J. Phys. Ther. Sci. 33: 345–350, 2021

The Journal of Physical Therapy Science

Original Article

# Impact of the state of emergency enacted due to the COVID-19 pandemic on the physical activity of the elderly in Japan

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**Abstract.** [Purpose] In Japan, the government issued a state of emergency due to the spread of COVID-19 in April 2020. In this study, we measured physical activity before and after the state of emergency, and assessed the factors that affected physical activity. [Participants and Methods] We included thirteen elderly people living in Hiroshima Prefecture, Japan, in the study. The participants wore 3-axis accelerometer on their hips to measure physical activity for a week, before (in October 2019) and after the state of emergency. According to the median rate of decrease in physical activity (23.6%), we divided the participants into two groups: one group had participants with a high rate of decrease (low physical activity) and the other had participants with a low rate of decrease (high physical activity). [Results] The following factors decreased after the state of emergency: total physical activity, amount of moderate-intensity physical activity and activities of daily living, amount of light-intensity physical activity and walking, daily activity time, and daily steps. Statistical analysis showed that engaging in housework was associated with high physical activity. [Conclusion] Elderly people who engaged in household chores had a smaller decrease in physical activity. In order to reduce the decrease in physical activity and the risk of cardiovascular events, the elderly should perform as many daily activities and hobbies as they can while paying attention to the infection control measures.

**Key words:** COVID-19, Self-restraint of activities, Physical activity

*(This article was submitted Nov. 25, 2020, and was accepted Jan. 14, 2021)*

## INTRODUCTION

In December 2019, the infectious disease (COVID-19) caused by the new coronavirus (SARS-CoV-2) spread from Wuhan, People's Republic of China[1)]. The WHO declared COVID-19 a pandemic[2)]. Many countries took steps to prevent this epidemiological phenomenon, but COVID-19 infection became widespread worldwide. The WHO reported more than 32.7 million cases and 991,000 deaths by September 2020[3)]. Quarantine and social distancing are methods to prevent and minimize the outbreak of infectious diseases. In public health situations, quarantine is a means of preventing the spread of people who may have an infectious disease and applies to the isolation of persons known to be infected[4)].

On January 16, 2020, a man who traveled abroad was reported as the first infected person in Japan[5)]. Since then, the number of infected people gradually increased. On April 16, a state of emergency was issued to all prefectures in Japan. Following the issuance of this declaration, the prefectural governor requested the residents to refrain from going out unnecessarily, and after setting the period and area, requested business owners to limit the opening of stores and facilities (self-restraint of activities). Residents refrained from going out except when necessary to maintain their livelihoods such

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as going to a medical institution, buying groceries, or commuting to work. Leisure facilities and events were also closed or postponed due to this request[6]. Several reasons for going out are physical activity (PA), housework, shopping, etc. in a period of quarantine. Elderly people in particular are at risk of COVID-19 infection, but they need to avoid a sedentary lifestyle to prevent heart failure. The American Heart Association (AHA) recommends that older people do the following to maintain their health: 150 minutes of moderate-intensity PA, 75 minutes of high-intensity PA, or a combination per week[7]. In Japan, the Ministry of Health, Labour and Welfare recommends that PA be performed at 10 metabolic equivalents (METs) / hour / week, regardless of the PA Standards 2013 for Health Promotion and Physical Activity Guidelines for Health Promotion. Specifically, exercise for 40 minutes or longer[8, 9]. Sedentary lifestyles and lowPA have been reported to increase the risk of heart failure and cerebrovascular disease in people with comorbidities such as hypertension and dyslipidemia[10]. There is a relationship between short-term (1–4 weeks) inactivity and increased cardiovascular risk factors, in addition to detrimental effects on cardiovascular function and structure[11]. Furthermore, low intensity PA improves athletic performance, quality of life, and the prognosis of both patients with heart failure and healthy adults[12–14]. There are several methods for measuring these physical activities such as self-reported questionnaires, heart rate monitoring, and pedometers[15–19]. Among them, wearable 3-axis accelerometers can measure body movements even at low intensity and use METs to indicate intensity[20, 21]. However, no study has used a three-dimensional accelerometer to measure the decrease in daily PA (volume) of the elderly during a period of self-restraint upon announcement of a state of emergency. In addition, it is unclear what factors are not affected by self-restraint. Therefore, the purpose of this study was to elucidate how much self-restraint from activity by the elderly with diseases, such as hypertension and dyslipidemia, reduces PA, and what factors are unaffected by self-restraint.

