

Effect of baseline self-efficacy on physical activity and psychological stress
after a one-week pedometer intervention¹

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Summary.—Physical activity and psychological stress were hypothesized to improve more in participants with high self-efficacy than in those with low and medium self-efficacy after a one-week intervention. 39 female university students participated. The intervention had two steps: a lecture on self-monitoring and goal setting (160 min.) and a one-wk. pedometer intervention. Analyses were conducted on tertile groups according to self-efficacy at baseline. Pedometer step counts were higher in the high self-efficacy group than in the low self-efficacy group after intervention. Helplessness decreased time dependently after intervention only in the low-self-efficacy group. Because physical activity improved more in the high self-efficacy group after a one-week intervention, one hypothesis was supported.

In Japan, the prevalence of overweight and obesity is gradually increasing among young people (e.g., Sun, Sekine, & Kagamimori, 2009). As a result, health education for young people has been increased (e.g., Baba, Koketsu, Nagashima, & Inasaka, 2009). Because low physical activity plays a key role in the development of obesity, interventions intended to increase physical activity are currently emerging as important intervention methods for young people and adults (Lewis, Smith, Wallace, Williams, Bild, & Jacobs, 1997).

It is known that some specific psycho-behavioral factors relate to obesity or overweight (Orii, Kumano, Munakata, & Fukudo, 2005; Saito, Kimura, Tashima, Takao, Nakagawa, Baba, *et al.*, 2009). Others are related to general physical health, including physical activity (Marcus, Bock, Pinto, Forsyth, Roberts, & Traficante, 1998; Pinto, Lynn, Marcus, DePue, & Goldstein, 2001). Interventions aimed at increasing physical activity have thus far been performed to modify cognition (Dunn, Marcus, Kampert, Garcia, Kohl, & Blair, 1997), knowledge (Parcel, Simons-Morton, O'Hara, Baranowski, & Wilson, 1989), self-concept (Schneider, Dunton, & Coope, 2008), self-efficacy (Calfas, Sallis, Oldenburg, & French, 1997), social support (Luepker, Perry, McKinlay, Nader, Parcel, Stone, *et al.*, 1996), and psychological stress (Warschburger, Fromme, Petermann, Wojtalla, & Oepen, 2001). The relationship between self-efficacy and physical activity is particularly well documented (Rodgers & Gauvin, 1998; Delahanty, Conroy, & Nathan, 2006). After an intervention increases physical activity, self-efficacy increases (Calfas, *et al.*, 1997).

It is well known that interventions that include self-monitoring increase physical activity (Nichols, Wellman, Caparosa, Sallis, Calfas, & Rowe, 2000; Miller, Trost, & Brown, 2002; Arai, Kiuchi, Nakamura, & Urai, 2005; Aittasalo, Miilunpalo, Kukkonen-Harjula, & Pasanen, 2006; Adachi, Sato, Yamatsu, Ito, Adachi, & Yamagami, 2007). Interventions using self-monitoring methods have been coalescing into a style of cognitive behavioral strategy (Nichols, *et al.*, 2000; Cumming & Hall, 2004; Arai, *et al.*, 2005; Raedeke, Focht, & King, 2010). Recently, pedometers have become popular tools for increasing physical activity (Tudor-Locke, Ainsworth, Thompson, & Matthews, 2002; Le Maurier & Tudor-Locke, 2003; Baker, Gray, Wright, Fitzsimons, Nimmo, Lowry, & Mutrie, 2008). It is known that even a short pedometer intervention increases physical activity within one week (Spence, Burgess, Rodgers, & Murray, 2009).

The goal-setting method is one form of behavior therapy and promotes the effect of self-monitoring (Kazdin, 1974; Maag, Rutherford, & DiGangi, 1992). Previous studies show that pedometer intervention with a step goal increased physical activity (Bravata, Smith-Spangler, Sundaram, & Gienger, 2007). Pedometer interventions without a step goal resulted in no significant improvement in physical activity, in contrast with increases of more than 2,000 steps per day with the use of a 10,000-step-per-day goal (Ransdell, Robertson, Ornes, & Moyer-Mileur, 2004; Ornes, Ransdell, Robertson, Trunnell, & Moyer-Mileur, 2005).

