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Original Article

Impact of the simultaneous distribution of e-learning and exercise videos on the health literacy and lifestyle of college students during the COVID-19 pandemic: a randomized controlled trial

Kazuki Kaneda, PT, PhD[1)*], Noriaki Maeda, PT, PhD[1)], Kazuki Fukui, PT, PhD[1)], Tsubasa Tashiro, PT, PhD[1)], Makoto Komiya, PT, PhD[1)], Yukio Urabe, PT, PhD[1)]

[1)] *Graduate School of Biomedical and Health Sciences, Hiroshima University: 1-2-3 Kasumi, Minami-ku, Higashihiroshima-shi, Hiroshima 739-8511, Japan*

Abstract. [Purpose] The coronavirus disease of 2019 (COVID-19) pandemic and its associated restrictions have raised concerns regarding the lack of exercise among college students. Videos on digital platforms have addressed this issue, although their effects on student behavior are unclear. The present study investigated whether the simultaneous distribution of e-learning and exercise videos among college students during the lifting of behavioral restrictions during the COVID-19 pandemic was effective in promoting health. [Participants and Methods] We conducted a randomized controlled trial in which 100 college students were recruited. The data of 61 students (e-learning and exercise video group=21, exercise video group=20, and control group=20) who completed baseline surveys were analyzed. The preliminary outcomes were physical activity, health habits, eHealth literacy, health-related quality of life, subjective well-being, and psychological stress. A mixed-model repeated-measures analysis of variance was used to compare these variables before and after the intervention. [Results] Health practice and eHealth literacy scales exhibited significant interactions in the e-learning and exercise video groups compared to the other groups. [Conclusion] The combined distribution of e-learning and exercise videos did not significantly enhance physical activity among college students during the COVID-19 pandemic; however, health literacy and habits improved.
Key words: Physical activity, Health literacy, Lifestyle

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INTRODUCTION

Healthy habits, particularly regular physical activity (PA), benefit the educational, mental, and physical health of college students. However, a survey by the World Health Organization (WHO) from 2011 to 2016 has revealed that 80% of the youth do not get an appropriate amount of PA[1)], and that this global trend has not improved over the past 11 years. Moreover, the COVID-19 pandemic, declared by the WHO in March 2020, has become a major barrier to PA and restricts individuals' activities, which has had an adverse effect on lifestyles[2–4)]. Consequently, encouraging healthier lifestyles among college students, who are already prone to sedentary behaviors, is challenging.

Healthy behaviors are important in establishing a healthy lifestyle, which includes regular PA, Therefore, improving health literacy is key to changing health behaviors[5)]. Individuals with higher levels of health literacy have healthier lifestyles[5)]. The appropriate processing and adaptation to excessive information can lead to improved health behaviors. Younger generations,

*Corresponding author. Kazuki Kaneda (E-mail: kzknswp@gmail.com)

including college students, often obtain health-related information via the Internet[6, 7]. eHealth literacy is the ability to search for, evaluate, and use the health information available on the Internet to solve health problems (Organization for Economic Co-operation and Development [OECD]); therefore, it is an important evaluation indicator for the utilization of rampant health information on digital platforms[8]. Studies that have used interventions for physical inactivity to encourage improvements in health behaviors have lacked the use of behavioral change strategies[9–12]. Although feedback on application (app) quality, accessibility, and performance is becoming standardized[10], very few apps follow PA guidelines[13]. Behavior changes strategies through progressive task setting and educational motivation are required[14]. Thus, it is necessary to examine existing interventions, rather than PA alone.

