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Original Research

Adherence and aerobic exercise intensity in live online exercise sessions for older adults with mild cognitive impairment: Insights from the Japan-Multimodal Intervention Trial for the Prevention of Dementia

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ABSTRACT

Background: Intervention adherence is crucial to ensure cognitive benefits in trials designed to prevent cognitive decline. During the coronavirus disease 2019 (COVID-19) pandemic, the Japan-Multimodal Intervention Trial for the Prevention of Dementia offered live online exercise sessions to older adults with mild cognitive impairment (MCI).

Objectives: To assess adherence and aerobic exercise intensity through live online exercise sessions in older adults with MCI.

Design: Posthoc analysis of the 18-month, multi-center, randomized controlled trial.

Setting: The study was conducted across five institutions in Japan.

Participants: Older adults aged 65–85 years who were assigned to the intervention group and completed the intervention. Participants were stratified by region (Aichi and Tokyo), where the state of emergency duration due to COVID-19 varied.

Interventions: The intervention group participated in multidomain interventions, including 90-minute group-based physical exercise sessions held weekly for 78 sessions. During the state of emergency, live online sessions were conducted via video conferencing.

Measurements: Attendance rates and aerobic exercise intensity (based on heart rates) during online and onsite sessions were compared using the Wilcoxon signed-rank test.

Results: A total of 207 participants were analyzed. Over 18 months, 78 exercise sessions were conducted, including live online sessions. In the Aichi region, 2 online sessions were held, while in the Tokyo region, 24 online sessions were conducted. In the Tokyo region, adherence was higher in online sessions compared to onsite sessions (92 % vs. 86 %, $p = 0.046$), while exercise intensity showed no significant difference (49 % vs. 52 %, $p = 0.279$). No adverse events were reported.

Conclusions: Live online exercise sessions were safe, feasible, and demonstrated adherence and intensity comparable to onsite sessions.

Trial registration: The trial was registered at the University Hospital Medical Information Network Clinical Trials Registry (UMIN-CTR) on November 24, 2019 (UMIN000038671) (https://center6.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000044075).

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1. Introduction

Dementia is becoming a serious public health issue and a global challenge [1]. It has multiple mechanisms, and several modifiable risk factors that contribute to approximately 45 % of global dementia cases have been identified [2]. Thus, multidomain intervention trials, such as the Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER) [3], which target multiple risk factors simultaneously, have gained considerable attention. In 2017, the World-Wide FINGERS network was established, facilitating the global implementation of multidomain intervention studies across various settings [4].

The Japan-Multimodal Intervention Trial for the Prevention of Dementia (J-MINT) study aimed to examine the efficacy of multidomain interventions in preventing cognitive decline among older Japanese adults with mild cognitive impairment (MCI). This study was initiated as part of the World-Wide FINGERS network [5]. The primary analysis did not yield statistically significant results. However, results showed that a subgroup of participants with high adherence to group-based exercise sessions, defined as attendance in ≥70 % of exercise sessions, presented with cognitive improvement compared with the control and low-adherence intervention groups [6]. Similarly, in the FINGER study, the participants with high adherence exhibited cognitive benefits [7], underscoring the importance of maintaining and enhancing adherence to multidomain interventions.

The J-MINT study faced great challenges in the recruitment and provision of interventions because of the coronavirus disease 2019 (COVID-19) pandemic [8]. Among the multidomain intervention programs, including the management of vascular risk factors, exercise, nutritional counseling, and cognitive training, group-based exercise interventions were significantly restricted. During the COVID-19 pandemic, the J-MINT study protocol was modified to maintain adherence by conducting online exercise sessions via a video-conference platform using study-distributed tablet computers. Live online exercise interventions have been feasible in older adults without cognitive impairment [9–11]. Live online exercise sessions, accessible from home, may help maintain adherence even during the COVID-19 pandemic. However, implementing online exercise sessions for participants with MCI raises concerns about potential barriers, such as difficulties with internet connectivity and the use of digital devices, which can lead to reduced adherence. In addition, due to space limitations at home and the use of small screens, there were concerns about safety management, including risks of falls and the potential reduction in aerobic exercise intensity, which is a key factor related to the cognitive benefits of exercise [12,13]. However, the possible impacts have not been completely elucidated.

