Technology and Health Care 30 (2022) 775–785
DOI 10.3233/THC-202583
IOS Press

Implementation of a health education program in Asia, comparing Thailand, Indonesia, and Japan

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Received 15 September 2020
Accepted 19 December 2021

Abstract.
BACKGROUND: The global community is faced with aging societies, which will result in increased health care costs. we have been introducing our International Organization for Standardization (ISO)-certified health education system in Thailand and Indonesia.
OBJECTIVE: The purpose of this study was to collect data on the effects of this ISO-certified health education system, to extend the healthy life expectancy and to study the feasibility of implementing this program and in new social contexts.
METHODS: We implemented the health education program recruiting 43, 114 and 119 participants, respectively, in Japan, Thailand and Indonesia. The participants' conditions before and after the program were determined through anthropometry, physical fitness tests, blood chemistry tests, brain function tests and pedometry.
RESULTS: Regarding pedometry, the Japanese participants took the highest number of daily steps on average, followed by the Indonesian and Thai participants. In the 10-m obstacle walk, the Thai and Indonesian participants had significantly increased times. Furthermore, the differentiation reaction time, reverse differentiation reaction time, total number of "misses", total number of "mistakes" and total number of errors significantly improved.

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CONCLUSION: It is possible to implement a program of an ISO-certified health education system, but how to develop exercise habits is important.

Keywords: Brain function, health promotion, pedometer, physical fitness

1. Background

In 1978, the World Health Organization defined and advocated for "primary health care," which concerns health care provided in communities with a focus on prevention and treatment [1]. In 1986, this concept was redefined as "health promotion," which involves enabling people to increase their control over their health [2]. Sustained physical activity reduces the risk of lifestyle-related diseases [3]; however, there are situations in which it is difficult to maintain physical activity [4].

Since 1988, we have incorporated dementia prevention activities into our systematic health education programs, targeting young older adults in five areas of Nagano Prefecture. Through these programs, we have administered comprehensive social capital-oriented health education based on fostering empathy and cooperation. In 2014, these health education systems were awarded International Organization for Standardization (ISO) 9001; QC14J0022 certification, which is an international standard [5–8].

In Thailand, in 2005, the percentage of the population over 65 years of age was 7%, and this percentage is expected to rise to 14% by 2025; meanwhile, in Indonesia, this percentage is projected to reach 7% by 2020 and 14% by 2045. Thus, in addition to Japan, several other Asian countries are also facing challenges regarding their aging populations [9]. Consequently, implementing an ISO-certified health education system such as the one that we have developed to promote dementia prevention activities can play an important role in this region, contributing to extending the population's life expectancy and controlling medical expenses [10–13]. Since 2013, in cooperation with Mahidol University, Thailand, and Udayana University, Indonesia, we have introduced our ISO-certified health education system into the areas surrounding both universities [14–17].

The purpose of this study was to collect data on the effects of an ISO-certified health education system and to study the feasibility of this program in new social contexts.

2. Methods

2.1. General methods

For this research, the ISO 9001; QC14J0022-certified health education system was introduced into the Nikhom Phatthana District, Rayong Province, central Thailand, and Denpasar City and Tabanan Regency, Bali, Indonesia (Fig. 1). The ISO is a non-governmental organization headquartered in Geneva, Switzerland, and its main activity is to establish internationally accepted standards [18]. Our ISO-certified health education system collects anthropometry, blood pressure, blood chemistry, physical fitness, and brain function data before and after the health education program. These data are collected in the same way in all countries (Fig. 2).