A review of intervention studies for improving health behaviors has shown that the use of digital platforms has increased PA in all age groups regardless of physical capability[15–17]. However, whether watching exercise videos on video streaming sites—the most frequently used platforms since the COVID-19 outbreak—increases PA remains unclear[18]. Streaming services are the most frequently used digital platforms to guide or assist PA. Many platforms are either free or very inexpensive, which has led to high expectations for PA promotion have suggested that streaming services may provide self-affirmation based on the expectations of exercise videos and contribute to improved mental health, which has also increased the demand for streaming services on digital platforms[18, 19]. Moreover, due to the pandemic, online learning or e-learning has played an integral role in education worldwide by meeting multiple learning expectations and increasing the effectiveness of learning[20]. As a deeper understanding of content requires the utilization of the obtained information, the use of e-learning, which can include tests after viewing, is expected to increase health literacy and contribute to an improvement in health behaviors. However, to the best of our knowledge, no study has examined whether the simultaneous distribution of e-learning and exercise videos has been beneficial to health literacy, lifestyle, and PA.

This study examines whether the distribution of e-learning and exercise videos on a video streaming site would be effective in improving students' health. The videos were created by physical therapists for college students and encouraged the students to watch the videos and exercise more than twice a week. We hypothesized that the distribution of e-learning and exercise videos during the lifting of the COVID-19 pandemic restrictions would improve health literacy and lifestyle habits and increase PA.

PARTICIPANTS AND METHODS

Sample size calculations performed using G*Power version 3.1 (Heinrich Heine University, Düsseldorf, Germany) showed that 64 participants would be required to obtain 80% power (α=0.05, effect size=0.40, numerator df=2, and number of groups=6) to test the primary outcome and interaction before and after distribution. Next, 100 undergraduate students were recruited from Japanese universities between October 25 and November 5, 2021, one month after COVID-19 restrictions were lifted. The inclusion criteria were: (1) participants had to be at least 20 years old and enrolled in an undergraduate program, and (2) have access to a computer or smartphone and the Internet. Students who did not have a device to view the videos or were unable to complete all the questionnaires were excluded from the analysis.

This was a randomized controlled trial (RCT). The participants were recruited online and provided their informed consent via Google Forms. Due to COVID-19, all the college students were taking remote, online classes using smartphones and computers. Thus, they were fairly skilled at Internet use. The participants were recruited through digital advertising on campus platforms and digital flyers. They were then randomly allocated to the e-learning and exercise video group (e-L group), exercise video group (Ex group), or control group before the baseline survey was completed (single-blind method). Randomization was performed using a computer-generated sequence with an assignment ratio of 1:1:1. After randomization, those who completed the baseline questionnaire were provided access to the assigned programs. A digital platform was developed at no cost using Wix (https://pt.wix.com), which is useful for implementing educational programs on digital platforms[21]. The Wix platform is freely customizable, and videos and Google Forms are integrated into Wix for easy access. Information was organized in a clear and objective manner, thereby stimulating and facilitating access to and use of the environment. Two digital platforms were created. One was dedicated to e-learning videos, where content was created and recorded in PowerPoint (for Mac version 16.59, Microsoft Inc., Redmond, WA, USA) and published on the Wix platform. The other was dedicated to exercise videos filmed on an iPhone 11 OS X (Apple Inc., Cupertino, CA, USA), edited using iMovie (Apple Inc.), and published on the Wix platform.

After the four-week intervention period, participants were sent a post-intervention questionnaire on a mobile messenger app. This study was approved by the Ethical Committee for Epidemiology of Hiroshima University (approval ID: E-2250), and participants provided their informed consent before the study began. This RCT was registered with the UMIN (UMIN000044868) before the study commenced. All the guidelines issued by the Consolidated Standards of Reporting Trials were followed[22].

After completing the baseline questionnaire, participants in the e-L group received the URL of a website to access the e-learning and exercise videos produced by the physical therapists. Eight e-learning videos were prepared on health-related topics including health information, exercise, PA, nutrition, and sleep (Fig. 1). The authors could confirm whether the videos were played but not who played them and how many times. This was confirmed by attaching a short Google Forms test to the video link, which was completed after watching. Exercise was similarly confirmed by responses to Google Forms attached to the videos.

