outcomes over time (Joseph et al., 2022). All of these previous studies used short-term data since the early stage of the COVID-19 pandemic. There are no studies that capture changes in mental health from before the pandemic or clarify long-term changes in mental health. It has been pointed out that it is necessary to evaluate the long-term impact of COVID-19 on the mental health of older adults during the prolonged pandemic (Parlapani et al., 2021).

Presently, coping strategies to maintain physical and mental health is attracting attention, and some studies have focused on the relationship between coping strategies and mental health during the COVID-19 pandemic. Among adults in the United Kingdom, socially-supportive coping (emotional support, instrumental support, and venting) was associated with a faster decrease in anxiety and depression (Fluharty et al., 2021). Moreover, positive thinking, social support, and active stress coping, evaluated by the Stress and Coping Inventory, contributed to higher psychological quality of life and well-being, and lower depression and anxiety among Austrian adults (Budimir et al., 2021). Furthermore, few studies created a new coping scale focusing on concrete behaviors during COVID-19-related restrictions. Tuason et al. (2021) reported five ways of coping as identified in a cross-sectional study: “having more time with family or people I live with,” “having more time for myself to rest/reflect/re-energize/slow down,” “getting projects done around the house,” “the outdoors, nature, the environment,” and “having the ability to work from home,” which were associated with higher psychological well-being among US adults. Fullana et al. (2020) demonstrated that “following a healthy/balanced diet,” “following a routine,” “not reading news/updates about COVID-19 very often,” “taking the opportunity to pursue hobbies,” and “staying outdoors or looking outside” were associated with lower levels of depressive symptoms among Spanish adults. In this regard, however, as these studies are cross-sectional and target adults, there is a lack of research on the relationship between coping strategies and mental health among older adults, who may be at higher risk of aggravation due to COVID-19 infection and higher risk of health deterioration due to the activity restriction.

Few studies have reported that older adults have been coping well with the COVID-19 pandemic. In the initial weeks of the pandemic in the US, the majority of older adults perceived themselves to be coping well with emotional distress related to COVID-19 (Fuller and Huseth-Zosel, 2021). Knepple Carney et al. (2021) reported that the effect of perceived COVID-19 disruption on stress and negative affect decreased with increased age. According to the authors, the reason for this trend was that older adults had more personal resources to deal with stressors than younger ones, and may be better at regulating their emotions even if they perceived the stressors as disruptive. Another cross-sectional study reported that older adults are less depressed and stressed than younger populations during the COVID-19 pandemic (Parlapani et al., 2021). However, even at older ages, depression and anxiety increased (Parlapani et al., 2021) and psychological well-being decreased (Ejiri et al., 2021) during the early stage of the pandemic compared to prior to the pandemic. Therefore, it is important to identify specific coping behaviors that are useful in maintaining the mental well-being of older adults. Ejiri et al. (2021) revealed that older adults who walked as a coping strategy during COVID-19-related restrictions maintained psychological well-being in the early stage of the pandemic (Ejiri et al., 2021). However, there is a lack of knowledge regarding the association between concrete coping behaviors like walking and psychological well-being. Specifically, there is no research on coping behavior and long-term changes in psychological well-being during a prolonged pandemic. Hence, analyzing the kind of coping behavior which contributes to maintaining psychological well-being during the pandemic will shed valuable insight in the event of an occurrence of an infectious disease pandemic in the future.

The aims of this study were 1) to identify the trajectory of psychological well-being during the prolonged COVID-19 pandemic among community-dwelling older adults using two-year survey data from The

Otassha Study, including before the pandemic, and 2) to analyze the association between coping behavior in the early stage of the pandemic and the trajectory of psychological well-being.

