

## A Case Study of Health Education from Nagano Prefecture in Japan: The Relationship between Health Education and Medical Expenses

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### Abstract

**Background:** Health promotion is not only the responsibility of the health sector, but extends from healthy lifestyles to wellbeing. We developed an active health program acquired ISO9001 (the International Organization for Standardization) in 2014. This health education program desired to Asian countries in cooperation with Asian Universities with the aim of increasing the health longevity of their populations.

**Methods:** The authors implemented a 10-month health program from May 2010 to Feb 2011 in Minowa town, Nagano prefecture, Japan. Participants of a health education group (HEG) in Minowa town included 41 elderly (age:  $63.4 \pm 5.9$ ) individuals; 6 residents of Nagano city (aged  $59.4 \pm 7.9$ ) acted as a control group (CG).

**Results:** The HEG participants showed significant improvement in weight, BMI, anthropometric measurements, systolic blood pressure, diastolic blood pressure, physical fitness factors including sit-ups, sit-and-reach flexibility, eyes-open single-leg stance, 10 m obstacle walk and 6 min walk, LDL, and brain function as reflected in response time and error rates for go/no-go tasks. In contrast, CG had no significant differences in any items before and after the health education program period. Systolic blood pressure, sit-and-reach flexibility and 10 m obstacle walk of HEG participants showed a significant improvement compared to those of the CG. Medical expenses of HEG participants were significantly reduced for the 1<sup>st</sup> year and 2<sup>nd</sup> year after the health education program compared to those of the non-participants.

**Conclusion:** The systolic blood pressure, sit-and-reach flexibility and 10 m obstacle walk of HEG participants showed a significant improvement compared to those of the CG. Medical expenses of HEG participants were significantly reduced during health education and 1<sup>st</sup> and 2<sup>nd</sup> years after the health education program compared to those of non-participants.

**Keywords:** Health education; Pedometer; Brain function; Physical fitness; Blood chemistry

### Background

In 1978, the Declaration of Alma-Ata was adopted at the International Conference on Primary Health Care. The primary health care approach has since been accepted as the key to achieving the goal of "Health for All" [1]. In 1986 in Ottawa, Canada, it was declared that health promotion is the process of enabling people to increase control over and improve their health [2]. Therefore, health promotion is not only the responsibility of the health sector, but extends from healthy lifestyles to wellbeing. Japan has the world's highest longevity rate. Citizens of Nagano enjoy the longest lifespan in Japan. Health promotion improvements are considered one reason for Japan being the world's top country for longevity. We developed an active health program, which assesses energy expenditure, anthropometry, blood pressure, physical fitness, blood chemistry, and brain function as well as providing educational seminars on exercise, nutrition, and recreational activities such as hiking and cooking. This health education program acquired ISO9001 (the International Organization for Standardization) in 2014 and has been implemented in Nagano, Japan for 20 years. The authors desired to extend this health education

program to Asian countries in cooperation with Asian Universities with the aim of increasing the health longevity of their populations. We hope to develop and implement substantial health education with continued cooperation with other country University, and to help promote a prosperous, health long-lived society.

### Method

#### General method

The authors implemented a 10 month health program from May 2010 to Feb 2012 in Minowa town, Nagano prefecture, Japan. This was the latest version of this program developed in Japan, measuring energy expenditure using pedometers, anthropometry, blood pressure, physical fitness, blood chemistry and brain function. The participants in Minowa also participated in a series of recreational activities such as walking exercises, Tai Chi Chuan, hiking tours and cooking practice, as well as medical seminars on topics such as blood pressure, mouth care and nutritional balance. In addition, they performed 90 min strength and weight training once a week (Table 1). A total of 41 elderly participants (age:  $63.4 \pm 5.9$  years (Mean  $\pm$  SD); 14 men aged  $66.2 \pm 2.8$  years and 27 women aged  $61.9 \pm 6.6$  years) who participated in the health education group (HEG) in Minowa town completed the

program. Six residents of Nagano city (age:  $59.4 \pm 7.9$  years; 2 men aged  $68.5 \pm 3.5$  years and 4 women aged  $57.8 \pm 8.1$  years) served as a control group (CG). The CG subjects went about their daily lives as normal without participating in the health education program; we monitored them over a period of time similar to that of the Minowa program. The latest guidelines based on the Helsinki Declaration were adopted by the Institutional Ethics Committee of Shinshu University (UMIN00009309). Written informed consents were obtained from all participants.