The students were recommended at least 150 min of PA per week (WHO) Eight exercise videos were prepared: three low-intensity workouts (3–5 metabolic equivalent tasks [METs]), three medium-intensity workouts (6–8 METs), and two high-intensity workouts (8 METs). Each video was approximately 20 minutes long. Participants were allowed to select the exercise videos that suited them as many times as they wanted during the study period. As the WHO guidelines recommend exercising at least twice a week (WHO), two videos were distributed per week, starting with workouts with a lower intensity. Eight videos were distributed over the four weeks. Reminders to watch the videos were sent through a messenger app twice a week based on the WHO's recommendation. A follow-up questionnaire was administered four weeks later.

Participants in the Ex group only received the URL of the website to access the exercise videos produced by physical therapists after completing the baseline questionnaire. The content of the videos was identical to the videos watched by the e-L group. As in the e-L group, a confirmation form and twice-weekly reminders were sent with a follow-up questionnaire four weeks later.

The control group did not receive a URL after responding to the baseline survey. They were given no specific instructions on how to spend the four-week period and were surveyed again at the end of the study period using a questionnaire.

At the beginning of the study, the participants completed an online questionnaire that included demographic information (age, height, weight, body mass index, and sex), whether they belonged to an exercise community such as a sports club, and whether they had watched exercise videos on YouTube.

To investigate the effect of the intervention on PA, a self-reported, seven day, short form of the international physical activity questionnaire (IPAQ) was used at baseline and at follow-up[23)]. The questionnaire comprised nine items assessing PA levels at moderate intensity and vigorous intensity during walking and sitting. The total PA score was calculated in METs min/week units, which is the total of each mode of activity multiplied by the constant level of energy (MET) required for the task, the number of minutes the task is performed per day, and the time the task is performed per week[24)].

The short form-8 health survey (SF-8) was used at baseline and follow-up. The SF-8 is an eight-item instrument in which each item measures a different health dimension: physical function, physical role, bodily pain, general health, vitality, social function, emotional health, and mental health[25)]. Each score was weighted and two summary scores—the physical component score (PCS) and mental component score (MCS)—were calculated. Higher PCS and MCS scores indicated a better quality of life[26)]. The reliability and validity of the Japanese version used in this study have been confirmed[27)].

The eight-item health practice index (HPI) was used to measure baseline and follow-up health habits[28)]. The HPI was calculated as one point for each of the eight applicable items and was assessed using a total score of eight points (best lifestyle habits). The eight-item Japanese version of the HPI has been used for many years and has gained consensus as a valuable reference for Asia[29)].

The eHealth literacy scale (eHEALS) was used to measure baseline and follow-up eHealth literacy. The eHEALS evaluates the ability to process information appropriately in an increasingly technological, information-based, and Internet-dependent society. The questionnaire comprises eight items answered on a five-point scale ranging from 1 (totally disagree) to 5 (strongly agree). In Japan, Cronbach's alpha for the eHEALS shows sufficient internal consistency for evaluating health literacy[30)].