Users of pedometers not only increase their step counts but also improve psychological variables. For example, pedometer intervention has increased self-efficacy (Raedeke, *et al.*, 2010). Moreover, it is known that pedometer interventions improve mood and emotion (Ekkekakis, Hall, VanLanduyt, & Petruzzello, 2000; Haines, Davis, Rancour, Robinson, Neel-Wilson, & Wagner, 2007; Baker, *et al.*, 2008), and quality of life (Murphy, Neville, Neville, Biddle, & Hardman, 2002). Even as a single exercise, pedometer intervention is known to decrease

depression and anxiety (Tate & Petruzzello, 1995; McAuley, Mihalko, & Bane, 1996; Scully, Kremer, Meade, Graham, & Dudgeon, 1998).

Previous studies found that baseline self-efficacy affected change between pre- and post-intervention step counts after a 16-week exercise program (D'Alonzo, Stevenson, & Davis, 2004). However, the effects of baseline self-efficacy on step counts after a one-week intervention using a pedometer are unknown. Furthermore, it is unknown whether baseline self-efficacy affects psychological stress after a pedometer intervention. The purpose of this study was to investigate the effect of self-efficacy on physical activity and psychological stress after a one-week pedometer intervention. It was hypothesized that step counts and psychological stress would improve more in a group with high self-efficacy compared to groups with low and medium self-efficacy after a one-week pedometer intervention.

Method

Participants

Female college students ($N=45$) were recruited into this study. Six subjects dropped out during the intervention for personal reasons. Data were analyzed for 39 participants. The mean age was 20.3 yr. ($SD=0.7$, range= 19–22). They had neither symptoms nor history of major diseases. Informed consent was obtained from all subjects. This study was approved by the Ethics Committee of Nagasaki University.

Intervention

The pedometer intervention was carried out in two steps. First there was a lecture about cognitive and behavioral strategies including self-monitoring and goal setting (160 min.) (Table 1). Then, all participants initiated self-monitoring of step counts for one week. All participants set their goals at more than 10,000 steps per day during the intervention period (Table 1).

Protocol and Measurements

Experimental protocols were applied in the baseline, intervention, and post-intervention periods (one week each). A psychological assessment was performed to examine self-efficacy (Narita, Shimonaka, Nakazato, Kawai, Sato, & Osada, 1995) and psychological stress (Suzuki, Shimada, Miura, Katayanagi, Umamo, & Sakano, 1997). The self-efficacy scale consisted of 23 items. Self-efficacy scale scores ranged from 23 (low self-efficacy) to 115 (high self-efficacy). The psychological stress scale included subscales of depression-anxiety, irritability-anger, and helplessness. The subscales each have six items. Each subscale had scores ranging from 0 (low stress response) to 18 (high stress response).

Daily physical activities were measured using a uniaxial accelerometer [Life-Corder (LC), Suzuken Co., Nagoya, Japan] as described in previous studies (Kumahara, Schutz, Ayabe, & Yoshioka, 2004; Iemitsu, Maeda, Otsuki, Sugawara, Tanabe, Jesmin, *et al.*, 2006). Step counts were continuously assessed. Exercise volume and total energy expenditure were measured using the LC for 21 days, except for times when participants were sleeping and bathing. The LC was set to blind the values of each physical activity during the baseline and post-intervention.

Statistical Analyses

Data analyses were conducted after dividing the subjects into tertile groups according to self-efficacy at baseline: the High self-efficacy (SE) group, Medium SE group, and Low SE group. The ranges for the tertiles were as follows: Low SE group, 46-63 points ($n=13$); Medium SE group, 64-70 points ($n=13$); High SE group, 72-86 points ($n=13$). Differences in means between the High SE group, Medium SE group, and Low SE group were compared by repeated two-way analysis of variance (ANOVA). The Mann-Whitney U test was used to compare the two groups at specific time points. The paired t test and Wilcoxon's signed rank test were used to detect significant changes within the same group. Probability (p) values of less than .05 were considered significant.