Month	CTG program
1	Tai Chi Chuan and training once a week
2	The measurement before the health and training once a week
3	Closing ceremony
4	Opening Ceremony
5	The measurement before the health education, distribution of the pedometer and training once a week
6	Lecture of the important to health and training once a week
7	Practical recreation and training once a week
8	Hiking and training once a week
9	Lecture of nutrition and training once a week
10	Practical walking and training once a week
11	Lecture of blood pressure and training once a week
12	Lecture of dental health and training once a week

**Table 1:** Program contents of the one-year health education in the CTG.

### Pedometers

The number of steps walked and energy expenditure were measured from April 2010 to Feb 2011 in the Minowa program. The Weight Bearing Index (WBI) provided an approximate goal for the number of daily walking steps [3]. A recent pedometer model (Acoss Inc., FS500) enabled pedometer data to be transferred and saved to a personal computer. Exercise steps are defined as steps taken during expenditure greater than 4 METS. Participants reported their results to a project leader when they gathered for monthly meetings.

### Anthropometry and blood pressure

Anthropometric measurement adopted weight and body mass index (BMI) measurements. Weight measurement used body composition monitors with scales (Omron Healthcare Co., Ltd. JAPAN; HBF-359). Weight measurement was implemented at the time of fasting >10 h from the last meal. Maximum and minimum blood pressures were measured via auscultation (mercury sphygmomanometer, Kenzumedico 0601B001, Japan) after the study participants had been sitting for 15 min in a room with an ambient temperature of 25°C and relative humidity of approximately 50%.

### Physical fitness

The physical test approved by the Japan Ministry of Education, Culture, Sports, Science and Technology [4] is composed of six

physical assessments: Grip strength, sit-ups, sit-and-reach flexibility, eyes-open single-leg stance, 10-meter obstacle walk and a 6 min walk. Each participant's physical ability was assessed before and after the health education program.

### Blood chemistry

The blood test used for the current study, which is recommended by the Japan Ministry of Health, Labour and Welfare [5] for the assessment of metabolic syndrome, measured four components: High density lipoprotein (HDL), low density lipoprotein (LDL), triglyceride, and fasting glucose. Participants underwent blood tests before and after the health education program.

### Brain function

We adopted go/no-go tasks for the brain function test [6-8]. The go/no-go tasks consisted of three experimental stages: Formation, differentiation and reverse differentiation. First, in the formation stage, participants were instructed to squeeze a rubber ball in response to a red light. Second, during the differentiation stage, they squeezed a rubber ball in response to a red light, but not a yellow light, when a red or yellow light was randomly displayed. Third, during the reverse differentiation stage, participants squeezed a rubber ball in response to a yellow light but not a red light. In each of the differentiation and reverse differentiation stages participants completed 20 trials. Red and yellow lights were equally likely to be displayed 10 times each. In this paper, the term "forget" indicates an incorrect response when participants did not squeeze a rubber ball when it was to be squeezed. Conversely, the term "mistake" means an incorrect response when participants did squeeze the rubber ball when it was not supposed to be squeezed.