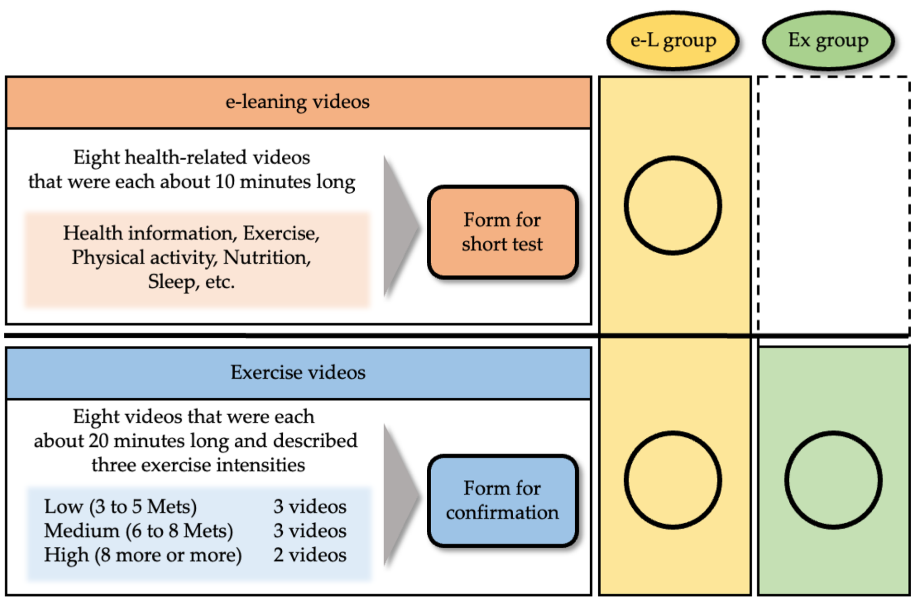

Fig. 1. Components of each intervention program.
e-L group: e-learning and exercise video group; Ex group: exercise video group.

The five-item WHO well-being index (WHO-5) was used to measure baseline and follow-up SWB. It is widely used, and its efficacy has been reported in many countries[31, 32]. Respondents were asked to rate how well five statements applied to them over the preceding 14 days, from 5 (all the time) to 0 (none of the time). Raw scores ranged from 0 (worst outcome) to 25 (best outcome). The scores were stable in the Japanese version[33].

The six-item Kessler screening scale for psychological distress (K6) was used to assess the participants' baseline and follow-up psychological distress. The K6 comprises six questions assessing mood and anxiety over the preceding month; each question is rated from 0 (never) to 4 (always), with total scores ranging from 0 (no psychological distress) to 24 (severe psychological distress). The Japanese version has been used in Japan studies and is gaining international attention[34].

Data were analyzed using SPSS software (version 27.0; IBM Japan Co., Ltd., Tokyo, Japan). The Shapiro–Wilk test was used to test the normality of the data distribution. A mixed-model repeated measures (MMRM) analysis of variance (ANOVA) was used to analyze the effect of delivering videos, thus comparing the mean outcome scores between the e-L, Ex, and control groups[35]. The main effects and group and time interactions of the outcome measures were also assessed. MMRM is an intention-to-treat analysis with unbiased estimates that considers all available data from participants enrolled in the trial[36]. An unstructured variance-covariance matrix is assumed. The results of the main estimates are expressed as mean ± standard error of the mean (SEM), and values of $p<0.05$ were considered significant.

RESULTS

A flowchart of the participant selection process is shown in Fig. 2. Overall, 100 participants expressed an interest in the study; however, only 72 were formally enrolled. Among the 72 participants, 24 (33.3%) were randomly assigned to the e-L, e-Ex, or control group. Three, four, and four participants from the e-L, Ex, and control groups, respectively, were excluded because they did not complete the baseline survey. Of the 61 participants who completed the baseline survey, 46 completed the follow-up sessions. The demographic and baseline characteristics of participants are presented in Table 1.

Table 2 presents the means, standard deviations (SD), and SEM of the outcome variables for the three groups. The e-L group reported their implementation of the short tests and confirmation forms, whereas the Ex group reported their implementation of the confirmation forms. Eight videos were prepared for each type.

And finally, fixed effects estimate from the MMRM-ANOVA model are presented below. No significant interaction was observed between total PA and sitting time in the e-L, Ex, and control groups ($F=0.16$, $p=0.85$; $F=1.39$, $p=0.26$, respectively). For the SF-8, no significant interaction was observed between PCS and MCS in the e-L, Ex, and control groups ($F=0.04$, $p=0.96$; $F=0.87$, $p=0.42$, respectively). The same was true for the subscales. Both HPI and eHEALS revealed significant interactions in the e-L, Ex, and control groups ($F=3.56$, $p<0.05$; $F=4.18$, $p<0.05$, respectively) and improved more in the e-L group than in the other groups. There were no significant interactions between WHO-5 and K6 in the e-L, Ex, and control groups ($F=0.54$, $p=0.59$; $F=0.05$, $p=0.95$, respectively).