All participants were healthy, middle-aged to older adults (42–86 years) with no history of cardiovascular or pulmonary diseases. They provided written informed consent and were enrolled in the health education programs in their communities in Thailand, Indonesia, and Japan. Participants were informed of the safety of participation in this study. Participation in this study is voluntary and should not be adversely

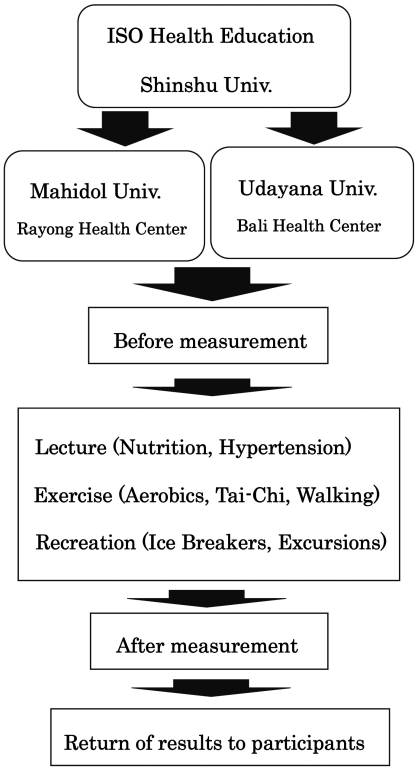

Fig. 1. ISO health education flowchart.

affected by non-participation. Even if they agree to participate once, they can withdraw at any time. The programs were offered by the health centers in each country. The participants agreed to participate in this research as volunteers after receiving a detailed explanation of the ISO-certified health program.

In Thailand, we implemented a six-month health education program from August 2013 to January 2014; in Indonesia, we implemented a seven-month program from February to August 2014; and in Japan, we implemented a six-month program from June to November 2013. Before and after the implementation of the health education program, we conducted physical fitness, blood chemistry, and brain function tests. The control participants were not given pedometers. There were 114 Thai participants (aged 60.5 $\pm$ 11.1 years; 31 men [66.3 $\pm$ 7.1 years] and 83 women [58.3 $\pm$ 11.5 years]), 119 Indonesian participants (66.0 $\pm$ 6.2 years; 41 men [67.7 $\pm$ 5.7 years] and 78 women [65.1 $\pm$ 9.6 years]), 43 Japanese participants (63.2 $\pm$ 4.4 years; 17 men [61.8 $\pm$ 4.1 years] and 26 women [65.5 $\pm$ 4.0 years]), and seven Japanese participants who served as controls (61.3 $\pm$ 7.8 years: three men [66.0 $\pm$ 2.5 years] and four women [57.8 $\pm$ 9.5 years]). At the beginning of the study, all participants in Thailand, Indonesia and Japan were given a lecture regarding the importance of maintaining health, especially the effect of walking 7,000 steps a day, which leads to improvements in anthropometry, blood pressure, physical fitness, blood chemistry, and brain function. All participants in Thailand, Indonesia and Japan attended a series of classes regarding recreational activities such as aerobics, stretching or yoga (see Table 1); these classes lasted 90 min each and were conducted twice a month. All exercise were measured by the pedometer.

This research was approved by the institutional ethics committees of Mahidol University (no. 01-58-10) and Shinshu University (no. UMIN000009309) and in accordance with the code of ethics of the World Medical Association. Written informed consent was obtained from all participants.

Table 1
Program contents of the health education in Thailand, Indonesia, and Japan

Month	Thailand	Indonesia	Japan
Feb.		1. Measurements before the health education	
Mar.		2. Specific exercise	
Apr.		3. Fun walk around the village	1. Measurements before the health education
May		4. Psychologic and brain function exercise	2. Lecture on health education and nutrition
June	1. Measurements before the health education	5. Traditional orchestra and religious song	3. Practice of yoga and recreation
July	2. Aerobic exercises	6. Exercise and walk	4. Promoting the use of muscle strength and walking
Aug.	3. Aaerobic exercises	7. Measurements after the health education	5. Excursion in town and practical skill of Tai Chi
Sept.	4. Lecture on blood pressure		6. Measurements after completion of the program
Oct.	5. Visit to the temple		
Nov.	6. Measurements after completion of the program		