### Medical expenses

Minowa town cooperated in checking the effect of this health education program for the two years following the program by comparing the medical expenses of participants with those of non-participants. We selected 29 subjects (age:  $63.1 \pm 3.4$ ; 12 men aged  $64.5 \pm 1.7$  years and 17 women aged  $62.2 \pm 4.0$  years, age range: 50-69) who were enrolled in National Health Insurance out of the 41 participants of the HEG. The 2,768 comparison subjects, who were also enrolled in National Health Insurance, did not participate the health education program (NP; age:  $62.7 \pm 4.0$  years; 1,380 men aged  $62.9 \pm 3.9$  years and 1,388 women aged  $62.5 \pm 4.1$  years, age range: 50-69). Next, because the initial medical expenses of HEG participants and NP subjects were different even before the health education program, we adjusted the initial expenses by removing NP subjects with high medical expenses and compared the medical expenses of the adjusted non-participants (ANP; total 2,725 aged  $62.7 \pm 4.0$  years; 1,354 men aged  $62.9 \pm 3.9$  years and 1,371 women aged  $62.5 \pm 4.1$  years, age range: 50-69) with those of the 29 HEG participants.

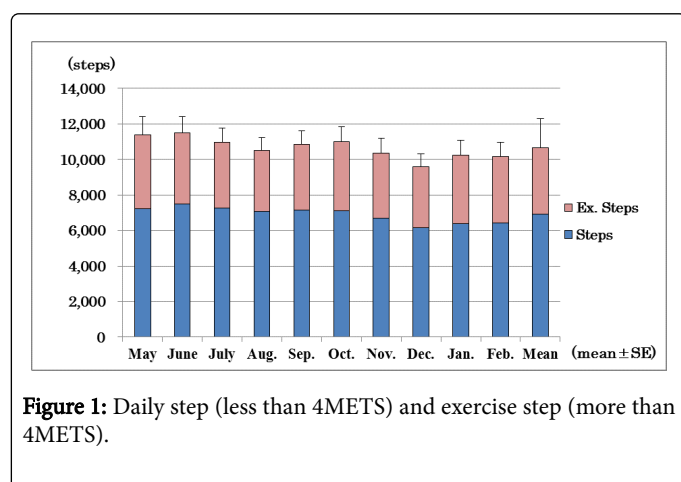
### Statistical analysis

A paired t-test was used to compare the results before and after participation in the health program. Comparison of pre and post health program in CG and HEG were analyzed via a two-way ANOVA replication. Medical expenses were compared using Welch's t-test. The level of significance was set at  $p < 0.05$ . Statistical analyses were performed using SPSS 11.0.1 Statistical Packages (SPSS Inc., Chicago, USA).

## Results

### Pedometer

**Anthropometry and blood pressure:** The CG had no significant difference in weight, BMI, waist circumference, systolic blood pressure and diastolic blood pressure before and after the health education program period. In contrast, HEG participants showed significant decreases in weight (before (B): 59.4 kg ± 1.8, after (A): 57.9 kg ± 1.8, t=4.0, p<0.000), BMI (B: 23.7 ± 3.5, A: 23.3 ± 3.3, t=2.4, p<0.019), systolic blood pressure (B: 139.8 ± 2.1, A: 125.2 ± 2.0, t=8.0, p<0.0001), and diastolic blood pressure (B: 87.3 ± 1.7, A: 78.7 ± 1.4, t=6.6, p<0.0001) before and after the health education program. Systolic blood pressure of the HEG participants was significantly different from that of the CG (F=4.4, p<0.039; Table 2).



**Figure 1:** Daily step (less than 4METs) and exercise step (more than 4METs).

Figure 1 shows the average number of walked and exercise steps for each month (May: walking steps, 11,374.4 ± 1,021.8 (mean ± SE),

exercise steps, 4,165.2 ± 485.0; June: 11,498.9 ± 897.9, 4,006.0 ± 437.0; July: 10,948.1 ± 798.0, 3,673.9 ± 399.1; August: 10,510.1 ± 713.6, 3,448.5 ± 357.4; September: 10,858.5 ± 738.3, 3,701.4 ± 363.1; October: 10,994.9 ± 856.4, 3,868.3 ± 402.2; November: 10,358.7 ± 831.5, 3,658.7 ± 394.7; December: 9,585.0 ± 737.8, 3,413.1 ± 357.0; January: 10,228.2 ± 851.6, 3,852.4 ± 420.4; February: 10,164.0 ± 787.5, 3,727.0 ± 386.6; Total: 10,652.1 ± 1,655.0, 3,705.5 ± 363.0). The average steps walked and exercise steps gradually increased in June and October. However, both walking and exercise steps decreased in August and December.

