Are middle-aged and older adult users of physical activity monitors more physically active and at a lower risk of locomotive syndrome? Cross-sectional Web-based Online Survey

A short running title: using physical activity monitors and locomotive syndrome

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Abstract

Background: Physical inactivity is a risk factor for locomotive syndromes and functional limitations in middle-aged and older adults. Therefore, strategies to promote physical activity should be considered. This study investigated whether users of physical activity monitors were more physically active and exhibited a lower risk of locomotive syndrome, compared with non-users. Methods: We analyzed data from 742 Japanese adults aged 60–79 years. The participants were surveyed for their use of physical activity monitors in their daily lives. We also assessed the prevalence of locomotive syndrome. Results: We observed significantly higher physical activity levels in users compared with non-users. Moreover, the use of a physical activity monitor was significantly associated with decreased odds of locomotive syndrome (adjusted odds ratio [aOR] = 0.48). Significantly lower risk of locomotive syndrome were observed in individuals who had used a monitor for >2 years (aOR = 0.42) or had set a personal step goal (aOR = 0.32). Discussion: Physical activity monitoring may increase engagement in physical activity-associated behavior. Therefore, monitoring could serve as a useful tool to promote physical health in middle-aged and older adults.

Keywords: walking, exercise, behavioral change
Introduction

Physical inactivity is a major risk factor for death from noncommunicable diseases and injuries (1). In middle-aged and older adults, decreased physical activity levels are associated with greater health risks, such as dementia, cardiovascular disease, and cancer (2). Therefore, guidelines recommend physically active lifestyles, defined as 150–300 min of moderate-intensity or 75–150 min of vigorous-intensity physical activity per week and muscle-strengthening activities at moderate or greater intensity ≥ 2 days per week, for all adults (3).

Physical inactivity is also a risk factor for the increased incidence of functional limitations in middle-aged and older adults (4). During the coronavirus disease 2019 (COVID-19) pandemic, many people experienced negative lifestyle changes, including an approximately 30% decrease in physical activity among middle-aged and older adults (5). Physical inactivity due to the pandemic might have increased the risk of frailty and locomotive syndrome (6, 7). However, some people positively changed their lifestyle by exercising indoors and walking in their neighborhoods (8). Higher physical activity levels during the pandemic may also be associated with healthy lifestyle habits, such as the use of physical activity monitors.

During the COVID-19 pandemic, physical activity monitoring may have played an important role in the maintenance of a physically active lifestyle. Increased sedentary behavior and weight gain during the COVID-19 pandemic occurred among middle-aged individuals regardless of physical activity monitoring (9). However, the proportion of older adults using such monitors during the COVID-19 pandemic have not been
reported. Among older adults, activity monitoring was linked with meeting aerobic physical activity requirements and walking (10). In addition, although continuity and goal setting are important for adopting healthy behavioral changes (11), the association between the period of physical activity monitoring, step goal setting, and health status remain undetermined.

In 2007, the Japanese Orthopaedic Association defined locomotive syndrome as a condition that requires nursing care due to a decline in mobility resulting from disorders of the locomotive system, including the bones, joints, muscles, and nerves (12). Understanding the relationship between physical activity monitoring and its relevance in the maintenance of physical activity levels and locomotion status among individuals, including older adults, will provide clinical information for the adoption of healthy habits in normal daily life.

This study investigated whether users of physical activity monitors in Japan were more physically active, and whether the duration of use of monitors and having personal step goals were associated with a lower risk of locomotive syndrome in middle-aged and older adults. Clarification of these associations may provide information to promote the use of physical activity monitors and to develop guidance strategies.

Methods

Participants

We collected data for this study from an online survey panel administered through the
sampling of Y cloud systems among Japanese adults. The Y cloud system is a
crowdsourcing service launched by Yahoo Japan Corporation, Inc. (Tokyo, Japan) in
2013. This study recruited Yahoo Japan users aged ≥60 years who were registered in the
Y cloud systems. We requested these users to participate in this study for 2 weeks. The
full quota of participants was 800. From June 21, 2021 to June 28, 2021, 800 Japanese
middle-aged and older adults aged ≥60 years completed an online survey. We excluded
responses from the users who reported a history of stroke, Parkinson’s disease,
dementia, neurological disorders, those aged ≥80 years, and those who reported >960
min/day of total physical activity. We conducted this study in accordance with the
guidelines proposed by the Declaration of Helsinki. The study was approved by the
Institutional Review Board of the authors’ affiliated institutions. We obtained informed
consent from all the participants.