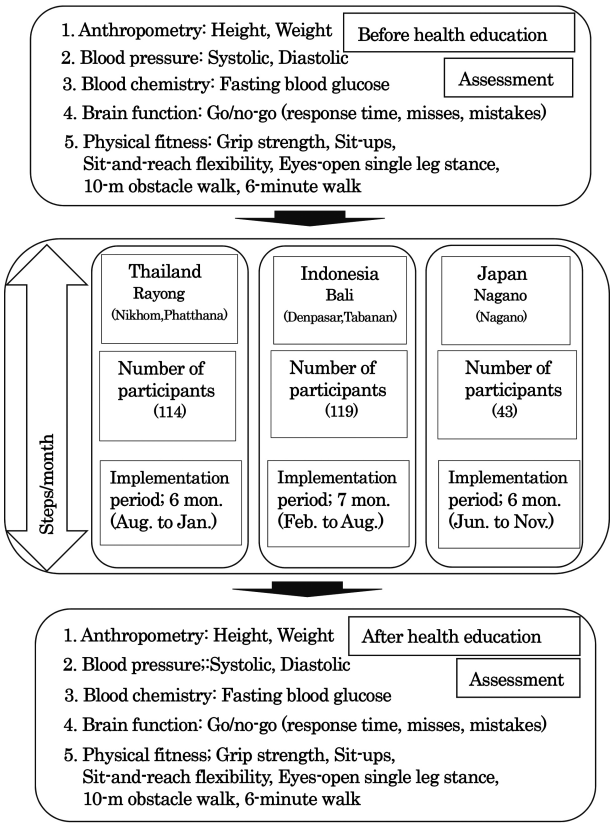

Fig. 2. ISO 9001 health education services implementation status.

2.2. Pedometry

The number of steps taken each day and energy expenditure were measured using a pedometer (Acos Co. Ltd., Japan; JP800). Daily total steps were divided into "exercise-related" steps (steps exceeding four metabolic equivalents [METs]) and "normal" steps (less than four METs). For all groups, steps were measured throughout the program period.

2.3. Anthropometry, blood chemistry measurements and blood pressure measurements

These measurements and the blood chemistry measurements were taken when the participants were in a fasted state ($>$ 10 h since the previous meal). The company responsible for performing the blood tests (Hokushin Co.) reported the measured values of each parameter. Systolic and diastolic blood pressures were measured via auscultation (mercury sphygmomanometer, Kenzumedico 0601B001, Japan) after the participants had been sitting for 15 min in a room with an ambient temperature of 25°C and a relative humidity of approximately 50%.

2.4. Physical fitness tests

The administered physical fitness test was approved by the Japanese Ministry of Education, Culture, Sports, Science and Technology [19]. This test (target age: 65–79 years) features six physical assessments: hand-grip strength, sit-ups, sit-and-reach flexibility, an eyes-open single-leg stance, a 10-m obstacle walk, and a six-minute walk test. The participants' physical ability was assessed before and after the health program.

2.5. Brain function tests

The go/no-go task [20–22] was used to estimate the inhibitory decision-making process, and this task consisted of three experimental stages: formation, differentiation, and reverse differentiation. First, in the formation stage, which consisted of five trials, the participants were instructed to squeeze a rubber ball in response to the illumination of a red light, which occurred at random intervals. Second, during the differentiation stage, the participants squeezed the rubber ball in response to the red light but refrained from doing so when the yellow light was illuminated. Third, during the reverse differentiation stage, the participants squeezed the rubber ball in response to the yellow light but not the red light. The differentiation and reverse differentiation stages consisted of 20 trials each; in both, the red and yellow lights were randomly illuminated 10 times each.

2.6. Statistical analyses

One-way analysis of variance (ANOVA) was performed to compare the step counts of the three groups, and when a significant difference was observed, Tukey-Kramer post hoc comparisons were performed. Two-way repeated-measures ANOVA was employed to compare the results before and after the health education program. When significant interactions were found, one-way ANOVA was conducted; then, Tukey-Kramer post hoc comparisons were performed if ANOVA showed significant results. Additionally, a paired-samples t-test was used to compare the health measurement results before and after the health education program for each group: Thailand, Indonesia, Japan, and the control group. The level of significance was set at $p < 0.05$. Statistical analyses were performed using SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA).