### Physical fitness

The CG had no significant differences in any items before and after the health education program period. In contrast, HEG participants showed significant improvement in sit-ups (B: 10.7 ± 1, A: 14.5 ± 1.1, t=-8.4, p<0.0001), sit-and-reach flexibility (B: 39.1 ± 1.2, A: 45.8 ± 1.3, t=-8.6, p<0.0001), eyes-open single-leg stance (B: 84.8 ± 7.0, A: 104.3 ± 5.1, t=-3.1, p<0.003), 10-meter obstacle walk (B: 7.4 ± 0.1, A: 5.9 ± 1.0, t=22.1, p<0.0001) and 6 min walk (B: 597.5 ± 6.4, A: 658.5 ± 9.4, t=-13.6, p<0.0001) before and after the health education program. The sit-and-reach flexibility (F=4.5, p<0.036) and 10-meter obstacle walk (F=8.7, p<0.001) results of HEG participants showed significant improvement compared to those of the CG (Table 2).

### Blood chemistry

The CG showed no significant difference in HDL, LDL, triglyceride and fasting glucose before and after the health education program period. HEG participants showed no significant improvement in HDL, triglyceride or fasting glucose; however LDL (B: 126.9 ± 4.4, A: 119.2 ± 3.8, t=2.4, p<0.022) was significantly improved after the health education program (Table 2).

	M/pre	M/post	P-value	C/pre	C/post	p-value	2 way ANOVA		
							B*A	C*M	Intracation
<b>Body measurement</b>									
Weight (kg)	59.4 ± 1.8	57.9 ± 1.8	0	53.3 ± 2.5	53.0 ± 2.8	0.467	0.573	0.122	0.868
BMI	23.7 ± 3.5	23.3 ± 3.3	0.019	21.3 ± 1.0	21.1 ± 1.1	0.332	0.585	0.022	0.922
Waist circumference (cm)	82.0 ± 1.6	81.8 ± 1.4	0.791	82.2 ± 3.4	82.7 ± 3.6	0.765	0.96	0.859	0.907
<b>Blood pressure</b>									
Systolic blood pressure	139.8 ± 2.1	125.2 ± 2.0	0	126.7 ± 7.6	132.2 ± 13.2	0.432	0	0.511	0.036
Diastolic blood pressure	87.3 ± 1.7	78.7 ± 1.4	0	75.8 ± 2.9	75.7 ± 5.8	0.958	0.001	0.025	0.189
<b>Physical fitness test</b>									
Hand Grip Strength (kg)	30.3 ± 1.5	31.4 ± 1.6	0.112	27.7 ± 2.5	27.5 ± 2.5	0.94	0.637	0.262	0.823
Sit Up (times)	10.7 ± 1.0	10.7 ± 1.0	0	9.5 ± 3.3	8.5 ± 4.1	0.624	0.027	0.066	0.223
Sit and reach flexibility (cm)	39.1 ± 1.2	45.8 ± 1.3	0	37.2 ± 5.7	33.3 ± 3.8	0.529	0.003	0.01	0.036
Eyes open single leg stance (sec)	84.8 ± 7.0	104.3 ± 5.1	0.003	92.5 ± 13.1	83.7 ± 20.3	0.675	0.086	0.538	0.277
10m Obstacle walk (sec)	7.4 ± 0.1	5.9 ± 0.1	0	5.1 ± 0.3	5.4 ± 0.4	0.479	0	0	0.001