This posthoc analysis of the J-MINT study aimed to investigate how live online exercise sessions impact adherence and exercise intensity in older adults with MCI, compared to onsite sessions. We hypothesized that online sessions, with substantial support, would show adherence rates comparable to or higher than those of onsite sessions, although exercise intensity might decrease. These findings may provide preliminary data to support the integration of online exercise programs into dementia prevention trials for older adults with MCI.

2. Methods

2.1. Study population and design

The data used in these posthoc analyses were collected from the J-MINT study. The study protocol and primary results were published previously [5,6]. The J-MINT study was an 18-month, randomized, controlled trial conducted at five independent institutions in Japan. It recruited 531 participants aged 65–85 years who presented with MCI, operationally defined as having age- and education-adjusted cognitive decline, from hospitals, memory clinics, and/or community-based centers. The purpose and potential risks of this trial were fully explained to the participants, and all participants provided written informed consent before participating in the trial. The Institutional Review Boards of all participating institutions approved the study procedures.

Of the 531 participants, those assigned to the intervention group and who completed the trial were included in the current analysis.

2.2. Interventional procedures

The intervention group received multidomain intervention programs, including managing vascular risk factors, group-based physical exercise, nutritional counseling, and cognitive training [5]. The J-MINT study provided 78 group-based physical exercise sessions lasting 90 min once a week. The exercise sessions comprised muscle stretching, muscle strength training, aerobic exercise, dual-task training, and group meetings.

2.3. Live online exercise session

During the COVID-19 pandemic, group-based physical exercise sessions were restricted in accordance with the government's declaration of a state of emergency. The Japanese government strongly recommended staying at home, maintaining physical distancing, and avoiding places with the "3Cs" (closed spaces, crowded places, and close-contact settings). Under such circumstances, live online exercise sessions were provided via the video-conference platform Zoom (Zoom Video Communications, Inc., San Jose, CA, USA). Before the introduction of online exercise sessions, the J-MINT trial provided adequate training, education, and support in using tablet computers and video-conference applications via face-to-face platforms or telephone.

Each online exercise session had a maximum of 12 participants. In every online exercise session, trial instructors and study staff checked the internet connection status and device audio and cameras. The study staff called and supported the participants who were not able to log in and connect to the video-conference application. After the connection, the instructors assessed the participant's body condition and their vital signs, including body temperature, blood pressure, and heart rate (HR). Further, the instructors confirmed environmental safety using the checklist that included the following items: the chair is stable, no object is near, the room is not dark, and the floor is not slippery.

Compared with onsite exercise sessions, online exercise sessions included more programs with a lower risk of falls, such as resistance training and group meetings. In addition, at the beginning of the online intervention, aerobic exercise and dual-task training were performed in a seated position to ensure participant safety.

2.4. Adherence and exercise intensity

The attendance rates for all 78 exercise sessions and those for the onsite and online exercise sessions were calculated.

During each session, the participant's resting and peak HRs during aerobic exercise were recorded using the Fitbit® Inspire HR activity monitor. Aerobic exercise intensity was calculated using the following formula: exercise intensity (%) = $[(HR_{exercise} - HR_{rest})/(HR_{max} - HR_{rest})] \times 100$. HR_{max} was estimated using the age-predicted maximal HR formula: $(207 - 0.7 \times \text{age})$ [14]. During the study period, the target exercise intensity was set at a moderate level and progressively increased from 40 % to 80 % [5]. Setting aerobic exercise intensity based on HR has been utilized in intervention studies targeting individuals with MCI [15,16].