## PARTICIPANTS AND METHODS

The participants were 13 elderly people, 2 males and 11 females, residing in Asakita Ward, Hiroshima City, Hiroshima Prefecture. They performed light-intensity (<2 METs) exercises once a week at a meeting house. We excluded patients with severe heart failure (AHA/ACC classification Stage C/D)[22], end-stage renal disease, malignant tumor, dementia, severe chronic lung disease, myocardial infarction within 12 weeks, and those unable to walk 20 m. All participants were briefed on the purpose and procedure of the experiment, consent was received. The study was approved by Hiroshima Cosmopolitan University Ethics Committee (2019004). All patients provided written informed consent for inclusion in this study.

In October 2019, the social background, height, weight, blood pressure measurement, bilateral lower leg morphology measurement, grip strength, 6-m maximum walking speed[23], dementia prevention test, and dynamic balance test were collected for all participants. An activity meter with a three-dimensional acceleration sensor was attached to their left hip for one week and the daily PA was evaluated. After April 16, 2020, when the state of emergency was issued, the activity meter was disinfected and mailed to all participants, and the activity meter was measured using the same method, period, and activity meter. All participants wore an activity meter for one week and then returned it. Other evaluations were not possible due to the prohibition of going out unnecessarily. All participants were stratified into a group with a large rate of decrease (High-PA) and a group with a low rate of decrease (Low-PA) according to the median rate of decrease in total daily activity after self-restraint of 23.6%.

All participants responded in writing about illnesses (under treatment), medications, means of transportation (car, bicycle, public transport, motorcycle, or do not go out), housework (cleaning and washing by yourself or not), and fall history within 1 year (yes/no) at the time of registration. When the state of emergency was announced and the activity meter was mailed, we confirmed in writing whether there were any changes in housework or transportation, and received written responses.

The amount of PA was evaluated using an activity meter with a three-dimensional accelerometer (HJA-750C OMRON Corporation) (3-axis accelerometer). All participants were instructed to wear it on the left hip for at least 7 days for 24 hours. Using this activity meter, we evaluated the number of steps per day, activity time, walking every 10 seconds, and METs, which reflect the intensity of activities of daily living. The amount of PA measured using this activity meter was calculated as MET*h/d. The activity data were analyzed using the activity meter data collection software V2.0 (OMRON Corporation). From the activity measurement results, days with less than 480 minutes of wearing time per day were excluded from the data analysis as non-wearing days[12]. Physical activity of 1.5 METs or more were calculated as activity, 1.5–2.9 METs were defined as light-intensity PA, and 3 or more METs were defined as moderate-intensity PA[20, 21]. The volume of total PA was calculated as the sum of both light-intensity and moderate-intensity PA.

The measurement posture of the participants was such that both hands were placed on the upper surface of the thigh, both knees were bent at right angles, and both soles were placed on the ground without leaning on the backrest of the chair. The grip strength was measured by taking the average value of the maximum values measured three times for 5 seconds with the maximum force in a state where the elbow was bent at a right angle from the above-mentioned measurement posture as the maximum grip strength value[23, 24]. The lower leg morphology was measured in the measurement posture using a measuring tape (GHX7706S Hoechstmass), and the maximum value of each of the left and right measurements were taken as the lower leg circumference[23].

Six meters of flat ground was used as the measurement section road[23]. In addition, the approach road was 3 meters in front of and 3 meters behind the measurement section road. The time required for the subject to walk in the measurement section was used as the measured value. The start and end of the measurement were when either toe of the subject crossed between the measurement section and the reserve path. All participants were instructed to walk at their usual walking speed before walking. The walking speed per 1 meter was calculated from the measured walking speed.

Commercially available software (SPSS ver.26 IBM) was used for statistical analysis. Regarding the data notation, the Table shows the average ± SD. Continuous variables are shown as mean values and categorical variables are shown as%. For the variables of activity-lowering factors, the odds ratio and 95% confidence interval were evaluated by logistic regression analysis. P-values less than 0.05 was considered to be significant.

## RESULTS

The social background and measurement results (excluding the amount of PA) are shown in Table 1. There were no differences in gender, illness, or medication between the High-PA and Low-PA groups, but few participants of the Low-PA group were engaged in household chores (p=0.03).