Table 2
Pedometry comparison of the steps in Thailand, Indonesia, and Japan

	Thailand	Indonesia	Japan	One way ANOVA	Tukey-Kramer (p value)		
				p value	T vs. I	I vs. J	T vs. J
Walking steps							
Total/day (steps)	4,700 ± 410	4,410 ± 60	5,330 ± 600	0.006	NS	0.05	NS
Exercise-related/day (steps)	1,370 ± 50	1,740 ± 40	2,780 ± 460	0.001	0.01	0.01	0.01

T: Thailand ($N = 114$), I: Indonesia ($N = 119$), J: Japan ($N = 43$).

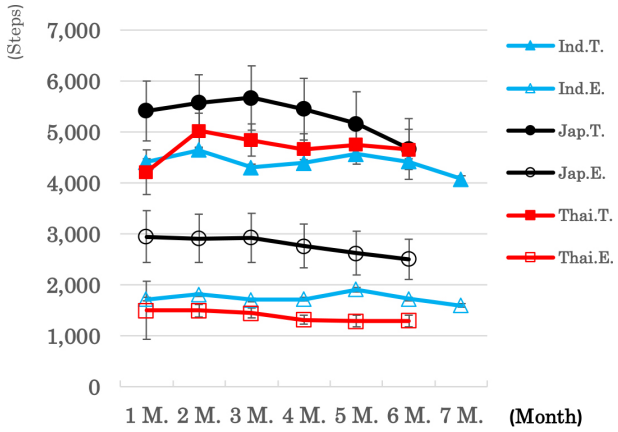

Fig. 3. The average daily number of total and exercise-related steps taken each month by the Thai, Indonesian, and Japanese participants. M; month, T; total steps, E; exercise-related steps.

3. Results

3.1. Pedometry

Figure 1 shows the average daily number of total (normal steps + exercise-related steps) and exercise-related steps taken each month by the Thai, Indonesian, and Japanese participants. Among the Thai participants, for the six-month period overall, the average number of total steps was 4,700 ± 410, and the average number of exercise-related steps was 1,370 ± 50. In Indonesia, for the seven months overall, the average number of total steps was 4,410 ± 60, and the average number of exercise-related steps was 1,740 ± 40. In Japan, for the six-month period, the average number of total steps was 5,330 ± 600, and the average number of exercise-related steps was 2,780 ± 460 (Fig. 3). There are no data for the Japanese control participants, as they were not given pedometers. The values were significantly larger for the Japanese group than for the Indonesian group, and they were larger for the Indonesian group than for the Thai group (Table 2).

3.2. Anthropometry, blood pressure measurements and blood chemistry measurements

The Thai participants' weight significantly increased after the program. For the Indonesian participants, their systolic blood pressure was significantly different. The interaction of the minimum blood pressure in two-way ANOVA significantly differed; consequently, one-way ANOVA was used to interpret the before and after results of all groups; this analysis showed no significant difference (Table 3).

Table 3
Comparison of before and after health program in Thailand, Indonesia, Japan, and Japan's control group