6minutes walk (m)	597.5 ± 6.4	658.5 ± 9.4	0	663.3 ± 22.6	663.3 ± 22.6	0.34	0	0.354	0.414
<b>Blood test</b>									
Fasting blood glucose (mg/dl)	100.0 ± 1.7	98.5 ± 2.8	0.473	101.2 ± 4.3	95.5 ± 7.4	0.295	0.512	0.85	0.651
HbA1c (%)	5.36 ± 0.1	5.44 ± 0.1	0.021	5.77 ± 0.1	5.90 ± 0.1	0.082	0.351	0.001	0.817
HDL (mg/dl)	63.3 ± 2.6	64.0 ± 2.7	0.59	65.8 ± 7.4	67.2 ± 7.9	0.715	0.822	0.6	0.955
LDL (mg/dl)	126.9 ± 4.4	119.2 ± 3.8	0.022	132.3 ± 13.9	126.2 ± 14.1	0.153	0.183	0.464	0.925
Triglyceride (mg/dl)	103.3 ± 7.4	90.1 ± 6.6	0.101	121.3 ± 23.1	105.3 ± 18.7	0.331	0.152	0.24	0.922
<b>Brain function test(go/no-go task) Response</b>									
Formation (msec)	261.1 ± 9.7	233.6 ± 6.6	0.003	260.3 ± 25.2	230.7 ± 11.1	0.262	0.013	0.913	0.948
Differentiation (msec)	381.3 ± 7.9	367.8 ± 10.1	0.076	411.8 ± 28.0	376.5 ± 21.7	0.418	0.179	0.275	0.538
Revers Differentiation (msec)	419.5 ± 9.3	401.4 ± 10.7	0.035	424.2 ± 28.0	431.0 ± 34.9	0.882	0.292	0.412	0.55
Average (msec)	374.7 ± 7.2	356.9 ± 8.6	0.005	388.8 ± 28.8	371.6 ± 21.2	0.633	0.081	0.399	0.941
<b>Times</b>									
Total number of Forgets (Times)	0	0.2 ± 0.1	0.168	0	0.0	1	0.22	0.385	0.629
Total number of Mistakes (Times)	2.3 ± 0.3	1.6 ± 0.2	0.021	1.7 ± 0.2	2.5 ± 0.8	0.317	0.204	0.749	0.125
Total number of Errors (Times)	2.4 ± 0.3	1.8 ± 0.2	0.062	1.7 ± 0.2	2.5 ± 0.8	0.317	0.365	0.945	0.169