2.5. Other variables

At baseline, participant characteristics include age, sex, education level, living situation (whether living alone), computer usage, activities of daily living, physical activity levels, self-reported comorbidities (such as hypertension, dyslipidemia, diabetes, atrial fibrillation, and congestive heart failure), and medications that may influence HR (specifically

antihypertensive and antiarrhythmic drugs and vasodilators) were assessed using a self-reported questionnaire [5]. The frequency of computer use was evaluated, and participants were categorized into two groups based on whether they used a computer at least once a week. Basic and instrumental activities of daily living were examined using the Barthel Index [17] and Lawton Index [18], respectively. The Lawton Index includes eight items (with scores ranging from 0 to 8). Notably, three of the items (food preparation, housecleaning, and laundry) were excluded from the calculation of the total Lawton Index score for men [18]. Participants who answered "No" to both questions—"Do you engage in moderate levels of physical exercise or sports aimed at health?" and "Do you engage in low levels of physical exercise aimed at health?"—were identified as physically inactive [19]. Cognitive function was evaluated using the Mini-Mental State Examination (MMSE) [20]. The MMSE score ranges from 0 to 30, with higher scores indicating better cognitive function. The usual gait speed (m/s) over 2.4 m was measured twice. Then, its mean value was calculated [21].

2.6. Statistical methods

Data were expressed as means ± standard deviation or medians with interquartile range for continuous variables and as percentages for categorical variables.

Considering that the duration of the state of emergency due to the COVID-19 pandemic varied by region, the participants were stratified into two regions: the Aichi region, with a population density of approximately 1,400 people/km^2, and the Tokyo region, with a population density of approximately 6,400 people/km^2. Each area's attendance rates and aerobic exercise intensities were identified for online and onsite exercise sessions. To compare attendance and exercise intensity rates between online and onsite exercise sessions, the Wilcoxon signed-rank test was used. Subgroup analyses were conducted based on living status (whether living alone or with others), computer usage (weekly or less frequent), and physical activity levels (physically inactive or otherwise). Additionally, a subgroup analysis excluding participants with atrial fibrillation and those receiving antiarrhythmic drugs, which can influence HR, was conducted.

To visually assess trends in exercise intensity between online and onsite sessions, we plotted the mean exercise intensity and 95 % confidence intervals for the groups that began participating in the intervention in the Tokyo region on July 16, 2020. Due to the extended state of emergency during the COVID-19 pandemic, the Tokyo region had more online interventions than the Aichi region.

All statistical analyses were conducted using Stata version 17.0 (StataCorp) *P*-values of <0.05 were considered statistically significant.

3. Results

3.1. Characteristics of the participants

Of 531 participants enrolled in the J-MINT study, 265 were allocated to the intervention group. Among them, 207 who completed the trial were included in the analysis. In the Aichi region, the participants' mean age and MMSE score were 74 years and 27.7, respectively, and 57.9 % were men. In the Tokyo region, the participants' mean age and MMSE score were 76 years and 28.4, respectively, and 14 % were men (Table 1).

3.2. Adherence to exercise sessions

Of 78 exercise sessions, a median of 2 sessions in the Aichi region were conducted online. The median attendance rates were 92 % for onsite sessions and 100 % for online sessions (Table 2). Online sessions had a significantly higher attendance rate than onsite sessions ($p < 0.001$).

Of 78 exercise sessions in the Tokyo region, a median of 24 were performed online. The median attendance rates were 86.2 % for onsite sessions and 91.7 % for online sessions (Table 2). The Wilcoxon signed-rank test showed that online sessions had a significantly higher adherence rate than onsite sessions ($p = 0.046$).

Table 1
Baseline characteristics of the participants who completed the intervention.