Results

Table 2 shows the clinical characteristics of the studied subjects. The Low SE group had a significantly lower mean self-efficacy score than the Medium SE group ($p = .0001$). The High SE group had a significantly higher mean self-efficacy score than the Low SE group ($p = .0001$) and Medium SE group ($p = .0001$). Other variables did not differ between the groups (Table 2).

Physical Activity

There was a significant group-by-period interaction for step counts (two-way ANOVA, $F_{2,36}=3.11$, $p=.05$, $\eta^2=.12$) and exercise volume (two-way ANOVA, $F_{2,36}=3.90$, $p= .03$, $\eta^2=.16$)(Table 3). No significant group-by-period interaction was indicated for total energy expenditure. Step count was higher in the High SE group than in the Low SE group during the post-intervention period. Non-significantly higher step count in the High SE group compared to the Medium SE group was observed during the post-intervention period (Table 3).

In all study subjects, physical activity was not greater during the post-intervention period than during the baseline (Table 3). In the Low SE group, step count and exercise volume increased after intervention. In the Medium SE group, physical activity did not increase after intervention. Similarly, in the High SE group, physical activity did not differ between the baseline and post-intervention periods.

Psychological Measures

There was a significant group-by-period interaction in the total scores for stress response (two-way ANOVA, $F_{2,36}= 4.07$, $p = .03$, $\eta^2=.17$), irritability-anger (two-way ANOVA, $F_{2,36}= 3.90$, $p = .05$, $\eta^2=.15$), and helplessness (two-way ANOVA, $F_{2,36}= 3.87$, $p = .03$, $\eta^2=.15$)(Table 4). No significant group-by-period interaction was observed for depression-anxiety. A period effect was detected for helplessness (two-way ANOVA, $F_{2,36}=6.44$, $p= .01$, $\eta^2=.12$). The Mann-Whitney U test was used to compare the two groups during the post-intervention period; significant differences were not detected between the groups (Table 4).

The total score for psychological stress increased in the post-intervention period compared with the baseline period in the Medium SE group ($p = .01$). In the other groups, the total score for psychological stress did not differ between periods. In the Medium SE group, depression-anxiety during the post-intervention period was higher than during the baseline period ($p = .05$). Irritability-anger increased during the post-intervention period compared with the baseline period in the Medium SE group ($p = .005$). In the other groups, irritability-anger did not

differ between periods. Helplessness decreased during the post-intervention period compared with the baseline period in the Low SE group ($p = .008$). In the other groups, helplessness scores did not differ between periods.

Discussion

This is the first study to demonstrate the effect of baseline self-efficacy on the outcome measures of physical activity and psychological stress after a one-week pedometer intervention. Step count was higher in the High SE group than in the Low SE group during the post-intervention period. Because step counts improved more in the High self-efficacy group than in the Low and Medium self-efficacy groups after a short intervention, one hypothesis was supported. However, psychological stress was not reduced in High self-efficacy group more than in the other two groups after the intervention. The other hypothesis was not supported.

The reason why physical activity increased after intervention in the High SE group maybe that baseline high self-efficacy contributes to the formation of exercise habits. It is known that self-efficacy correlates with physical activity (e.g., Rodgers & Gauvin, 1998; Delahanty, *et al.*, 2006). Physical activity did not differ between the three groups at baseline. However, frequency of physical activity in the High SE group was higher than in the other two groups during the post-intervention period. After an intervention increases physical activity, self-efficacy is increased (Calfas, *et al.*, 1997). Inversely, in this study, self-efficacy might have begun to support exercise habits via the one-week intervention.