2. Material and methods

2.1. Participants

This study was based on a cohort study, known as “The Otassha Study,” conducted with community-dwelling older adults living in Itabashi Ward, an urban area of Tokyo, Japan. At the beginning of the cohort, which started in 2011, we sent mail recruitment letters for a comprehensive health survey to all residents aged 65–84 years who were registered in the Basic Resident Register of Itabashi Ward and were living in the study area in October 2011. We excluded older adults who were institutionalized or had participated in previous surveys administered by our institute. The comprehensive health survey included motor and cognitive functioning tests, medical interviews, and a questionnaire about daily life. Furthermore, we followed up with our participants every year and recruited new participants each year as they turned 65 years. In the current study, we targeted the participants in 2019. For the 720 older adults who participated in the survey in October 2019 (T0), we administered three follow-up surveys. The timing of each follow-up survey and the number of participants were as follows. T1: June 2020, $n = 618$; T2: October 2020, $n = 563$; and T3: October 2021, $n = 434$. We delivered a self-administered mail survey only at T1 due to the early stage of the COVID-19 pandemic. In Tokyo, which is the target area of this study, the state of emergency was declared several times as a control measure for COVID-19. Prior to T1 and T3, the first (April to May 2020) and fourth (July to September 2021) state of emergency were lifted (Fig. 1). In the first state of emergency in Tokyo, the stay-at-home order to the public, working-from-home order to the workers, and shutdown requests for schools, public places, and businesses were strongly requested. Although stay-at-home orders and shutdown requests for restaurants were also requested in the fourth state of emergency, the restriction was liberalized compared to the first one.

Ethical approval was granted by the ethics committee of the Tokyo Metropolitan Institute of Gerontology (approval no. 2020-2, 2019-E32). Prior to commencement of the study, all participants provided written informed consent for all the surveys. The research was performed in accordance with the Declaration of Helsinki.

2.2. Measures

2.2.1. Psychological well-being

This study employed the WHO-5 Well-Being Index (WHO-5) to assess psychological well-being in all the surveys. WHO-5 is the most widely used questionnaire for measuring subjective psychological well-being (Topp et al., 2015). The WHO-5 includes five items: (1) I have felt cheerful and in good spirits, (2) I have felt calm and relaxed, (3) I have felt active and vigorous, (4) I woke up feeling fresh and rested, and (5) My daily life has been filled with things that interest me. We asked the respondent to rate how they feel over the past 2 weeks. The total score ranges from 0 to 25, with higher scores indicating higher psychological well-being. The validity and utility of the Japanese version among older adults were already evaluated (Awata et al., 2007).

2.2.2. Coping behavior

To explore coping behavior during the COVID-19 pandemic, the authors—who have specialized in gerontology and health behavioral sciences—developed a questionnaire regarding coping behaviors (Kera et al., 2021). We focused on concrete behaviors in daily life rather than subjective coping strategies. The scale asked the following question: What measures have you taken to maintain your physical and mental health during the stay-at-home period? The respondents selected answer (s) from the following items: 1) watching TV programs at home, 2)

	2019			2020												2021										
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
Survey	T0								T1																	T3
State of emergency								1st									2nd			3rd				4th		

Fig. 1. Timing of survey and state of emergencies in Tokyo.

hobby activities at home, 3) conversations with family living together, 4) calls with friends, 5) walking, 6) exercise and strength training at home, 7) carefully monitoring food intake, 8) actively gathering information on COVID-19, 9) avoiding information related to COVID-19, and 10) use of mail-order sale.

2.2.3. Baseline characteristics

To understand the characteristics of participants, we assessed sex, age, family structure (living alone or not), perceived financial status, chronic diseases, instrumental activities of daily living (IADL), frequency of going outdoors, and frequency of interaction at T0.

We assessed perceived financial status using the following items: very comfortable, comfortable, average, tight, and very tight. Very comfortable to average levels were categorized as not tight, whereas tight and very tight were categorized as tight. Furthermore, a nurse assessed currently treated chronic diseases that increase vulnerability to COVID-19, such as hypertension, heart disease, and diabetes. We assessed IADL using a subscale of the Tokyo Metropolitan Institute of Gerontology Index of Competence, which includes five questions on instrumental self-maintenance (Koyano et al., 1991). We categorized respondents as completely independent or having at least one disability. The frequency of going outdoors was divided into two categories based on the definition of being homebound: once a week or less (homebound) and twice a week or more (Shinkai et al., 2005). Furthermore, the frequency of interaction was defined based on the frequency of face-to-face contact and non-face-to-face contact with non-resident family and friends. Based on the definition of social isolation, we categorized respondents as less than once a week (social isolation) and once a week or more (Ejiri et al., 2019).

2.3. Statistical analysis

To identify trajectories of psychological well-being, we employed group-based trajectory modeling (GBTM). GBTM considers the patterns of change for measures across multiple time points and identifies distinctive trajectories (Nagin and Odgers, 2010). We constructed models with different numbers of trajectory groups and different forms of potential trajectories (linear, quadratic, or cubic) using a Stata Plugin. Model fit was assessed by the following methods: (1) the Bayesian Information Criterion, (2) the number of participants in each trajectory (>5 % of overall population), (3) the average probability of final group membership across the trajectory groups, and (4) a reasonably narrow confidence interval (CI).