Locomotive syndrome status

Locomotive syndrome status can be assessed using the two-step test, stand-up test, and
25-question Geriatric Locomotive Function Scale (GLFS-25) (13). Among these
assessment methods, the GLFS-25 score is a simple, self-administered, contactless
screening tool to assess the risk of locomotive syndrome (14, 15). We evaluated
locomotive syndrome status in the present study using the GLFS-25. The questionnaire
consists of questions on pain (four questions), activities of daily living (sixteen
questions), social functions (three questions), and mental health status (two questions)
during the previous month (thirteen questions). Each question is scored from 0 (no
impairment) to 4 (severe impairment) points; thus, the maximum total score is 100
points, with higher scores indicating lower locomotive function (greater risk of
locomotive syndrome). The reliability and validity of the GLFS-25 were previously verified with a predetermined cutoff score for Japanese individuals (13). Locomotive syndrome status is categorized into three stages (1–3) according to the total GLFS-25 score (7–15, 16–23, and ≥24 points) (16). This classification has been applied in studies that examined older participants in the community (17, 18). In this study, we segregated the participants into a locomotive syndrome group (GLFS-25 score ≥16 points, ≥stage 2) and a control group (GLFS-25 score <16 points, <stage 2).

**Physical activity levels**

We asked the participants to report their physical activity based on the abbreviated version of the International Physical Activity Questionnaire (IPAQ) (19), which consists of three-dimensional activity items: activity intensity level (walking, moderate, or vigorous intensity), activity frequency per week, and activity time per day. Following the IPAQ guidelines for data processing and analysis, we included only activity values of ≥10 min in the calculation of the summary scores. Responses that were <10 min (and their associated days) were re-coded as “0.” Furthermore, we set the activity time variables for each level exceeding “3 h” or “180 min” to “180 min” as a new variable. We determined the total duration of physical activity (min/week) as the combined values for each activity level, which were then multiplied by the activity frequency per week and activity duration per day (min) at each activity level (20). We calculated the total physical activity time (min/week), moderate-vigorous physical activity (3–6 metabolic equivalents [MET]) time (min/week), walking time (min/week), and sedentary time (total minutes per day of sitting activities; min/day) (19). All IPAQ data were analyzed using the median and interquartile range, based on previous
recommendations (21).

Survey of physical activity monitor usage
We determined whether the participants used a physical activity monitor in their daily lives by asking the question “Do you usually use a physical activity monitor?” Physical activity monitor included any wearable device that could measure physical activity, such as a dedicated device, wristwatch, cell phone, or smartphone. If participants answered “yes”, we also asked about the period of use, and whether they had a daily step goal by asking the questions “How long have you used a physical activity monitor?” and “Do you have a daily personal step goal?” The responses for the period of use were as follows: ≥2 years, 1–2 years, 6 months–1 year, 3–6 months, 1–3 months, <1 month, and never. This cross-sectional online survey was conducted during the COVID-19 pandemic from June 21, 2021 to June 28, 2021 after the government had declared a state of emergency due to the pandemic in April 2020. We divided the participants into two groups based on their duration of monitor use: ≥2 years (responses of ≥2 years) and <2 years (responses of 1–2 years, 6 months–1 year, 3–6 months, 1-3 months, or <1 month). This segregation was done to distinguish between participants who had used physical activity monitors before the COVID-19 pandemic and those who had not. Additionally, few participants reported <2 years of monitor use. Participants responded to the question regarding whether they had a step goal.