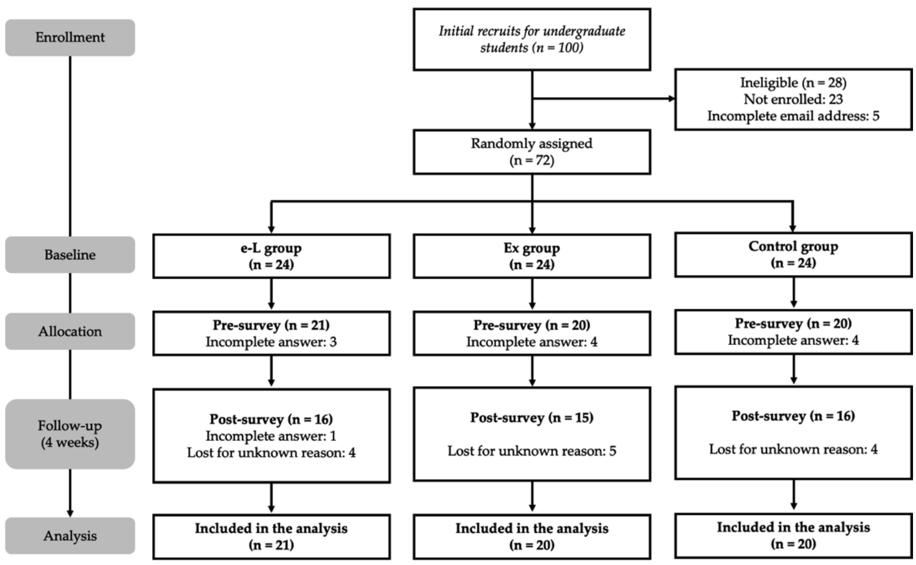

Fig. 2. The flowchart of this study following the consolidated standards of reporting trials statement.
e-L group: e-learning and exercise video group; Ex group: exercise video group.

Table 1. Demographic characteristics of participants at baseline

Characteristic	Total (n=61)	e-L group (n=21)	Ex group (n=20)	Control group (n=20)
Age (years), mean ± SD	20.8 ± 1.2	21.3 ± 2.0	21.1 ± 1.3	20.3 ± 1.1
Height (cm), mean ± SD	165.1 ± 8.4	165.8 ± 8.5	163.6 ± 8.8	166.0 ± 7.6
Weight (kg), mean ± SD	58.2 ± 8.2	58.3 ± 7.2	57.6 ± 7.9	58.0 ± 7.6
BMI (kg/m^2), mean ± SD	21.0 ± 1.9	21.2 ± 1.7	20.7 ± 1.7	21.0 ± 1.9
Sex, n (%)				
Male	28 (45.9)	13 (61.9)	6 (30.0)	9 (45.0)
Female	33 (54.1)	8 (39.1)	14 (70.0)	11 (55.0)
Belong to an active community, n (%)				
Yes	35 (58.3)	8 (39.1)	12 (60.0)	13 (65.0)
No	26 (42.7)	13 (61.9)	8 (40.0)	7 (35.0)
Experience watching Ex videos, n (%)				
Yes	57 (95.0)	19 (90.4)	20 (100)	18 (90.0)
No	4 (5.0)	2 (9.6)	0 (0)	2 (10.0)
Screen time (hours), mean ± SD	8.2 ± 3.1	8.5 ± 3.3	7.5 ± 2.8	8.3 ± 2.4

e-L group: e-learning and exercise video group; Ex group: exercise video group: SD: standard deviation.