Regarding the amount of PA after the announcement of the state of emergency, a decrease was observed in total PA, moderate-intensity PA, moderate-intensity LA, light-intensity PA, moderate-intensity walking activity and LA, daily activity time, and the number of steps per day (Table 2). Regarding the changes in each activity amount after the announcement, the total PA amount decreased by 22.3%. Moderate-intensity PA decreased by 32.3%. Among the moderate-intensity PA, the activity of only the daily activity decreased by 32.6%. Light-intensity PA decreased by 18.2%. Among the light-intensity PA, walking activity decreased by 17.0% and LA decreased by 18.5%. The daily activity time decreased by 20.7%. The average daily number of steps decreased by 38.9%. No items improved after the announcement, and no changes in walking intensity or LA intensity were observed.

In the High-PA group, the number of steps, activity time, moderate-intensity PA, light-intensity PA, and total PA decreased after self-restraint (p>0.02) in Table 2. The Low-PA group reported a decrease in activity time, moderate PA, moderate-

**Table 1.** Baseline people characteristics, physical function data

| | All | High-PA | Low-PA | p value |
|---|---|---|---|---|
| Number | 13 | 7 | 6 | |
| Male gender, n (%) | 2 (15.4) | 1 (14.3) | 1 (16.7) | 090 |
| Age (years) | 77.5 ± 3.5 | 77.9 ± 3.8 | 77.2 ± 3.3 | 0.73 |
| Body mass index (kg/m$^2$) | 23.1 ± 3.4 | 22.7 ± 3.3 | 23.9 ± 2.6 | 0.47 |
| SBP (mmHg) | 128.7 ± 4.6 | 127.9 ± 4.8 | 129.7 ± 4.6 | 0.50 |
| Heart rate (bpm) | 70.7 ± 3.8 | 71.1 ± 3.2 | 70.2 ± 4.6 | 0.67 |
| Social background, n (%) | | | | |
| Car user | 4 (30.8) | 3 (42.9) | 1 (16.7) | 0.31 |
| Housework | 7 (53.8) | 6 (85.7) | 1 (16.7) | 0.01 |
| Fall down history within 1 year | 0 (0) | 0 (0) | 0 (0) | |
| Comorbidities, n (%) | | | | |
| Hypertension | 7 (53.8) | 3 (42.9) | 4 (66.7) | 0.39 |
| Dyslipidemia | 5 (38.5) | 3 (42.9) | 2 (33.3) | 0.73 |
| Coronary artery disease | 0 (0) | 0 (0) | 0 (0) | |
| Medication, n (%) | | | | |
| ARB/ACE-inhibitors | 7 (53.8) | 3 (42.9) | 4 (66.7) | 0.59 |
| CCB | 2 (15.4) | 1 (14.3) | 1 (16.7) | 0.90 |
| Statin | 4 (30.8) | 2 (28.6) | 2 (33.3) | 0.85 |
| Physical function | | | | |
| Calf circumference (cm) | | | | |
| Rt | 33.9 ± 2.9 | 33.7 ± 3.3 | 34.3 ± 2.6 | 0.72 |
| Lt | 34.0 ± 2.7 | 33.8 ± 3.1 | 34.4 ± 2.3 | 0.72 |
| Handgrip strength (kg) | | | | |
| Rt | 21.3 ± 5.3 | 19.6 ± 3.1 | 18.8 ± 2.9 | 0.89 |
| Lt | 20.1 ± 5.0 | 20.0 ± 4.7 | 18.3 ± 3.3 | 0.76 |
| 6 m speed gait (sec) | 4.0 ± 0.8 | 3.6 ± 0.5 | 4.4 ± 1.0 | 0.11 |

Values are mean ± SD or n (%); High-PA indicates people who PA rate of decrease is small at Emergency Declaration on Changes. Low-PA indicates people who PA rate of decrease is big at Emergency Declaration on Changes; SBP: Systolic Blood Pressure; ARB: Angiotensin II Receptor Antagonists; ACE: Angiotensin Converting Receptor; CCB: Calcium Channel Blocker; Rt: Right; Lt: Left; m: meters; p<0.05 High-PA vs. Low-PA.