Data on participant characteristics are presented as means and standard deviations for continuous variables and as numbers and percentages for categorical variables. We compared the frequency of each coping behavior in each trajectory pattern using the chi-square test. Furthermore, we examined the relationship between coping behavior and the trajectory pattern of psychological well-being by multinomial logistic regression analysis—with each coping behavior as the independent variable; trajectory pattern as the dependent variable; and sex, age, and IADL disability at T0 as the covariates.

All statistical analyses were performed using TRAJ in STATA 16.1 (StataCorp LLC, College Station, Texas, USA) and IBM SPSS Statistics for Windows, Version 27.0 (IBM Japan, Ltd., Tokyo, Japan). The significance level was set at $p < 0.05$.

3. Results

The data of 508 participants were analyzed to elucidate the trajectory of WHO-5 scores. The three-group trajectory model was identified as the best-fitting model. The trajectory of WHO-5 was divided into 3 groups: a heavily decreased group (9 points decreased at T1, 1 point improved at T2, and then maintained; $n = 39$), decreased group (2 points decreased at T1, and then maintained; $n = 352$), and an increased group (2 points increased at T1, and then maintained; $n = 117$) (Fig. 2). The probability of final group membership was 87.8 %–91.5 %.

Table 1 shows the baseline characteristics of participants in three trajectory patterns. The proportion of men was 25.6 % in the heavily decreased group, 34.9 % in the decreased group, and 50.4 % in the increased group. The average age was about 73 years in all groups. Furthermore, about 20 % of participants lived alone. The prevalence of heart disease and diabetes was highest in the increased group. Moreover, about 20 % of the participants were socially isolated.

To examine the association between coping behaviors and the trajectory pattern of psychological well-being, the data of 487 participants who completed the questionnaire about coping behavior were analyzed. Table 2 shows the frequency of coping behavior according to the trajectory patterns. Exercise and strength training at home was significantly associated with trajectory patterns in the chi-square test: 55.6 % in the heavily decreased group, 58.2 % in the decreased group, and 44.7 % in the increased group ($p = 0.045$). Walking behavior showed slight differences as well depending on the trajectory patterns: 50.0 % in the heavily decreased group, 62.6 % in the decreased group, and 70.2 % in the increased group ($p = 0.077$). Moreover, the careful monitoring of food intake exhibited slight differences: 66.7 % in the heavily decreased group, 54.9 % in the decreased group, and 46.5 % in the increased group ($p = 0.082$).

Table 3 presents the adjusted odds ratios (ORs) and 95 % CIs using the heavily decreased group as the reference group. Walking had a significantly higher OR in the increased group (OR = 2.32, 95 % CI: 1.06–5.05, $p = 0.035$). Moreover, although the associations were not significant, conversations with family living together had a slightly higher OR in the increased group (OR = 1.96, 95 % CI: 0.87–4.41, $p = 0.106$), and actively gathering information on COVID-19 had slightly lower OR in the decreased group (OR = 0.53, 95 % CI: 0.26–1.06, $p = 0.072$).

4. Discussion

In this study, we assessed the trajectory of psychological well-being among community-dwelling older adults during the COVID-19 pandemic using two-year survey data including data prior to the pandemic. The trajectory of psychological well-being was divided into three patterns in the early stage of the pandemic: heavily decreased, decreased, and increased, and there was almost no change thereafter in all groups. In addition, walking, conversations with family living together, and not actively gathering information on COVID-19 as coping behaviors in the early stage of the pandemic may contribute to maintaining psychological well-being.