Table 2. Outcome measures at baseline and follow-up (four weeks)

Outcome Measure	e-L group		Ex group		Control group	
	Baseline (n=21)	Follow-up (n=16)	Baseline (n=20)	Follow-up (n=15)	Baseline (n=20)	Follow-up (n=16)
Number of e-L accesses, mean ± SD	-	6.2 ± 2.4	-	-	-	-
Number of Ex lessons, mean ± SD	-	6.3 ± 2.3	-	6.8 ± 1.4	-	-
IPAQ, mean ± SEM						
Total physical activity (MET-min/week)	1,516.9 ± 245.1	1,729.9 ± 335.7	1,880.0 ± 455.6	2,742.7 ± 697.1	3,414.9 ± 1,375.4	4,003.3 ± 2,242.8
Sedentary time (hour/day)	9.3 ± 0.5	7.3 ± 0.7	9.3 ± 0.6	9.1 ± 0.4	9.0 ± 0.6	8.8 ± 0.3
SF-8 (scores), mean ± SEM						
PCS	52.0 ± 1.4	53.0 ± 2.0	53.1 ± 1.0	52.5 ± 2.0	52.2 ± 1.0	51.9 ± 2.0
MCS	49.0 ± 1.3	44.8 ± 1.6	47.7 ± 1.8	43.5 ± 1.5	49.8 ± 1.0	45.9 ± 1.7
Physical function	52.8 ± 0.7	51.6 ± 0.9	52.5 ± 0.7	51.1 ± 1.1	52.3 ± 0.8	51.5 ± 1.2
Role physical	52.3 ± 1.3	51.2 ± 1.4	51.9 ± 1.3	51.6 ± 1.4	52.5 ± 1.0	52.0 ± 1.3
Bodily pain	52.4 ± 1.2	51.4 ± 2.4	53.4 ± 1.3	53.9 ± 1.9	52.5 ± 1.3	51.6 ± 1.4
General health	52.9 ± 1.3	55.5 ± 1.2	51.7 ± 1.3	52.5 ± 1.3	52.6 ± 1.2	52.9 ± 1.8
Vitality	54.1 ± 0.7	53.2 ± 1.3	54.1 ± 0.9	53.5 ± 1.4	54.6 ± 0.7	54.5 ± 1.1
Social functioning	52.7 ± 0.9	51.2 ± 0.9	51.8 ± 1.1	50.7 ± 1.1	51.2 ± 1.2	52.3 ± 1.2
Role emotional	50.9 ± 0.9	50.6 ± 1.2	49.8 ± 1.5	49.3 ± 1.6	50.4 ± 1.0	51.3 ± 1.2
Mental health	49.0 ± 1.3	47.0 ± 1.2	49.9 ± 1.5	46.4 ± 0.8	50.4 ± 1.1	47.5 ± 2.2
HPI (scores), mean ± SEM	4.8 ± 0.2	6.0 ± 0.3	5.1 ± 0.2	5.2 ± 0.3	5.0 ± 0.2	5.1 ± 0.2
eHEALS (scores), mean ± SEM	24.8 ± 0.7	26.8 ± 0.9	24.6 ± 0.8	24.1 ± 1.3	24.4 ± 0.9	24.8 ± 1.2
WHO-5 (scores), mean ± SEM	14.9 ± 0.7	15.5 ± 1.1	15.9 ± 0.8	16.3 ± 1.2	16.2 ± 0.8	15.9 ± 1.2
K6 (scores), mean ± SEM	5.1 ± 0.6	5.2 ± 0.6	5.1 ± 0.6	5.6 ± 0.9	5.1 ± 0.7	5.4 ± 0.9

e-L group: e-learning and exercise video group; Ex group: exercise video group; SD: standard deviation; SEM: standard error of the mean; IPAQ: international physical activity questionnaire; SF-8: short form-8; PCS: physical component summary; MCS: mental component summary; HPI: health practice index; eHEALS: eHealth literacy scale; WHO-5: World Health Organization-5 well-being index; K6: six-item Kessler psychological distress scale.