Statistical analysis
We compared demographic variables, physical activity time, and locomotive syndrome status between monitor users and non-users using the unpaired t-test (for age and body
mass index (BMI)), Mann–Whitney U test (for physical activity time), or chi-square test (for proportion), as appropriate. We also calculated the effect size $r$ for physical activity times, and $\varphi$ for the percentage of participants with locomotive syndrome. Logistic regression models were used with locomotive syndrome status as the dependent variable, with calculation of odds ratios (ORs) and 95% confidence intervals (CIs). The independent variables were monitor use status, users, period of use (>2 years), and having a personal step goal. The potential covariates in the adjusted model included age, sex, education, BMI, and medical history (i.e., hypertension, diabetes mellitus, spinal canal stenosis, lumbar vertebrae herniated disk, rheumatoid arthritis, osteoporosis, and osteoarthritis). All analyses were performed using IBM SPSS Statistics, version 26.0 (IBM Japan, Tokyo, Japan). The level of statistical significance was set at $p < 0.05$.

**Results**

We analyzed data from 742 Japanese adults aged 60–79 years (mean age, 64.9 years; 31.4% women) (Fig. 1). Table 1 shows the characteristics of physical activity monitor users and non-users. Almost two-thirds (66.2%) of the users had been using the monitors for >2 years. Subsequently, we classified the users based on whether they had used the device for >2 or <2 years. Among all monitor users, 55.2% had personal step goals. There were no significant differences in age, sex, and BMI between the physical activity monitor users and non-users. The monitor users had a higher educational level than non-users ($p = 0.001$). Table 2 shows the results of the comparison of physical activity duration and locomotive syndrome status between users and non-users, in which users demonstrated significantly higher total physical activity time, moderate-to-
vigorous physical activity time, and walking time per week than non-users but no differences in sedentary time, compared with non-users (p = 0.635).

The results of both crude and adjusted logistic regression models demonstrated the association between physical activity monitoring and locomotive syndrome status (Table 3). In the adjusted model, which included age, sex, education, BMI, and medical history (i.e., hypertension, diabetes mellitus, spinal canal stenosis, lumbar vertebrae herniated disk, rheumatoid arthritis, osteoporosis, and osteoarthritis) as covariates, physical activity monitor use was significantly associated with a decreased risk of locomotive syndrome (OR = 0.48, 95% CI 0.30–0.79). Additionally, participants who used a physical activity monitor for >2 years were less likely to experience locomotive syndromes (OR=0.42, 95% CI 0.23–0.75) than those that did not. However, <2 years of use showed no such associations (OR=0.63, 95% CI 0.33–1.22). Similarly, users with a personal step goal were observed to have significantly lower odds of having locomotor syndrome (OR= 0.32, 95% CI 0.16–0.64), whereas no such association was observed for users without a personal step goal (OR= 0.65, 95% CI 0.36–1.16).

Discussion

The results of the analysis of the web-based survey of 742 Japanese adults aged 60–79 years in this study demonstrated that users of physical activity monitors were more physically active and less likely to develop locomotive syndromes. In particular, long-term (≥2 years) use and having a personal step goal were associated with lower odds of locomotive syndrome. Our results highlight the benefits of long-term monitoring of physical activity, and underscore the importance of setting personal goals for physical
activity.

This study investigated the physical activity levels and prevalence of locomotive syndrome in users and non-users of physical activity monitors, and the potentially positive association with the duration of use and a set personal step goal. In a previous meta-analysis and systematic review, pedometer use was associated with significantly increased physical activity, corresponding to an increase of approximately 2,000 steps or roughly 1 mile of walking per day, compared with non-users (11). The results of the current study revealed that the median difference in walking time and total physical activity time between physical activity monitor users and non-users was 210 min/week (30 min/day) and 300 min/week (43 min/day), respectively. Increased physical activity can positively influence future health conditions of the bone, brain, heart, and lung, as well as cardiometabolic health (22). In addition, step goals are an important predictor of increased physical activity (11). The results of the present study indicated that the long-term (≥2 years) use of a physical activity monitor and having a step goal were associated with higher levels of physical activity and reduced chances of developing locomotive syndrome. Therefore, using physical activity monitors and setting personal step goals may promote a physically active lifestyle and decrease the incidence of locomotive conditions in middle-aged and older adults.