	Aichi region (n = 164)	Tokyo region (n = 43)
Age, mean (*SD*)	73.8 (5.0)	76.0 (4.8)
Male sex, n (%)	95 (57.9)	6 (14.0)
Education, mean (*SD*)	12.6 (2.6)	12.5 (2.3)
Living alone, n (%)	15 (9.2)	14 (32.6)
Use of computer weekly, n (%)	72 (43.9)	14 (32.6)
Barthel Index, mean (*SD*)	99.6 (2.1)	98.6 (4.5)
Lawton Index, mean (*SD*)		
Male, (/5)	4.9 (0.4)	4.7 (0.5)
Female, (/8)	7.9 (0.3)	7.9 (0.3)
Physical inactivity, n (%)	41 (25.0)	8 (33.3)
Gait speed, m/s, mean (*SD*)	1.2 (0.2)	1.2 (0.3)
Mini-Mental State Examination, mean (*SD*)	27.7 (1.8)	28.4 (1.5)
Self-reported comorbidities, n (%)		
Hypertension	76 (46.3)	22 (51.2)
Dyslipidemia	60 (36.6)	19 (44.2)
Diabetes	24 (14.6)	8 (18.6)
Atrial fibrillation	14 (8.5)	5 (11.6)
Congestive heart failure	5 (3.1)	0 (0.0)
Antihypertensive drugs	60 (36.6)	14 (32.6)
Antiarrhythmic drugs	14 (8.5)	3 (7.0)
Vasodilators	37 (22.6)	13 (30.2)
Intervention period	July 2020–November 2022	July 2020–August 2022
Period of declaration of the state of emergency	April 10, 2020–May 25, 2020 January 14, 2021–February 28, 2021 August 27, 2021–September 30, 2021	April 7, 2020–May 25, 2020 January 8, 2021–March 21, 2021 April 25, 2021–June 20, 2021 July 12, 2021–September 30, 2021
Number of exercise sessions, median (*IQR*)		
Overall	78	78
Onsite intervention	76 (75–76)	54 (54–56)
Online intervention	2 (2–3)	24 (22–24)

Abbreviation: IQR, interquartile range; SD, standard deviation

Table 2
Exercise attendance and intensity in onsite and online sessions, Wilcoxon signed-rank test, and effect sizes (r).

	N	Mean (SD)	Median (IQR)	N	Difference* Mean (SD)	Difference* Median (IQR)	Z†	P-value†	r‡
Aichi region (n = 164)									
Attendance rate, %									
Onsite	164	85.2 (18.5)	92.1 (82.0–96.1)	164	0.17 (24.3)	−4.0 (−10.0–0.0)	−3.41	0.001	0.27
Online	164	85.0 (29.5)	100.0 (87.3–100)						
Exercise intensity, %									
Onsite	164	47.1 (9.8)	48.1 (42.2–53.6)	117	15.6 (13.4)	15.2 (7.5–23.4)	8.53	<0.001	0.79
Online	117	32.6 (14.1)	32.4 (22.1–42.4)						
Tokyo region (n = 43)									
Attendance rate, %									
Onsite	43	80.7 (19.1)	86.2 (75.9–94.4)	43	−1.5 (16.1)	−3.7 (−8.6–2.8)	−1.99	0.046	0.30
Online	43	82.2 (27.1)	91.7 (79.2–100)						
Exercise intensity, %									
Onsite	43	51.2 (12.3)	51.7 (44.8–60.6)	41	1.2 (8.6)	1.2 (−2.8–8.1)	1.08	0.285	0.17
Online	41	50.6 (12.4)	48.8 (41.2–56.3)						

Exercise intensity (%) was calculated using the following formula: exercise intensity (%) = $[(HR_{exercise} - HR_{rest})/(HR_{max} - HR_{rest})] \times 100$. The maximum HR was estimated using the age-predicted maximal HR formula: $207 - 0.7 \times$ age.

* : Different adherence rates were calculated by subtracting online adherence rates or exercise intensity from the onsite session values.