	T/B	T/A	Paired t-test	I/B	I/A	Paired t-test	J/B	J/A	Paired t-test	JC/B	JC/A	Paired t-test	Tow-way ANOVA			One way ANOVA each groop	Tukey-Kramer			
													B/A	T/I /J/C	Interaction		T-B /A	I-B /A	J-B /A	C-B /A
Anthropometry measurements																				
Weight (kg)	61.7 ± 1.1	62.3 ± 1.1	0.006	58.6 ± 0.9	59.4 ± 1.1	0.249	56.3 ± 1.8	55.3 ± 1.5	0.133	53.3 ± 2.1	53.0 ± 2.3	0.388	0.612	0.001	0.950					
BMI	24.9 ± 0.4	24.8 ± 0.4	0.955	23.0 ± 0.3	22.8 ± 0.6	0.927	22.6 ± 0.6	22.3 ± 0.5	0.109	21.4 ± 0.8	21.0 ± 1.0	0.538	0.654	0.001	0.974					
Blood pressures measurements																				
Systolic blood pressure	134.0 ± 1.7	135.7 ± 1.6	0.271	122.7 ± 1.4	128.3 ± 1.5	0.004	132.1 ± 3.1	127.2 ± 3.2	0.086	126.7 ± 6.4	132.2 ± 11.1	0.351	0.048	0.001	0.164					
Diastolic blood pressure	79.2 ± 1.3	79.1 ± 1.0	0.889	78.2 ± 0.9	79.8 ± 0.8	0.186	80.0 ± 1.7	77.9 ± 1.7	0.197	75.8 ± 2.4	75.7 ± 4.9	0.950	0.493	0.739	0.001	0.860	NS	NS	NS	NS
Blood chemistry tests																				
Fasting blood glucose (mg/dl)	102.5 ± 2.8	96.9 ± 4.4	0.109	113.6 ± 2.6	115.4 ± 3.1	0.981	97.9 ± 2.8	98.7 ± 5.0	0.764	101.2 ± 3.6	95.5 ± 6.3	0.215	0.522	0.001	0.672					
Physical fitness tests																				
Grip strength (kg)	26.3 ± 0.8	27.8 ± 0.7	0.003	24.5 ± 0.6	24.2 ± 0.6	0.875	27.8 ± 1.2	28.2 ± 1.1	0.430	27.7 ± 2.1	27.5 ± 2.1	0.928	0.424	0.001	0.658					
Sit-ups (times)	5.1 ± 0.7	5.4 ± 0.9	0.612	6.7 ± 0.6	5.2 ± 0.6	0.025	9.6 ± 0.9	11.7 ± 1.2	0.035	9.5 ± 2.8	8.5 ± 3.5	0.559	0.608	0.001	0.177					
Sit-and-reach flexibility (cm)	34.4 ± 0.9	38.0 ± 1.3	0.004	33.9 ± 0.8	33.5 ± 0.9	0.858	41.1 ± 1.3	38.4 ± 1.1	0.058	37.7 ± 4.8	33.3 ± 3.2	0.454	0.156	0.001	0.037	0.009	NS	NS	NS	NS
Eyes-open single leg stance (sec.)	45.0 ± 4.1	35.2 ± 3.8	0.003	57.0 ± 3.9	61.9 ± 4.4	0.308	94.7 ± 6.7	87.5 ± 7.3	0.194	92.5 ± 11.1	83.7 ± 17.2	0.618	0.883	0.001	0.002	0.001	NS	NS	NS	NS
10-m obstacle walk (sec.)	8.5 ± 0.2	8.4 ± 0.2	0.069	9.6 ± 0.2	8.4 ± 0.2	0.001	5.2 ± 0.1	5.6 ± 0.4	0.335	5.1 ± 0.2	5.4 ± 0.3	0.401	0.008	0.001	0.026	0.001	NS	0.010	NS	NS
Six-minutes walk (m)	514.3 ± 9.6	508.3 ± 8.7	0.537	454.7 ± 8.5	458.2 ± 8.4	0.429	639.3 ± 9.2	644.4 ± 18.9	0.768	625.8 ± 26.9	663.3 ± 19.1	0.259	0.523	0.001	0.811					
Brain function tests (go/no-go)																				
Response																				
Formation (msec.)	356.4 ± 13.5	380.0 ± 14.4	0.137	799.4 ± 57.2	663.6 ± 50.1	0.293	246.3 ± 7.5	248.0 ± 8.4	0.862	260.3 ± 21.3	230.7 ± 9.4	0.185	0.063	0.001	0.305					
Differentiation (msec.)	446.9 ± 9.0	481.7 ± 10.0	0.001	666.1 ± 55.6	545.9 ± 58.2	0.602	405.1 ± 10.3	405.3 ± 11.2	0.985	411.8 ± 23.7	376.4 ± 18.4	0.336	0.179	0.001	0.373					
Reverse differentiation (msec.)	427.6 ± 12.1	483.9 ± 11.2	0.001	566.8 ± 45.2	500.6 ± 46.7	0.646	429.5 ± 12.5	412.6 ± 11.3	0.151	424.2 ± 34.1	431.0 ± 29.5	0.151	0.546	0.043	0.443					
Average (msec.)	425.1 ± 8.3	446.2 ± 9.6	0.005	677.4 ± 44.1	570.0 ± 40.9	0.354	386.2 ± 9.1	379.0 ± 9.2	0.330	388.8 ± 25.2	371.6 ± 17.9	0.330	0.076	0.001	0.284					
Times																				
Total number of misses (times)	1.2 ± 0.2	0.3 ± 0.1	0.001	0.1 ± 0.0	0.1 ± 0.1	0.710	0.1 ± 0.0	0.2 ± 0.1	0.254	0.0 ± 0.0	0.0 ± 0.0	–	0.015	0.001	0.001	0.001	0.010	NS	NS	NS
Total number of mistakes (times)	5.8 ± 0.5	2.6 ± 0.3	0.001	7.5 ± 0.5	5.6 ± 0.5	0.024	2.5 ± 0.5	2.0 ± 0.3	0.176	1.7 ± 0.2	2.5 ± 0.7	0.236	0.001	0.001	0.124					
Errors (times)	7.1 ± 0.6	2.9 ± 0.3	0.001	7.5 ± 0.5	5.7 ± 0.5	0.024	2.6 ± 0.5	2.2 ± 0.3	0.332	1.7 ± 0.2	2.5 ± 0.7	0.236	0.001	0.001	0.016	0.001	0.010	0.050	NS	NS