Few studies have reported the trajectory of mental health among adults during the early stage of the COVID-19 pandemic (Fluharty et al., 2021; Piumatti et al., 2022). However, our study assessed psychological well-being on a long-term basis among older adults and classified its trajectory patterns for the first time. The pattern identified in the early

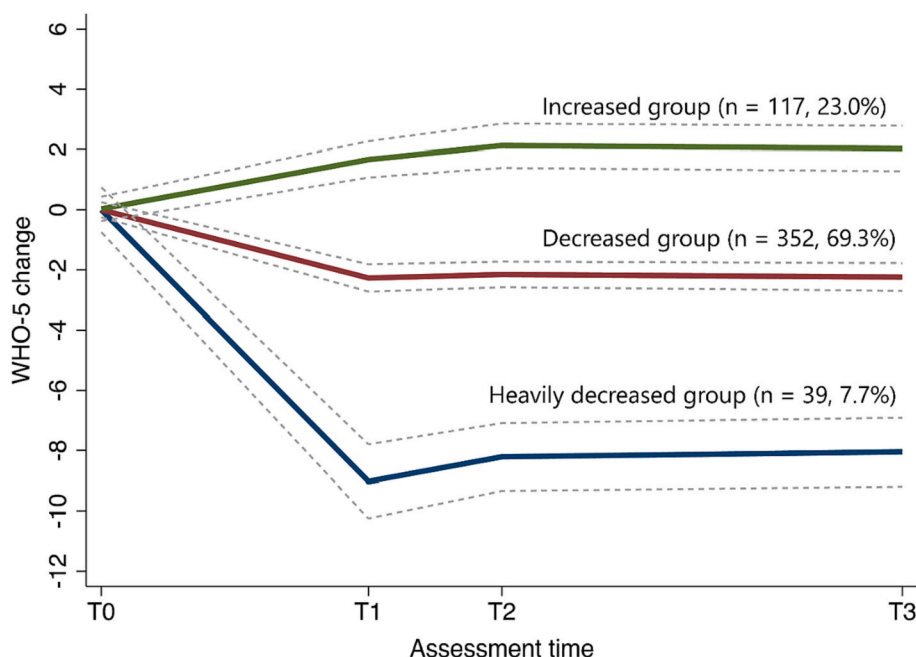


Fig. 2. The trajectory of WHO-5.

Table 1

Baseline characteristics of the participants (n = 508).

	Heavily decreased group (n = 39)		Decreased group (n = 352)		Increased group (n = 117)	
	n	%	n	%	n	%
Men	10	25.6 %	123	34.9 %	59	50.4 %
Age (mean(SD))	72.8	(6.7)	73.9	(6.4)	72.9	(5.9)
Living alone	8	20.5 %	94	26.7 %	27	23.1 %
Tight financial status	5	12.8 %	43	12.2 %	18	15.4 %
Hypertension	18	46.2 %	147	41.8 %	46	39.3 %
Heart disease	5	12.8 %	56	15.9 %	26	22.2 %
Diabetes	2	5.1 %	38	10.8 %	16	13.7 %
IADL disability	1	2.6 %	10	2.8 %	6	5.1 %
Homebound	1	2.6 %	8	2.3 %	6	5.1 %
Social isolation	8	20.5 %	71	20.2 %	27	23.1 %

SD; standard deviation, IADL: Instrumental Activities of Daily Living.

stage of the pandemic had hardly changed following the pandemic, suggesting that how to maintain health in the early stage of the pandemic had a great influence on the long-term health condition. Particularly, the heavily decreased group, which decreased by 9 points on the WHO-5, was considered to be at high risk of negative health outcomes and the health conditions of this group should be paid close attention. In addition, while most older adults had decreased psychological well-being, a quarter of participants had increased psychological well-being. A previous study reported that many older adults perceived themselves to be coping well with the pandemic (Fuller and Huseth-Zosel, 2021). The psychological well-being of older adults may have been improved by the successful experience of coping with this difficult situation. Moreover, several studies have reported another positive change during the pandemic, that some older adults increased their physical activity in the early stage of the pandemic (Callow et al., 2020; Faulkner et al., 2021; Suzuki et al., 2020). Physical activity is one of the factors positively related to psychological well-being even during the pandemic (Jacob et al., 2020; Maugeri et al., 2020). Older adults who were able to cope with the pandemic well or changed their behavior may have improved their psychological well-being.

The frequency of a coping behavior varied depending on the

Table 2

Association between coping behaviors and the trajectory pattern of psychological well-being: Chi-square test (n = 487).