† : Wilcoxon rank sum test results

‡ : Effect size (r) was calculated as $r = |Z|/\sqrt{N}$Abbreviations: HR, heart rate; IQR, interquartile range; SD, standard deviation

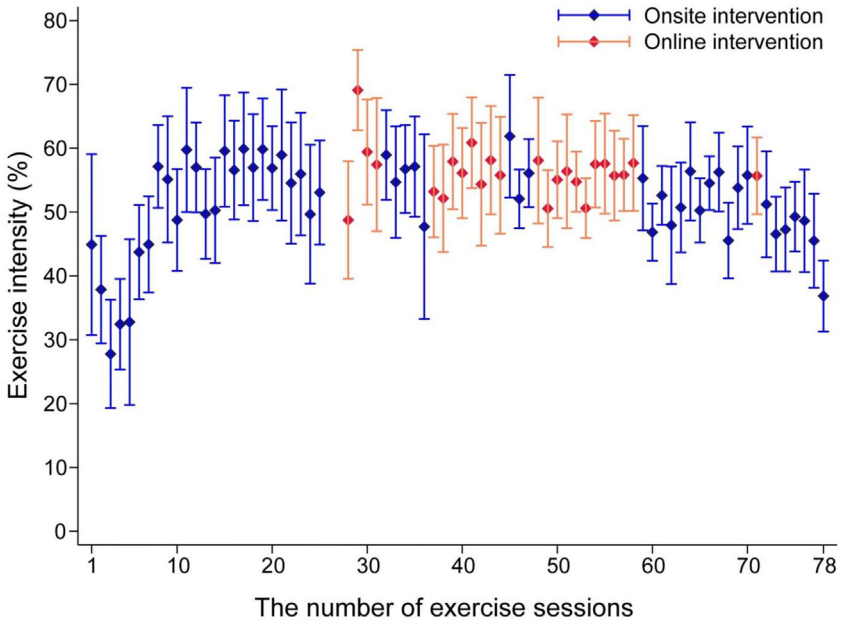

Fig. 1. Trends in exercise intensity (%) among the participants in the intervention group (n = 24) who started on July 16, 2020, in the Tokyo region.
The average exercise intensity (%) and its 95 % confidence interval for each exercise session are presented. Exercise intensity (%) was calculated using the following formula: $[(HR_{exercise} - HR_{rest})/(HR_{max} - HR_{rest})] \times 100$. The maximum HR was estimated using the age-predicted maximal HR formula: $207 - 0.7 \times$ age. The 26th and 27th exercise sessions were canceled due to the coronavirus disease 2019 pandemic. After approval of the revised study protocol, online interventions were started. Live online exercise sessions were provided during the state of emergency (28th–31st, 37th–44th, and 48th–58th sessions). The 71st exercise session was conducted online due to expected transportation disruptions caused by heavy snowfall. The median exercise intensity rates were 52.1 % for onsite sessions and 52.7 % for online sessions.

Analyzing subgroups by living status, computer usage, and physical activity revealed that online sessions exhibited similar or greater median adherence rates than onsite sessions across both regions (Supplementary Table 1). A subgroup analysis excluding participants with atrial fibrillation and those receiving antiarrhythmic drugs yielded similar results (Supplementary Table 2).

3.3. Aerobic exercise intensity

In the Aichi region, the median exercise intensity for online sessions was significantly lower than that for onsite sessions (32.4 % vs. 48.1 %) ($p < 0.001$). Subgroup analyses revealed consistent findings (Supplementary Table 1 and 2).

In the Tokyo region, the median exercise intensity was 51.7 % for onsite sessions and 48.8 % for online sessions (Table 2). Based on the Wilcoxon signed-rank test, there was no significant difference in terms of aerobic exercise intensity between onsite and online sessions ($p = 0.279$). Subgroup analyses also revealed no notable differences in exercise intensity between onsite and online sessions across all groups (Supplementary Table 1 and 2). Fig. 1 shows the trend in exercise intensity across all sessions for the group that started on July 16, 2020, in the Tokyo region (n = 24).