DISCUSSION

This study is the first to examine whether delivering both exercise videos and health-related e-learning to undergraduate students via video streaming sites during the COVID-19 pandemic would lead to changes in health literacy, lifestyle, and PA. The findings revealed that the combination of e-learning and exercise videos did not improve PA among college students; however, eHealth literacy and health habits improved significantly.

We found no significant changes in PA in either the e-L or Ex group, which differed from the results of conventional interventions using digital platforms. This is because the intervention method used in this study differed from conventional methods. Conventional interventions change the behavior of the participants directly by using techniques such as face-to-face exercise instructions and motivational interviews[35–37]. In contrast, this simple intervention comprised eight remotely distributed 20-minute exercise videos with no direct instructions. Expectations for streaming services as digital platforms that guide, and support PA are high[18]. The exercise rate was high in both groups, exceeding 70%, and the raw values of the total IPAQ improved; however, the difference was not significant. The PA of our participants was greater than 1,300 METs min/week, which was in the moderate category set by Lee et al[24]. Therefore, the lack of a direct link to PA deficiency may explain the lack of significant improvement after the intervention. The lower the PA level of a participant, the greater the average improvement[38]. Although the COVID-19 self-restraint period may have resulted in a significant improvement in PA, this study was conducted after the self-restraint period was lifted, making it impossible to obtain a sufficient effect. The MCS and mental health scores of both the intervention and control groups showed similar trends. During the COVID-19 pandemic, changes in the lives of college students may have affected their mental health[39]. Changes in student life, such as the lifting of voluntary self-restraint and the resumption of face-to-face classes at the university, may have caused stress among our participants.

Conversely, the e-L group showed significant improvements in health literacy and lifestyle. The average eHEALS score was 23.6 points[40]. In this study, the difference was less than one point, which is comparable to that of a typical Japanese person[41]. To improve health literacy, it is necessary to train students to understand and evaluate health information and adapt it for themselves. During COVID-19, many people experienced psychological distress due to excessive information on the Internet[42, 43]; discarding and selecting information are necessary skills to protect oneself. This e-learning program included short tests to check students' understanding of the content. This approach provided participants with knowledge through e-learning, which fostered their ability to understand everyday health information and discern it based on their thoughts. Moreover, the HPI scores of the e-L group significantly improved. The delivery of health-related e-learning and the short test may have made participants more careful about health-related aspects and altered their lifestyle habits. People with higher health literacy have healthier lifestyles[5]. In the future, e-Health literacy will become even more important[8, 19]. Improving health literacy is a public health goal and has been recognized as an important healthcare issue worldwide[7]. This study demonstrated that the combined delivery of e-learning and exercise videos, improvement of comprehension through short tests, and enhancement of information selection skills are useful, thereby ultimately augmenting eHealth literacy and changing lifestyle habits.

This study has limitations due to the short intervention period. Although long-term interventions are recommended to improve PA and form persistent habits, our study was limited to four weeks owing to the lifting of COVID-19 restrictions during the baseline and follow-up survey periods. External factors were eliminated as much as possible by conducting the survey during this period; however, membership attribution bias was not fully eliminated. Additionally, the survey items were self-reported, and the short tests did not sufficiently eliminate recall bias. Last, approximately one-fourth of the participants dropped out of the program, which reduced the sample size. The dropout rate issue has emerged in many studies requiring interventions[44]. Here, this may be due to the exercise being unsupervised and the lifting of restrictions extending the scope of life activities. In the future, we recommend a system that automatically checks whether the participant has exercised and records the results for greater accuracy. Furthermore, we also aim to establish a follow-up system to prevent participants from dropping out.

Conflicts of interest

The authors declare no conflict of interest.

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