	Heavily decreased group (n = 36)		Decreased group (n = 337)		Increased group (n = 114)		p
	n	%	n	%	n	%	
Watching TV programs at home	25	69.4 %	243	72.1 %	81	71.1 %	0.932
Hobby activities at home	14	38.9 %	150	44.5 %	45	39.5 %	0.566
Conversations with family living together	11	30.6 %	130	38.6 %	54	47.4 %	0.122
Calls with friends	14	38.9 %	132	39.2 %	39	34.2 %	0.637
Walking	18	50.0 %	211	62.6 %	80	70.2 %	0.077
Exercise and strength training at home	20	55.6 %	196	58.2 %	51	44.7 %	0.045
Careful monitoring of food intake	24	66.7 %	185	54.9 %	53	46.5 %	0.082
Actively gathering information on COVID-19	17	47.2 %	109	32.3 %	40	35.1 %	0.195
Avoiding information related to COVID-19	2	5.6 %	37	11.0 %	10	8.8 %	0.514
Use of mail-order sale	4	11.1 %	38	11.3 %	7	6.1 %	0.282

trajectory pattern of psychological well-being. The increased group was less likely to perform exercise and strength training at home, whereas were more likely to do walking. Older adults who engaged in walking were more likely to be in the increased group compared to the heavily decreased group. A previous study reported that older adults who walked as a coping behavior maintained psychological well-being in the early stage of the COVID-19 pandemic (Ejiri et al., 2021). Our study suggested that walking is related to long-term maintenance of psychological well-being as well. During the first state of emergency in Japan, walking outdoor was one of the only ways to go out except for shopping for daily necessities or going to the hospital. Previous studies conducted during the COVID-19 pandemic also reported that spending time

Table 3

Association between coping behaviors and the trajectory pattern of psychological well-being: multinomial logistic regression analysis ($n = 487$).

	Decreased group			Increased group		
	OR	(95 % CI)	<i>p</i>	OR	(95 % CI)	<i>p</i>
Watching TV programs at home	1.17	(0.53–2.43)	0.742	1.31	(0.56–3.03)	0.534
Hobby activities at home	1.25	(0.62–2.54)	0.532	1.01	(0.46–2.21)	0.975
Conversations with family living together	1.46	(0.69–3.09)	0.326	1.96	(0.87–4.41)	0.106
Calls with friends	1.13	(0.54–2.35)	0.745	1.13	(0.50–2.54)	0.777
Walking	1.65	(0.83–3.31)	0.157	2.32	(1.06–5.05)	0.035
Exercise and strength training at home	1.11	(0.55–2.26)	0.765	0.76	(0.35–1.65)	0.486
Careful monitoring of food intake	0.64	(0.31–1.36)	0.247	0.56	(0.25–1.27)	0.166
Actively gathering information on COVID-19	0.53	(0.26–1.06)	0.072	0.60	(0.28–1.30)	0.198
Avoiding information related to COVID-19	2.17	(0.50–9.44)	0.303	1.93	(0.40–9.36)	0.413
Use of mail-order sale	1.13	(0.38–3.41)	0.824	0.61	(0.17–2.25)	0.459

Reference: heavily decreased group. Adjusted for sex, age, and instrumental activities of living disability at T0.

OR: odds ratio, CI: confidence interval.

outdoors was positively associated with mental health among adults (Fullana et al., 2020; Tuason et al., 2021). Therefore, it is possible that going out itself influenced mental health. By contrast, before the pandemic, exercise had been well known as a stress coping mechanism (Stults-Kolehmainen and Sinha, 2014). The Centers for Disease Control and Prevention has recommended exercising to cope with stress and maintain health during the COVID-19 pandemic (Centers for Disease Control and Prevention, 2021). Our study suggested that the association between exercise and long-term change in psychological well-being during the pandemic differs depending on the types and setting (outdoor or indoor) of exercise. De Sousa et al. (2021) pointed out that there is a lack of studies to recommend and prescribe the best exercise to be performed during COVID-19 (De Sousa et al., 2021). Research on exercise intensity and frequency will be able to strengthen the knowledge of what kind of and how much exercise should be done during the pandemic to maintain mental health in the future.

Although not statistically significant, our findings suggested that conversations with family living together may be associated with a positive change, and actively gathering information on COVID-19 may be associated with a negative change in psychological well-being. As a coping strategy with regard to family, a previous study reported that having more time with family living together was associated with better mental well-being during COVID-19 (Tuason et al., 2021). During the pandemic, increasing communication with family was an effective way to stay connected (Fuller and Huseth-Zosel, 2021). Furthermore, considering information about COVID-19, a study reported that not reading news about COVID-19 very often was associated with lower level of depression (Fullana et al., 2020). A systematic review revealed negative associations between exposure to COVID-19-related news and mental health from knowledge of several studies (Salari et al., 2020). Our findings suggest that these coping behaviors are also effective in maintaining the psychological well-being of older adults. A previous

study pointed out that sustainable coping strategies need to be identified as COVID-19 may be prolonged and protracted (Tuason et al., 2021). However, we focused on coping behaviors in the early stage of the pandemic in the current study; it is necessary to clarify how coping behavior changed in the prolonged pandemic and its relationship with psychological well-being in the future.