None of the participants reported adverse events, such as falls, during the live online exercise sessions.

4. Discussion

The J-MINT study conducted live online exercise sessions during the COVID-19 pandemic. Adherence to online exercise sessions and exercise intensity were comparable to those of onsite sessions. No adverse events were reported. Based on our findings, live online exercise sessions are safe and feasible for older adults with MCI.

Previous studies have investigated the feasibility of 8–12-week live online group training sessions among community-dwelling older adults without cognitive impairment [9–11]. These studies reported high adherence rates at 89 %–92 % without adverse events [9–11]. Our findings support previous studies and show that such interventions are feasible and safe for older adults with MCI. Regarding safety management, no adverse incidents associated with the online exercise interventions were reported. Various preventive strategies, aligned with a previous

study [9], likely played a role in achieving this result: pre-screening evaluations of participants' existing health conditions, medications, and physical capabilities; checks of vital signs and environment assessments performed before each exercise session; as well as modifications to the program, including a higher ratio of seated exercises, resistance training, and group meetings relative to onsite sessions.

Regarding adherence, the trends showed that regardless of living conditions, computer usage, and physical activity levels, online session adherence rates were comparable to or even higher than onsite sessions in Aichi and Tokyo regions. These results could be linked to the great support offered before and during the sessions, which included measures to ensure technological readiness and immediate technical assistance. For instance, a previous study involving older adults recruited via advertisements in social media reported that a few participants faced login difficulties, unstable internet connection, and issues activating their device camera. However, these problems were promptly resolved [9]. In the J-MINT study, in anticipation of the initiation of online interventions during the early stages of the COVID-19 pandemic, onsite practice sessions were conducted to ensure that the participants could connect online. Additionally, individual troubleshooting was available via telephone throughout the online exercise sessions. Together, these efforts suggest that establishing robust support systems and gradually shifting from a hybrid model of in-person and live online sessions to entirely online formats may facilitate the introduction of online interventions and improve adherence. However, feasibility studies and pilot trials are essential to assess the viability of these strategies and their effect on adherence.

High intervention adherence is essential in achieving cognitive benefits in multidomain intervention trials. In the J-MINT study, participants with adherence rates ≥70 % for exercise sessions exhibited a significant intervention effect [6]. In Tokyo, approximately 30 % of the sessions were conducted online. If all exercise sessions had been canceled during the COVID-19 pandemic, none of the participants in the Tokyo region could have achieved sufficient adherence. Further, the J-MINT study provided online sessions during not only the COVID-19 pandemic but also periods of severe weather conditions, such as heavy snowfall (Fig. 1). According to these findings, live online exercise sessions can overcome barriers caused by pandemics, severe weather conditions, and geographic locations and maintain adherence to intervention.

This study compared the intensity of exercise between onsite and online sessions. In the Aichi region, online sessions had a lower exercise intensity than onsite sessions. The Japanese government encouraged public cooperation with infection control measures but did not take compulsory actions, such as a lockdown. Onsite interventions in Aichi were provided with strict infection control protocols, including wearing masks or mouth shields and maintaining physical distancing, while regional infection numbers were monitored [8]. Consequently, only two online sessions were conducted in the region. During these initial sessions, ensuring proper connectivity and safety was the primary focus, which likely limited the time available for exercise. In contrast, onsite and online Tokyo sessions had a comparable exercise intensity. Regarding aerobic exercise intensity and cognitive function, moderate or vigorous intensities can have more cognitive benefits [12]. Intervention studies on individuals with MCI indicate moderate to vigorous exercise might enhance cognitive function [13]. In the J-MINT study, the exercise intensity rate gradually increased from approximately 40 %, and moderate-intensity exercise was maintained regardless of whether the sessions were delivered online or onsite (Fig. 1). This study showed that online exercise interventions could achieve sufficient exercise intensity and contribute to cognitive benefits. However, some participants had cardiovascular issues or were on medications affecting HR, suggesting that HR might not reliably indicate exercise intensity. The subgroup analyses excluding participants with atrial fibrillation or those receiving antiarrhythmic drugs had consistent findings (Supplementary Table 2). However, future research should consider incorporating alternative measures, such as the Borg scale for perceived exertion [22], to assess exercise intensity and its cognitive benefits [12,13]. Moreover, more intervention studies are needed to understand better the cognitive impacts of online exercise programs and how exercise intensity and adherence contribute to cognitive outcomes.