B/A: main effect of before and after, T/I/J/C main effect of Thailand ($N = 114$), Indonesia ($N = 119$), Japan ($N = 43$), and Control group ($N = 7$), Interaction: interaction effect between B/A and T/I/J/C Mean ± SE.

3.3. Physical fitness measurements

For the Thai participants, hand-grip strength and sit-and-reach flexibility significantly increased; in contrast, performance on the eyes-open single-leg stance significantly worsened. For the Indonesian participants, performance on the 10-m obstacle walk significantly improved; however, the number of sit-ups significantly decreased. For the Japanese participants, the number of sit-ups significantly increased. The interaction of sit-and-reach flexibility, the eyes-open single-leg stance, and the 10-m obstacle walk in two-way ANOVA was significant; thus, one-way ANOVA was used to interpret the before and after results of all groups. The results for sit-and-reach flexibility and the eyes-open single-leg stance showed no significant differences; however, among the Indonesian participants, performance on the 10-m obstacle walk significantly improved (Table 3).

3.4. Brain function measurements

For the Thai participants, the average differentiation reaction times, reverse differentiation reaction times, and total reaction times significantly increased after the program. Meanwhile, the total number of "misses", "mistakes", and errors significantly decreased after the program. The interaction of the total number of "misses" and errors was significant. The total number of "misses" among the Thai participants and the total number of errors among the Thai and Indonesian participants significant decreased.

4. Discussion

Regarding exercise-related steps, the Thai, Indonesia and Japan participants respectively, took 1,395 (30% of the number of total steps), 1,744 (40% of the number of total steps), and 2,782 (55% of the number of total steps) daily steps. In the future, it will be necessary to make an effort to increase the number of exercise-related steps. It has been reported that such walking is effective at preventing dementia; forty minutes of active walking a week over the course of a year results in a 2% increase in the hippocampal volume and improves memory [23].

The Thai participants' weight increased significantly after the health education program. Conversely, the other participants lost weight, but the difference was not statistically significant. The participants' BMI values did not significantly change in any group. In previous studies, significant improvements in body weight, BMI, blood pressure, and blood chemistry were found when the subjects incorporated walking and exercising into their lifestyle [3,24–26]. Thus, increasing the average number of total steps may help the participants in the present study improve in this regard.