The proportion of older adults who carefully monitored food intake was significant in the heavily decreased group and less in the increased group. Such monitoring might precipitate greater stress. On the contrary, Fullana et al.'s (2020) cross-sectional study results—that following a healthy/balanced diet was associated with lower levels of depressive symptoms—contrasted our study's results. This might be attributable to the difference in study design (cross-sectional instead of longitudinal).

This study has several limitations. First, due to the small sample size of the heavily decreased group for analyzing coping behavior, we could not adjust other variables such as financial status and chronic diseases, which may be related to changes in psychological well-being. It is possible that older adults who belonged to the heavily decreased group dropped out from the follow-up surveys, and it is also possible that their psychological well-being drastically decreased. Second, the validity and reliability of the assessment measure of coping behavior were not confirmed. However, the coping behaviors of our study were similar to those in previous studies (Fullana et al., 2020; Tuason et al., 2021), and it is considered that they can be sufficiently used to grasp the coping behavior during the COVID-19 pandemic. Third, the results of this study were obtained from community-dwelling older adults living in an urban area of Japan; thus, it is unclear whether these findings could be generalized to other areas with different situations and policies to control the spread of COVID-19. Fourth, we could not report other trajectories such as that of depression, due to the lack of data measured as common in T0 to T3.

5. Conclusion

The trajectory of psychological well-being during COVID-19 pandemic was divided into three patterns; heavily decreased, decreased, and increased groups. The trajectory presented with almost no change after the early stage of the pandemic; this suggested that the ways to maintain health in the early stage of the pandemic had a great influence on the long-term health condition. As coping behaviors in the early stage of the pandemic, walking, conversations with family living together, and not actively gathering information on COVID-19 may contribute to maintaining psychological well-being. In the future, it is necessary to continue to consider what kind of coping behavior would contribute to maintaining older adults' health in a prolonged pandemic.

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CRedit authorship contribution statement

Manami Ejiri: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft. **Hisashi Kawai:** Conceptualization, Investigation, Methodology, Writing – review & editing. **Keigo Imamura:** Formal analysis, Writing – review & editing. **Takeshi Kera:** Conceptualization, Investigation, Methodology. **Kazushige Ihara:** Investigation. **Yoshinori Fujiwara:** Investigation. **Hirohiko Hirano:** Investigation. **Hunhyung Kim:** Investigation. **Shuichi Obuchi:** Conceptualization, Project administration, Supervision.

Declaration of competing interest

None.

Data statement

The data from The Otassha Study contain sensitive participant information and cannot be released publicly due to ethical and legal restrictions imposed by the Ethics Committee of the Tokyo Metropolitan Institute of Gerontology.