This study first provided preliminary data showing that adherence to intervention could be maintained in individuals with MCI by offering online exercise sessions even during the COVID-19 pandemic. However, it also had several limitations. First, the sample size of the participants who received online interventions were small, which limits the generalizability of our findings. Additionally, the statistical power to detect meaningful differences between online and onsite interventions, especially in subgroup analyses, may have been insufficient. Additional research involving larger and more varied participant groups is necessary to validate our findings. Additionally, variations in regional pandemic restrictions might have influenced our results. Future research could adopt a cluster-randomized approach, utilizing geographic regions as clusters, to reduce these confounding factors and enhance the robustness of the findings. Second, the online intervention was introduced in the middle of the study in response to the state of emergency. This posed challenges in comparing adherence to intervention and exercise intensity between onsite and online sessions. In our trial, the participants learned and mastered basic exercise movements during the first few months of onsite exercise sessions. Furthermore, given that participants underwent onsite practice sessions beforehand to connect to the application and familiarize themselves with its use, the feasibility of introducing online interventions at the start of the trial and maintaining adequate exercise intensity and safety remains to be seen and warrants further investigation. Finally, there was no information regarding the participants' satisfaction with online interventions.

In conclusion, live online exercise sessions are safe and feasible for older adults with MCI and can help maintain adherence to intervention even during the COVID-19 pandemic.

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Data sharing statement

Due to ethical restrictions, the datasets generated and/or analyzed during the current study are not publicly available; however, the authors may complete further analyses upon reasonable request.

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Conflict of interest

TSu declares a research fellowship from the Manpei Suzuki Diabetes Foundation and a grant from the Keiko-Yamasaki Memorial Funds. The other authors declare no conflicts of interest.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jarlif.2025.100003.

References

[1] 2024 Alzheimer's disease facts and figures. Alzheimers Dement 2024;20:3708–821. doi:10.1002/alz.13809.

[2] Livingston G, Huntley J, Liu KY, Costafreda SG, Selbæk G, Alladi S, et al. Dementia prevention, intervention, and care: 2024 report of the Lancet standing commission. Lancet 2024;404:572–628. doi:10.1016/S0140-6736(24)01296-0.

[3] Ngandu T, Lehtisalo J, Solomon A, Levälahti E, Ahtiluoto S, Antikainen R, et al. A 2 year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial. Lancet 2015;385:2255–63. doi:10.1016/S0140-6736(15)60461-5.

[4] Kivipelto M, Mangialasche F, Snyder HM, Allegri R, Andrieu S, Arai H, et al. World-wide FINGERS network: a global approach to risk reduction and prevention of dementia. Alzheimers Dement 2020;16:1078–94. doi:10.1002/alz.12123.

[5] Sugimoto T, Sakurai T, Akatsu H, Doi T, Fujiwara Y, Hirakawa A, et al. The Japan-multimodal intervention trial for prevention of dementia (J-MINT): the study protocol for an 18-month, multicenter, randomized, controlled trial. J Prev Alzheimers Dis 2021;8:465–76. doi:10.14283/jpad.2021.29.

[6] Sakurai T, Sugimoto T, Akatsu H, Doi T, Fujiwara Y, Hirakawa A, et al. Japan-multimodal intervention trial for the prevention of dementia: a randomized controlled trial. Alzheimers Dement 2024;20:3918–30. doi:10.1002/alz.13838.