The reason why physical activity did not improve after intervention in Low and Medium SE groups maybe that the intervention was brief. Many long-term interventions (not less than 10 weeks) have been administered to patients with obesity (e.g., Schneider, Bassett, Thompson, Pronk, & Bielak, 2006), diabetes (e.g., Swartz, Strath, Bassett, Moore, Redwine, Groër, *et al.*, 2003), and hypertension (e.g., Moreau, Degarmo, Langley, McMahon, Howley, Bassett, *et al.*, 2001). On the other hand, most short interventions have been performed on healthy subjects, such as undergraduate students (e.g., D'Alonzo, *et al.*, 2004) and sedentary adults (e.g., Sidman, Corbin, & Le Masurier, 2004). Although it is known that even a short pedometer intervention has increased physical activity within one week (Spence, Burgess, Rodgers, & Murray, 2009), this may not have been long enough to increase physical activity in Low and Medium SE groups. Previous short intervention studies (e.g., Sidman, *et al.*, 2004; Hultquist, Albright, & Thompson, 2005; Koulouri, Tigbe, & Lean, 2006) with healthy adults showed that three- to four-week interventions using a pedometer increased step counts. A one-week consecutive intervention using a pedometer may improve physical activity only in people with high self-efficacy.

The total scores for psychological stress and irritability-anger increased after intervention in the Medium SE group. It is possible that the task of reaching the step goal may have been surprisingly easy for the Medium SE group. The reason why helplessness decreased during the post-intervention period compared with the baseline period in the Low SE group could be related to the interaction between physical activity and helplessness. Low self-efficacy is related to low physical activity (McAuley, Courneya, Rudolph, & Lox, 1994). In animal studies (Greenwood & Fleshner, 2008; Greenwood, Foley, Day, Campisi, *et al.*, 2003), it is known that learned helplessness produced by uncontrollable tail shock is blunted by wheel running in rats. The increased physical activity results in

reduced helplessness. A person with low self-efficacy might have stronger helplessness responses in intervention tasks, such as increasing physical activity.

This study has several limitations. Participants were all female undergraduate students. Physical activity is higher in male than in female university students (Johnson, Nichols, Sallis, Calfas, *et al.*, 1998). Helplessness is higher in adolescent males than females (Shimosaka, 2001). The main components of the intervention included goal setting and self-monitoring. Consequently, it is difficult to establish the independent contribution of either of these components. The sample size in this intervention study was small. Therefore, the analysis had limited statistical power. The scale for self-efficacy used in this study was not specific to physical activity, but general. It is possible that the selection of the scale might affect the results. There is a limitation involving the assessment validity of the SRS-18 as used in the present study. In the assessment of stress response, it might be important to use physiological indicators.

In conclusion, physical activity improved more in a group with high self-efficacy compared to groups with low and medium self-efficacy scores after a one-week intervention.

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Table 1. Description of the lecture contents

Step	Time 160 min	Contents
Step 1: Current history	40 min	<ul style="list-style-type: none"> • Explanation of physical activity • Information about baseline physical activities (step counts, exercise volume, and total energy expenditure)
Step 2: Self-monitoring	40 min	<ul style="list-style-type: none"> • Explanation of the self-monitoring method • Understanding the effect of self-monitoring using an accelerometer
Step 3: Barriers (Group work)	40 min	<ul style="list-style-type: none"> • Identifying barriers to increasing physical activity • Group discussion
Step 4: Goal setting	40 min	<ul style="list-style-type: none"> • Understanding the effects of goal setting • Identifying situations for increasing physical activity