References

- Awata, S., Bech, P., Koizumi, Y., Seki, T., Kuriyama, S., Hozawa, A., Ohmori, K., Nakaya, N., Matsuoka, H., Tsuji, L., 2007. Validity and utility of the Japanese version of the WHO-Five Well-being Index in the context of detecting suicidal ideation in elderly community residents. *Int. Psychogeriatr.* 19, 77–88. <https://doi.org/10.1017/S1041610206004212>.
- Budimir, S., Probst, T., Pieh, C., 2021. Coping strategies and mental health during COVID-19 lockdown. *J. Ment. Health* 30, 156–163. <https://doi.org/10.1080/09638237.2021.1875412>.
- Callow, D.D., Arnold-Nedimala, N.A., Jordan, L.S., Pena, G.S., Won, J., Woodard, J.L., Smith, J.C., 2020. The mental health benefits of physical activity in older adults survive the COVID-19 pandemic. *Am. J. Geriatr. Psychiatry* 28, 1046–1057. <https://doi.org/10.1016/j.jagp.2020.06.024>.
- Centers for Disease Control and Prevention, 2021. Coping with stress. <https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/managing-stress-anxiety.html>.
- De Sousa, R.A.L., Impropa-Caria, A.C., Aras-Júnior, R., de Oliveira, E.M., Soci, Ú.P.R., Cassilhas, R.C., 2021. Physical exercise effects on the brain during COVID-19 pandemic: links between mental and cardiovascular health. *Neurol. Sci.* 42, 1325–1334. <https://doi.org/10.1007/s10072-021-05082-9>.
- Ejiri, M., Kawai, H., Fujiwara, Y., Ihara, K., Watanabe, Y., Hirano, H., Kim, H.K., Ishii, K., Oka, K., Obuchi, S., 2019. Social participation reduces isolation among Japanese older people in urban area: a 3-year longitudinal study. *PLOS ONE* 14, e0222887. <https://doi.org/10.1371/journal.pone.0222887>.
- Ejiri, M., Kawai, H., Kera, T., Ihara, K., Fujiwara, Y., Watanabe, Y., Hirano, H., Kim, H., Obuchi, S., 2021. Exercise as a coping strategy and its impact on the psychological well-being of Japanese community-dwelling older adults during the COVID-19 pandemic: a longitudinal study. *Psychol. Sport Exerc.* 57, 102054. <https://doi.org/10.1016/j.psychsport.2021.102054>.
- Faulkner, J., O'Brien, W.J., McGrane, B., Wadsworth, D., Batten, J., Askew, C.D., Badenhorst, C., Byrd, E., Coulter, M., Draper, N., Elliot, C., Fryer, S., Hamlin, M.J., Jakeman, J., Mackintosh, K.A., McNarry, M.A., Mitchelmore, A., Murphy, J., Ryan-Stewart, H., Saynor, Z., Schaumberg, M., Stone, K., Stoner, L., Stuart, B., Lambrick, D., 2021. Physical activity, mental health and well-being of adults during initial COVID-19 containment strategies: a multi-country cross-sectional analysis. *J. Sci. Med. Sport* 24, 320–326. <https://doi.org/10.1016/j.jsams.2020.11.016>.
- Fluharty, M., Bu, F., Steptoe, A., Fancourt, D., 2021. Coping strategies and mental health trajectories during the first 21 weeks of COVID-19 lockdown in the United Kingdom. *Soc. Sci. Med.* 279, 113958. <https://doi.org/10.1016/j.socscimed.2021.113958>.
- Fujita, K., Inoue, A., Kuzuya, M., Uno, C., Huang, C.H., Umegaki, H., Onishi, J., 2021. Mental health status of the older adults in Japan during the COVID-19 pandemic. *J. Am. Med. Dir. Assoc.* 22, 220–221. <https://doi.org/10.1016/j.jamda.2020.11.023>.
- Fullana, M.A., Hidalgo-Mazzei, D., Vieta, E., Radua, J., 2020. Coping behaviors associated with decreased anxiety and depressive symptoms during the COVID-19 pandemic and lockdown. *J. Affect. Disord.* 275, 80–81. <https://doi.org/10.1016/j.jad.2020.06.027>.
- Fuller, H.R., Huseth-Zosel, A., 2021. Lessons in resilience: initial coping among older adults during the COVID-19 pandemic. *Gerontologist* 61, 114–125. <https://doi.org/10.1093/geront/gnaa170>.
- Jacob, L., Tully, M.A., Barnett, Y., Lopez-Sanchez, G.F., Butler, L., Schuch, F., López-Bueno, R., McDermott, D., Firth, J., Grabovac, I., Yakkundi, A., Armstrong, N., Young, T., Smith, L., 2020. 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.* 19, 100345. <https://doi.org/10.1016/j.mhpa.2020.100345>.
- Joseph, C.A., O'Shea, B.Q., Eastman, M.R., Finlay, J.M., Kobayashi, L.C., 2022. Physical isolation and mental health among older US adults during the COVID-19 pandemic: longitudinal findings from the COVID-19 coping study. *Soc. Psychiatry Psychiatr. Epidemiol.* 57, 1273–1282. <https://doi.org/10.1007/s00127-022-02248-4>.