**Table 2:** Comparison of pre and post health program in control and Minowa.

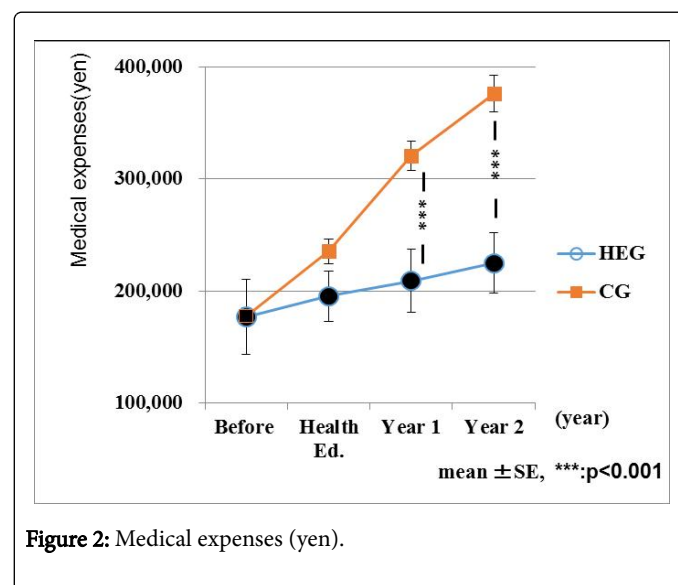
### Brain function

The CG had no significant differences in any items for go/no-go tasks before and after the health education program period. In contrast, HEG participants showed significant differences in response times for the formation task (B: 261.1 ± 9.7, A: 233.6 ± 6.6, t=3.2, p<0.003), response times for the reverse differentiation task (B: 419.4 ± 9.3, A: 401.4 ± 10.7, t=2.2, p<0.035), total response times (B: 373.7 ± 7.2, A: 356.9 ± 8.6, t=3.0, p<0.046), number of mistakes for the differentiation task (B: 1.8 ± 0.2, A: 1.2 ± 0.2, t=2.9, p<0.007), and the total number of “forgets” and mistakes (B: 2.4 ± 0.3, A: 1.8 ± 0.2, t=2.0, p<0.049) before and after the health education program (Table 2).

### Medical expenses

Without adjustment of the initial values of medical expenses, the comparison would have resulted in no significant difference between the NP and HEG participants before the program (NP: 234,069 ± 14,950 yen, HEG: 176,807 ± 33,453 yen, Dif: 57,262 yen). However, significantly higher medical expenses were observed for the NP compared to HEG participants during the health education program (NP: 268,026 ± 15,252 yen, HEG: 195,446 ± 22,744 yen, Dif: 72,579 yen, t=-2.2, p<0.05), 1st year after (NP: 302,479 ± 14,882 yen, HEG: 209,255 ± 28,348 yen, Dif: 93,224 yen, t=-2.9, p<0.01) and 2nd years after (NP: 405,802 ± 16,391 yen, HEG: 224,867 ± 26,954 yen, Dif: 180,936 yen, t=-5.0, p<0.0001) the pro-gram. Therefore, we excluded the non-participants who had exceptionally high medical expenses in order to make a comparison using similar initial medical expenses. There was no significant difference between ANP and HEG participants before (ANP: 177,883 ± 7,084 yen, HEG: 176,807 ± 33,453 yen, Dif: 1,076 yen) and during the health education pro-gram (ANP: 235,584 ± 10,979 yen, HEG: 195,446 ± 22,744 yen, Dif: 40,138 yen).

However significant differences were observed between the CG and HEG 1st year (ANP: 320,401 ± 13,078 yen, HEG: 209,255 ± 28,348 yen, Dif: 111,146 yen; t=-3.6, p<0.001) and 2nd years (DNP: 376,387 ± 16,391 yen, HEG: 224,867 ± 26,954 yen, Dif: 151,520 yen; t=-4.8, p<0.0001) after the health education program (Figure 2).



**Figure 2:** Medical expenses (yen).

## Discussion

### Pedometers

In this study, wearing pedometers may have encouraged participants to increase their walking distance and time. From the perspective of health education, it is important to encourage participants to increase the quality and quantity of exercise [9-11]. For example, research suggests that cardiac rehabilitation patients need to take at least 6,500 steps per day to obtain health benefits [12]. In addition, educational intervention is necessary to improve the quality of future programs. The average walking steps and exercise steps of HEG participants increased in June and October, whereas those averages decreased in August and December. The decreased number of steps is probably due to difficulties with walking in hot and cold weather: In Nagano, the average summer temperature is approximately 31°C and winter is snowy with an average temperature of approximately -1.6°C. Nevertheless, the average number of steps walked by HEG participants was  $10,652.1 \pm 1,655.0$  or more in all months except December. It is challenging to walk 10,000 steps or more per day; perhaps the encouragement of the trainer worked well.

### Anthropometry and blood pressure

In addition to exercise, therapeutic lifestyle changes are recommended. It has been shown that dynamic endurance exercise decreases body weight, BMI, waist circumference, and blood pressure [13,14]. HEG participants were asked to perform 90 min strength and weight training once a week and to exercise by walking more than 10,000 steps each day. As a result, weight, BMI, systolic blood pressure and diastolic blood pressure after the health education program had significantly decreased compared to before the program.