**Table 2.** The change of physical activity at Before and After state of emergency declaration

| | ALL | | High-PA | | Low-PA | | Interaction effect p value |
|---|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After | |
| Step (step/d) | 5,742.7 ± 1,393.4 | 3,506.6 ± 1,961.0* | 5,917.0 ± 1,246.0 | 3,568.7 ± 1,886.4* | 5,539.2 ± 1,644.5 | 3,434.2 ± 2,224.2 | 0.86 |
| Activity time (≥1.5 METs) (min/d) | 475.3 ± 55.4 | 376.9 ± 71.1* | 465.8 ± 60.4 | 414.7 ± 48.6* | 486.4 ± 52.0 | 332.8 ± 70.5* | 0.04 |
| Average walking METs (METs) | 2.7 ± 0.2 | 2.6 ± 0.3 | 2.8 ± 0.2 | 2.6 ± 0.3 | 2.7 ± 0.2 | 2.5 ± 0.3 | 0.79 |
| Average LA METs (METs) | 2.3 ± 0.1 | 2.3 ± 0.1 | 2.3 ± 0.1 | 2.3 ± 0.1 | 2.3 ± 0.1 | 2.2 ± 0.1 | 0.47 |
| Moderate intensity PA (METs*h/d) | 5.5 ± 1.0 | 3.7 ± 1.9* | 5.4 ± 1.1 | 4.3 ± 1.9 | 5.5 ± 1.0 | 3.0 ± 1.7 | 0.22 |
| Moderate intensity walking PA (METs*h/d) | 1.5 ± 0.8 | 1.0 ± 0.9 | 1.7 ± 0.7 | 1.2 ± 1.1 | 1.4 ± 0.9 | 0.8 ± 0.7* | 0.85 |
| Moderate intensity LA PA (METs*h/d) | 3.9 ± 1.0 | 2.6 ± 1.2* | 3.7 ± 0.8 | 3.1 ± 1.1 | 4.1 ± 1.3 | 2.1 ± 1.1* | 0.12 |
| Light intensity PA (METs*h/d) | 13.3 ± 1.7 | 10.9 ± 2.2* | 13.0 ± 1.8 | 11.9 ± 1.3* | 13.7 ± 1.5 | 9.7 ± 2.5* | 0.06 |
| Light intensity walking PA (METs*h/d) | 2.0 ± 0.4 | 1.7 ± 0.6* | 2.1 ± 0.5 | 1.7 ± 0.6* | 2.0 ± 0.1 | 1.7 ± 0.6 | 0.75 |
| Light intensity LA PA (METs*h/d) | 11.3 ± 1.6 | 9.2 ± 2.3* | 10.9 ± 1.6 | 11.9 ± 1.3 | 11.7 ± 1.6 | 8.0 ± 27* | 0.049 |
| Total PA (METs*h/d) | 18.8 ± 2.2 | 14.6 ± 3.0* | 18.4 ± 2.4 | 16.2 ± 2.4* | 19.2 ± 2.1 | 12.7 ± 2.5* | 0.03 |

Values are mean ± SD or n (%). Before indicates before state of emergency declaration; After indicates after state of emergency declaration; PA: Physical activity; LA: Living activity; METs: Metabolic equivalents; *p<0.05 vs. same group. Interaction effect p value indicates High-PA vs. Low-PA.

intensity LA, light-intensity activity, light-intensity LA, and total PA (p>0.01). In particular, the activity time, light-intensity LA, and total PA significantly decreased compared with those in the High-PA group (interaction effect p=0.049).

The factors that reduce daily physical activity by 23.6% or more were analyzed using logistic regression from the measurement results (Table 1) and physical activities (Table 2) at the time of registration. Among the variables measured at the time of registration, engagement in household chores was negatively correlated with the decrease in activity (odds ratio: p=0.03). However, no association was found between decreased activity and complications, fall history, walking speed, morphometry, and grip strength.

## DISCUSSION

Based on this study, the total amount of PA per day decreased after the declaration of emergency (refraining from unnecessary activities) due to COVID-19. Moderate-intensity PA (LA), light-intensity PA (walking and LA), daily activity time, and number of steps decreased. In addition, performing household chores may prevent a large decrease in the total amount of PA.