Among the Thai participants, hand-grip strength and sit-and-reach flexibility significantly increased; in contrast, performance on the eyes-open single-leg stance test significantly worsened. For the Indonesian participants, performance on the 10-m obstacle walk significantly improved, while the number of sit-ups significantly decreased. For the Japanese participants, the number of sit-ups significantly increased. However, there are few improvement items for physical fitness in Thailand, Indonesia, and Japan. If the average number of total steps taken by participants is 7,000 or more, the improvement rate of physical fitness measurement items will significantly increase [5–8].

Go/no-go tasks are frequently used to investigate response inhibition, which is an essential executive function performed by the prefrontal cortex, as well as a variety of other cognitive components [20–22, 27,28]. In the present study, the interaction between the total number of "misses" and "mistakes" was significant for all groups. The Thai and Indonesian groups had significantly fewer total "misses" and

errors after the program. Previous go/no-go task studies suggest that a health program could improve brain function [5–8]. In the first stage of the go/no-go task, the reaction time is short and the number of errors is large. Participants performed regular exercises in the second stage, and the go/no-go task reaction times increase and the number of error responses decreased. In the third stage, the go/no-go task reaction times decreased significantly, and the number of error responses decreased significantly. In the Thai participants, the go/no-go results for the first stage improved.

Since pedometers were not given to the control group in Japan, there are no data on the number of steps taken by this group. However, in another study [29], control group members were 5,220. In this survey, the target value of 7,000, and also the target value of 7,000 steps by 2022 established by the Ministry of Health, Labor and Welfare of Japan by people aged 65 and over [30]. The target value of 7,000 steps was not achieved in all areas; only a few measurement items of anthropometry, blood pressure, blood chemistry, physical fitness, and brain function showed improvement, and some even showed a significant decrease as the participants aged. Therefore, it is important for participants to encourage and sympathize with each other and continue their health education program with the aim of achieving more than 7,000 steps without dropping out.

4.1. Limitations

In this study, our ISO 9001 program was provided for six months in both Japan and Thailand; however, in Indonesia, it was provided for seven months. The reason is that in Indonesia, the schedule for the ISO staff was not set; thus, the assessment was postponed by one month. Japanese participants were from Nagano City, Nagano Prefecture, Japan, and a control group composed of senior citizens, also in Nagano, was created. There were only seven participants in the control group since 17 participants dropped out; therefore, a control group was created only for the Japanese participants.

5. Conclusions

The purpose of this study was to collect data on the effects of an ISO-certified health education system and to study the feasibility of this program in new social contexts. To that end, we implemented the health program in Thailand and Japan, recruiting 114 and 43 participants, respectively, and in Indonesia, recruiting 119 participants. The participants' conditions before and after the program were determined through anthropometry, physical fitness, blood chemistry, and brain function tests and pedometry. The Japanese participants in our study took 5,330 daily steps, the Thai participants took 4,696 daily steps, and the Indonesian participants took 4,406 daily steps. The target value of 7,000 steps was not achieved in all areas; only a few measurement items of anthropometry, blood pressure, blood chemistry, physical fitness, and brain function showed improvement, and some even showed a significant decrease as the participants aged. Therefore, it is important for participants to encourage and sympathize with each other and continue their health education program with the aim of achieving more than 7,000 steps without dropping out.

Acknowledgments

The authors would like to thank all individuals who participated in this study.

Author contributions

KT, AG, AN, SM, SK, TW, NT, RU and KA planned the experiment and collected the data. FS, MO, KK, HK and HT performed the data analysis. MK, TF, TN, KT and HT composed the article. All authors read and approved the final manuscript.

Availability of data and material

The data and materials are available.

Conflict of interest

The authors have no conflicts of interest to report.

Funding

Koji Terasawa is supported by grants-in-aid for scientific research (Kiban A: 16H02713) from the Ministry of Education, Culture, Sports, Science and Technology of Japan. The funder had no involvement in study design, the collection, analysis and interpretation of data, the writing of the report, or the decision to submit the article for publication.

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