[7] Ngandu T, Lehtisalo J, Korkki S, Solomon A, Coley N, Antikainen R, et al. The effect of adherence on cognition in a multidomain lifestyle intervention (FINGER). Alzheimers Dement 2022;18:1325–34. doi:10.1002/alz.12492.

[8] Röhr S, Arai H, Mangialasche F, Matsumoto N, Peltonen M, Raman R, et al. Impact of the COVID-19 pandemic on statistical design and analysis plans for multidomain intervention clinical trials: experience from World-Wide FINGERS. Alzheimers Dement (N Y) 2021;7:e12143. doi:10.1002/trc2.12143.

[9] Schwartz H, Har-Nir I, Wenhoda T, Halperin I. Staying physically active during the COVID-19 quarantine: exploring the feasibility of live, online, group training sessions among older adults. Transl Behav Med 2021;11:314–22. doi:10.1093/tbm/ibaa141.

[10] Granet J, Peyrusqué E, Ruiz F, Buckinx F, Abdelkader LB, Dang-Vu TT, et al. Online physical exercise intervention in older adults during lockdown: can we improve the recipe? Aging Clin Exp Res 2023;35:551–60. doi:10.1007/s40520-022-02329-z.

[11] Granet J, Peyrusqué E, Ruiz F, Buckinx F, Abdelkader LB, Dang-Vu TT, et al. Web-based physical activity interventions are feasible and beneficial solutions to prevent physical and mental health declines in community-dwelling older adults during isolation periods. J Gerontol A Biol Sci Med Sci 2023;78:535–44. doi:10.1093/gerona/glac127.

[12] Northey JM, Cherbuin N, Pumpa KL, Smee DJ, Rattray B. Exercise interventions for cognitive function in adults older than 50: a systematic review with meta-analysis. Br J Sports Med 2018;52:154–60. doi:10.1136/bjsports-2016-096587.

[13] Yu Y, Wang J, Xu J. Optimal dose and type of exercise to improve cognitive function in patients with mild cognitive impairment: a systematic review and network meta-analysis of RCTs. Front Psychiatry. 2024 Sep 12;15:1436499. doi: 10.3389/fpsyt.2024.

[14] Gellish RL, Goslin BR, Olson RE, McDonald A, Russi GD, Moudgil VK. Longitudinal modeling of the relationship between age and maximal heart rate. Med Sci Sports Exerc 2007;39:822–9. doi:10.1097/mss.0b013e31803349c6.

[15] Baker LD, Frank LL, Foster-Schubert K, Green PS, Wilkinson CW, McTiernan A, et al. Effects of aerobic exercise on mild cognitive impairment: a controlled trial. Arch Neurol 2010;67(1):71–9. doi:10.1001/archneurol.2009.307.

[16] Zheng G, Xia R, Zhou W, Tao J, Chen L. Aerobic exercise ameliorates cognitive function in older adults with mild cognitive impairment: a systematic review and meta-analysis of randomised controlled trials. Br J Sports Med 2016;50(23):1443–50. doi:10.1136/bjsports-2015-095699.

[17] Mahoney FI, Barthel DW. Functional evaluation: the Barthel index. Md State Med J 1965;14:61–5.

[18] Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9:179–86. doi:10.1093/geront/9.3_part_1.179.

[19] Satake S, Arai H. The revised Japanese version of the Cardiovascular Health Study criteria (revised J-CHS criteria). Geriatr Gerontol Int 2020;20:992–3. doi:10.1111/ggi.14005.

[20] Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–98. doi:10.1016/0022-3956(75)90026-6.

[21] Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, et al. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol 1994;49:M85–94. doi:10.1093/geronj/49.2.m85.

[22] Arney BE, Glover R, Fusco A, Cortis C, de Koning JJ, van Erp T, et al. Comparison of RPE (Rating of Perceived Exertion) Scales for Session RPE. Int J Sports Physiol Perform 2019 Jul 1;14(7):994–6. doi:10.1123/ijspp.2018-0637.