In 2014, Miyahara et al. reported the PA of patients of the same age (AHA/ACC classification Stage A/B) to be 15.4 ± 4.6 METs*h/d. Similar results were noted for the amount of PA. Hegde et al. found that patients with PA of less than 500 METs·min/week had a higher risk of HF hospitalization[25]. In 2013, the Ministry of Health, Labour and Welfare recommended that the amount of PA for people aged 65 and over be 10 METs*h/w of PA for 40 minutes every day, regardless of intensity, in the PA standards for health promotion[10]. In addition, the AHA recommend twice the amount of PA (1,000 METs*min/w) as Hegde et al., which reduces the risk of readmission for patients with heart failure preserved ejection fraction (HFpEF) by 19%[24, 25]. In this study, the total amount of PA was lower after the announcement. When the activity units in this study were converted to the same units used by the AHA, the activity amount was 1,127.8 ± 134.9 METs*min/w before the announcement and 876.0 ± 180.5 METs*min/w after the announcement. The amount of PA during self-restraint exceeded the Hegde recommendation, but not that recommended by the AHA[25–27]. The amounts of light-intensity and moderate-intensity activity decreased after self-restraint. As the average walking intensity and the average intensity of daily activity did not change after refraining from activity, the amount of activity decreased due to the shortening of the activity time. The number of steps also decreased after self-restraint. Regarding this decrease in the number of steps after self-restraint, there was no difference in the amount of moderate-intensity walking activity (p=0.23), but there was a difference in the amount of light-intensity walking activity (p=0.03). Clarke et al. reported that the PA decreased by approximately 6% annually per year in elderly Scottish individuals[28]. Yamada et al. reported that the total physical activity time in the elderly decreased significantly in April 2020 compared to January 2020[29]. The amount of PA of all participants in this study decreased by 22.3% after self-restraint (6 months). The comparison before and after self-restraint between the High-PA group and the Low-PA group is discussed below. The decrease in activity in the High-PA group was 20.4% for moderate-intensity activity, 8.5% for light-intensity activity, and 12.0% for total activity. In contrast, the decrease in medium intensity activity was 45.5%, that in light-intensity activity was 29.2%, and that in total activity was 33.9% in the Low-PA group. Both groups exceeded the 6% reported by Clarke et al[28]. Boyle et al. reported an increase in markers of vascular apoptosis and activation within 3–5 days of inactivity after 1 week of reduced daily PA (50%, from 10,000 to 5,000 steps/week)[30]. In this study, the number of steps decreased by 38.9% after self-restraint (6 months) (from 5,742 to 3,506). In addition to the extension of the self-restraint period and the decrease in activity due to aging, the amount of activity became lower than that recommended by the AHA, which may lead to cardiovascular events. In order to further elucidate the effects of PA on the clinical outcome of the elderly by refraining from activity due to the influence of COVID-19, a large-scale study targeting more participants is needed in the future.

Older participants with no overt HF, greater energy expenditure during a leisure activity, and faster-walking speed (≥4.8 km/h) were independently associated with a lower risk of Major Adverse Cardiovascular Events (MACE)[31, 32]. Similarly, Manson, et al. reported that brisker walking and fewer hours spent sitting daily were associated with a lower incidence of MACE in older women[33]. Suzuki et al. reported that there was a strong correlation between physical activity and subjective well-being[34]. In this study, the activity time decreased by 20.1% after self-restraint. However, the average walking and LA METs did not decrease after self-restraint. By increasing daily leisure time, housework exercise, and activity time, it may be possible to prevent MACE and declining quality of life during self-restraint.

In the revised "METs table of physical activity" by the National Institutes of Health and Nutrition, the intensity of items, such as cooking and food preparation, dishwashing, washing, and cleaning, which are household chores, is measured as 2 to 4 METs[33]. In the Low-PA group, the amount of light-intensity LA PA to which these corresponded was significantly reduced (interaction effect p=0.049). Furthermore, the activity time was significantly lower in the Low-PA group than in the High-PA group (interaction effect p=0.04). As there was no difference in the average METs, it is possible that the activity time had an effect. Routine household chores may prevent a decrease in PA. Miyahara et al. suggested that elderly patients with heart failure who have a high amount of light-intensity PA have a lower risk of readmission, and continued household chores may prevent readmission due to cardiovascular events and heart failure[12].

This study has several limitations. Due to the small number of participants, it may have a large impact on changes in each evaluation item. In addition, there were many items with simple measurements, and biomarker tests, and cardiac function tests that may affect PA were not performed. Furthermore, the maximum exercise stress test, which has been reported to be an independent predictor of life prognosis, was not conducted.

In conclusion, the nationwide self-restraint from unnecessary activities due to COVID-19 was unprecedented in many countries. Elderly people decreased physical activity during a period of self-restraint upon announcement of a state of emergency. Self-restraint of activity can refer to quarantine, but it also negatively affects physical health such as increased cardiovascular risk. Engaging in daily housework may prevent a large decrease in PA in the elderly. In daily medical care and rehabilitation, engaging in housework, performing daily activities, and hobbies (leisure time) may be able to maintain PA and prevent other diseases.


## *Conflict of interest*

None.


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