Physical inactivity is a risk factor for death from noncommunicable diseases and harm due to smoking and high blood pressure (1). A current social issue associated with secondary health issues during the COVID-19 pandemic is reduced physical activity in middle-aged and older individuals (5, 23). To our knowledge, the present study is the
first study conducted during the COVID-19 pandemic which examines the proportion of
individuals using physical activity monitors and the relationship between their use,
physical activity levels, and locomotive syndrome status. Our findings indicate that
users of physical activity monitors walked more and spent more time per week on total
physical activity and moderate-vigorous physical activity during the COVID-19
pandemic (June 2021), compared with non-users. Although most older adults have seen
gradual improvement in their physical activity levels after the COVID-19 pandemic,
socially inactive people and people living alone have not regained their level of physical
activity (24). Middle-aged and older adults who used physical activity monitors during
the COVID-19 pandemic may have exhibited more physical activity-associated
behavior, compared with non-users.

Users of physical activity monitors may be health-conscious and exhibit healthy
behavior in terms of physical activity, as well as with respect to other lifestyle traits,
including those associated with cognitive stimulation, social networking, and nutrition
(25). Higher health literacy may also influence behavioral changes, such as the use of
physical activity monitors during the COVID-19 pandemic. Health literacy plays a role
in motivating older adults to adopt healthy lifestyles (e.g., regular physical activity
monitoring) (26). Among community-dwelling older adults, high communicative health
literacy was associated with exercise during the COVID-19 state of emergency in Japan
(27). In addition, electronic health literacy, defined as the ability of older adults to apply
knowledge to address or solve health problems by seeking, finding, and understanding
health information from electronic sources, is essential for promoting an improved
response to major public health events such as the COVID-19 pandemic (28). Although
the cross-sectional design of the present study prevented us from directly investigating
the interactional relationship between the use of a physical activity monitor and risk of
locomotive syndrome, our findings indicated that older adults using a physical activity
monitor were less likely to develop locomotive syndromes.

The estimated prevalence of worsened locomotive function, defined as locomotive
syndrome, in Japan is >65% (15). As locomotive syndrome increases the risk of
disability and mortality (15), early assessment and prevention strategies are required in
the older adult population. Locomotion training (strengthening, muscle strength, and
balancing exercises) in older adults with locomotive syndrome has positive effects on
physical functions such as muscle strength and aerobic capacity (29, 30).

Multidimensional intervention strategies (e.g., in-person exercise classes and self-
management to maintain physical activity) are needed. Using a physical activity
monitor and setting a personal step goal could be useful strategies for maintaining
locomotive performance in middle-aged and older populations.

This study has some limitations. First, owing to the cross-sectional design, the causal
relationship between the use of physical activity monitors and the development of
locomotive syndrome remains unclear. Moreover, this study used a self-administered
questionnaire to determine the locomotive syndrome status. The reference values for
this risk assessment of locomotive syndrome were based on nationwide data from
Japanese adults (14). The two physical tests (the two-step and stand-up tests) are more
sensitive to increase in age than was the self-reported test (GLFS-25 score) (14).

Detailed assessments, including objective measures, are needed to examine their
validity for the evaluation of locomotive syndrome. A selection bias was also possible as all participants routinely used the Internet. Older adults who routinely use digital health information are associated with higher educational levels and higher income (31). We did not consider factors such as economic status, health behaviors, and chronic diseases. Additionally, we excluded individuals who reported a history of dementia and other neurological disorders; however, poor cognitive performance status (e.g., mild cognitive impairment) might have influenced the responses to the questionnaires. Furthermore, recall bias or memory impairment during the self-administered survey might also have affected the results. Further studies are needed to determine the causal relationship between the use of physical activity monitors and risk of age-related functional decline.

Conclusion

Approximately half of the participants aged ≥60 years used physical activity monitors during the COVID-19 pandemic. Middle-aged and older Japanese adults who used physical activity monitors during the pandemic may have engaged in more physical activity-associated behavior, compared with non-users. Such users with long-term (i.e., >2 years) usage and personal step goals were less likely to develop locomotive syndromes. Therefore, long-term physical activity monitoring and personal step goal setting could be beneficial for the physical health of middle-aged and older adults.