Table 2. Demographic data in the low-, medium-, and high-self-efficacy groups

Variables	All study subjects (n = 39)	Low self-efficacy (n = 13)	Medium self-efficacy (n = 13)	High self-efficacy (n = 13)
Age	20.3 ± 0.7	20.2 ± 0.6	20.5 ± 0.7	20.4 ± 0.8
Height (cm)	159.3 ± 5.8	157.8 ± 6.6	161.6 ± 6.8	158.6 ± 3.4
Weight (kg)	53.0 ± 6.9	52.2 ± 5.0	53.7 ± 8.7	53.6 ± 7.2
Body mass index (cm ²)	20.9 ± 2.2	21.0 ± 1.9	20.5 ± 2.3	21.3 ± 2.6
Waist-hip ratio	0.77 ± 0.03	0.77 ± 0.03	0.77 ± 0.04	0.77 ± 0.02
Systolic blood pressure (mmHg)	108.2 ± 11.4	105.1 ± 11.5	108.6 ± 14.4	110.8 ± 8.1
Diastolic blood pressure (mmHg)	70.6 ± 10.9	68.5 ± 12.2	72.3 ± 12.8	70.9 ± 11.5
Pulse pressure (mmHg)	71.4 ± 11.0	67.5 ± 10.3	71.1 ± 8.8	76.4 ± 13.3

Table 3. Comparisons of means on Step Count, Exercise Volume, and Energy Expenditure at baseline and post-intervention, for low, medium, and high self-esteem groups

Measure	Group	<i>n</i>	Baseline (B)		Post-Intervention (PI)		Comparison Effect Size (<i>r</i>)*
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Step Count, steps/day	All	39	7903.2	2891.9	7429.9	3427.2	.16
	Low SE	13	8109.0	2636.4	6341.8	1782.2	.53 *
	Medium SE	13	7810.2	2519.0	6968.1	2572.5	.35
	High SE	13	8180.4	3405.8	9269.4	4692.4	.31
Exercise volume, kcal/day	All	39	197.0	83.2	184.9	86.1	.15
	Low SE	13	205.6	77.7	158.0	42.8	.52 *
	Medium SE	13	200.4	90.4	171.1	64.8	.42
	High SE	13	195.4	81.6	233.7	116.6	.38
Energy expenditure, kcal/day	All	39	1624.4	294.1	1661	265.1	.18
	Low SE	13	1608.9	344.1	1603.1	237.5	.04
	Medium SE	13	1680.6	214.4	1725.8	199.1	.34
	High SE	13	1664.9	136.3	1717.1	254.2	.25

*No Baseline vs Post-intervention comparisons were statistically significant at $p < .05$.

Table 4. Comparisons of means on Self-Efficacy and Stress Response Factors at baseline and post-intervention, for low, medium, and high self-esteem groups

Measure	Group	<i>n</i>	Baseline (B)		Post-Intervention (PI)		Comparison Effect Size (<i>r</i>)*
			<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Self-efficacy	All	39	67.4	10.7	66.4	10.1	.13
	Low SE	13	55.8	5.7	56.6	7.5	.12
	Medium SE	13	66.7	2.2	66.7	5.7	.00
	High SE	13	77.8	4.8	74.5	6.5	.56 *
Total Stress Response	All	39	26	16.8	25.2	19.7	.04
	Low SE	13	28.2	21.2	22.1	24.1	.39
	Medium SE	13	24.9	15.3	30.9	20.4	.61 *
	High SE	13	23.6	14.0	22.9	14.6	.09
Depression-anxiety	All	39	8.2	5.4	8.4	7.1	.14
	Low SE	13	9	6.6	7.4	8.4	.28
	Medium SE	13	8.5	5.0	10.8	7.5	.54 *
	High SE	13	6.8	4.5	7.2	5.1	.10
Irritability-anger	All	39	7.9	6.3	8.5	7.2	.15
	Low SE	13	9.1	7.5	7.8	8.9	.20
	Medium SE	13	6.9	5.6	10.3	7.9	.70
	High SE	13	7.2	5.8	7.2	4.5	.00
Helplessness	All	39	9.9	5.8	8.4	6.1	.36
	Low SE	13	10.2	7.8	6.8	7.2	.65 *
	Medium SE	13	9.5	5.1	9.8	5.5	.13
	High SE	13	9.6	4.4	8.5	5.8	.32

*No Baseline vs Post-intervention comparisons were statistically significant at $p < .05$.