- Kera, T., Kawai, H., Ejiri, M., Takahashi, J., Nishida, K., Harai, A., Hirano, H., Watanabe, Y., Fujiwara, Y., Ihara, K., Kim, H., Obuchi, S., 2021. Change in subjective health status among frail older Japanese people owing to the coronavirus disease pandemic and characteristics of their responses. *Geriatr. Gerontol. Int.* 21, 1053–1059. <https://doi.org/10.1111/ggi.14276>.
- Knepple Carney, A., Graf, A.S., Hudson, G., Wilson, E., 2021. Age moderates perceived COVID-19 disruption on well-being. *Gerontologist* 61, 30–35. <https://doi.org/10.1093/geront/gnaa106>.
- Koyano, W., Shibata, H., Nakazato, K., Haga, H., Suyama, Y., 1991. Measurement of competence: reliability and validity of the TMIG index of competence. *Arch. Gerontol. Geriatr.* 13, 103–116. [https://doi.org/10.1016/0167-4943\(91\)90053-S](https://doi.org/10.1016/0167-4943(91)90053-S).
- Maugeri, G., Castrogiovanni, P., Battaglia, G., Pippi, R., D'Agata, V., Palma, A., Di Rosa, M., Musumeci, G., 2020. The impact of physical activity on psychological health during COVID-19 pandemic in Italy. *Heliyon* 6, e04315. <https://doi.org/10.1016/j.heliyon.2020.e04315>.
- Nagin, D.S., Odgers, C.L., 2010. Group-based trajectory modeling in clinical research. *Annu. Rev. Clin. Psychol.* 6, 109–138. <https://doi.org/10.1146/annurev.clinpsy.121208.131413>.
- Park, K.H., Kim, A.R., Yang, M.A., Lim, S.J., Park, J.H., 2021. Impact of the COVID-19 pandemic on the lifestyle, mental health, and quality of life of adults in South Korea. *PLOS ONE* 16, e0247970. <https://doi.org/10.1371/journal.pone.0247970>.
- Parlapani, E., Holeva, V., Nikopoulou, V.A., Kaprinis, S., Nouskas, I., Diakogiannis, I., 2021. A review on the COVID-19-related psychological impact on older adults: vulnerable or not? *Aging Clin. Exp. Res.* 33, 1729–1743. <https://doi.org/10.1007/s40520-021-01873-4>.
- Piumatti, G., Levati, S., Amati, R., Crivelli, L., Albanese, E., Corona Immunitas Ticino Working Group, 2022. Trajectories of depression, anxiety and stress among adults during the COVID-19 pandemic in Southern Switzerland: the Corona Immunitas Ticino cohort study. *Public Health* 206, 63–69. <https://doi.org/10.1016/j.puhe.2022.02.005>.
- Salari, N., Hosseini-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., Rasoulpoor, S., Khaledi-Paveh, B., 2020. Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Glob. Health* 16, 57. <https://doi.org/10.1186/s12992-020-00589-w>.
- Sepúlveda-Loyola, W., Rodríguez-Sánchez, I., Pérez-Rodríguez, P., Ganz, F., Torralba, R., Oliveira, D.V., Rodríguez-Mañas, L., 2020. Impact of social isolation due to COVID-19 on health in older people: mental and physical effects and recommendations. *J. Nutr. Health Aging* 24, 938–947. <https://doi.org/10.1007/s12603-020-1469-2>.
- Shinkai, S., Fujita, K., Fujiwara, Y., Kumagai, S., Amano, H., Yoshida, H., Wang, D.G., Watanabe, S., 2005. Prevalence and characteristics of different types of homeboundness among community-living older adults. *Nihon Koshu Eisei Zasshi* 52, 443–455. <https://doi.org/10.11236/jph.52.6.443>.
- Stults-Kolehmainen, M.A., Sinha, R., 2014. The effects of stress on physical activity and exercise. *In: Sports Med.* 44, Sports Publishing Med, pp. 81–121. <https://doi.org/10.1007/s40279-013-0090-5>.
- Suzuki, Y., Maeda, N., Hirado, D., Shirakawa, T., Urabe, Y., 2020. Physical activity changes and its risk factors among community-dwelling Japanese older adults during the COVID-19 epidemic: associations with subjective well-being and health-related quality of life. *Int. J. Environ. Res. Public Health* 17. <https://doi.org/10.3390/ijerph17186591>.
- Topp, C.W., Østergaard, S.D., Søndergaard, S., Bech, P., 2015. The WHO-5 Well-Being Index: a systematic review of the literature. *Psychother. Psychosom.* 84, 167–176. <https://doi.org/10.1159/000376585>.
- Tuason, M.T., Güss, C.D., Boyd, L., 2021. Thriving during COVID-19: predictors of psychological well-being and ways of coping. *PLOS ONE* 16, e0248591. <https://doi.org/10.1371/journal.pone.0248591>.