### Physical fitness

The practice of physical measurement differs from country to country. The physical fitness test employed with this study comprises six physical measurements and is designed for healthy elderly people from 65 to 79 years old [4]. In the CG, there were no significant differences in grip strength, sit-ups, sit-and-reach flexibility, eyes-open single-leg stance, 10-meter obstacle walk or 6 min walk before and after the health education program period. In contrast, while there was no significant difference in grip strength, HEG participants showed significant improvement in sit-ups, sit-and-reach flexibility, eyes-open single-leg stance, 10-meter obstacle walk and 6 min walk after the health education program compared to before the program. These results also may be effects by the strength and weight training and walk 10,000 steps or more per day.

### Blood chemistry

It is a well-known fact that metabolic syndrome produces a constellation of cardiovascular risk factors including abdominal obesity, impaired glucose control, hypertension and dyslipidemia [15]. It has been reported that blood composition, as a standard measure for metabolic syndrome, is improved with exercise [16]. Although HDL, Triglyceride and fasting glucose values improved in the HEG, the improvements were not significant. However, LDL values improved significantly with strength and weight training and walking exercise.

### Brain function

Performance of go/no-go tasks, which are frequently used to investigate response inhibition, requires a variety of cognitive components beside response inhibition. Response inhibition is an essential executive function implemented by the prefrontal cortex [6,17,18]. A previous study [19-22] using go/no-go tasks reported that reaction time was faster and error rates were reduced when participants continued to exercise for 10 months, taking an average of 7,000 steps per day. The two year continuation of this walking exercise seemed to further result in faster reaction times and decreased error rates. In the current study, The CG had no significant differences in any items for go/no-go tasks before and after the health education program period. In contrast, HEG participants showed significant improvement in response times for formation tasks, response times for reverse differentiation tasks, total response times, mistake rates for differentiation tasks and total "forget" and mistake rates before and after the health education program. These results show that the brain function was improved by 90 min strength and weight training once a week and challenging to walk 10,000 steps or more per day.

### Medical expenses

Without adjustment of the initial values of medical expenses, significantly higher medical expenses were observed for the NP compared to HEG participants during (Dif.: 72,579 yen), 1 year after (Dif.: 93,224 yen) and 2 years after (Dif.: 180,936 yen) the program. When we adjusted the initial value for medical expenses of the participants and non-participants of the health education program, significant differences were observed between the DNP and HEG 1 year (Dif.: 111,146 yen) and 2 years (Dif.: 151,520 yen) after the health education program. The participants of the health education program had significantly lower medical expenses than did non-participants. Non-adjusted initial values for NP medical expenses were higher than the adjusted (ANP) initial values; nevertheless no significant differences were observed between the 1<sup>st</sup> and 2<sup>nd</sup> years for either (NP and ANP) group. Taken together, these results suggest the importance of health education. However there are few subjects, we must have increase subjects in the future study.

### Conclusion

Participants of a health education group (HEG) in Minowa town included 41 elderly (age:  $63.4 \pm 5.9$ ) individuals; 6 residents of Nagano city (age:  $59.4 \pm 7.9$ ) acted as a control group (CG). The average number of steps walked daily by participants in the HEG was  $10,652.1 \pm 1,655.0$ . HEG participants showed significant improvement in anthropometric measurements, blood pressure, physical fitness, blood chemistry, and brain function. In contrast, CG participants had no significant differences in any items before and after the health education program period. The systolic blood pressure, sit-and-reach flexibility and 10-meter obstacle walk of HEG participants showed a significant improvement compared to those of the CG. Medical expenses of HEG participants were significantly reduced during health education and 1<sup>st</sup> and 2<sup>nd</sup> years after the health education program compared to those of non-participants.

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