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Effects of a transtheoretical model-based stage-matched intervention to promote physical activity among Korean adults

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ABSTRACT. The present quasi-experimental study examined an electronically delivered, stage-matched intervention aimed at promoting physical activity levels and enhancing psychological determinants of physical activity behavior among Korean adults. A total of 378 administrative staff participated in this study, which was delivered electronically at Seoul National University of Technology (South Korea) over 16 consecutive weeks. At baseline, week 8, and week 16, participants completed measures of stage of change, processes of change, decisional balance, self-efficacy, and physical activity behavior. Data were analyzed using frequency analysis and repeated measures MANOVA. Significant improvements were observed for stage of readiness for change, physical activity behavior, physical activity self-efficacy, pros, and the use of the cognitive and behavioral processes of change, with significant decreases in their cons for being physically active. To our knowledge, this is the first study to fully employ the transtheoretical model of behavior change as an organizing framework with the program being delivered using an emerging intervention technology (*i.e.,* e-mail) among Korean adults employed at a single worksite. Preliminary support was found for this intervention modality within a non-western sample.

KEYWORDS. Behavior change. Electronic mail. Psychology. Worksite health promotion. Quasi-experiment.

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RESUMEN. El presente estudio cuasi-experimental examinó una intervención alineada con el estado de desarrollo del cliente, enfocada en promover niveles de actividad física e incrementar determinantes psicológicos de actividad física entre coreanos adultos. Un total de 378 empleados administrativos participaron en este estudio, el cual se llevó a cabo de forma electrónica en la Universidad Nacional de Tecnología de Corea (Corea del Sur) durante el transcurso de dieciséis semanas consecutivas. Los datos se analizaron utilizando análisis de frecuencia y repetidas aplicaciones de medida MANOVA. Se observaron importantes mejoras en los casos de buena disposición para el cambio, actividad física, auto-eficacia en la actividad física, beneficios, y el uso de procedimientos de cambio de comportamiento y cognitivos, con una importante disminución de los efectos contrarios de estar físicamente activo. De acuerdo con nuestro conocimiento, este es el primer estudio que emplea completamente el modelo transteorético de cambio de comportamiento como un marco organizado con el programa administrado, utilizando una nueva tecnología de intervención (correo electrónico) entre adultos coreanos empleados en un solo trabajo. Se encontró apoyo preliminar para esta forma de intervención dentro de muestras no occidentales.

PALABRAS CLAVE: Modificación del comportamiento. Correo electrónico. Psicología. Promoción de la salud en el trabajo. *Quasi*-experimiento.

It is broadly recognized that a physically active lifestyle offers numerous benefits for physical and psychological health. Regular physical activity is associated with a significant decline in all-cause mortality and the prevention of other hypokinetic diseases, such as coronary heart disease, cancer, hypertension, type 2 diabetes mellitus, and obesity (An *et al.,* 2004; Annesi, Faigenbaum, Smith, Unruh, and Hamilton, 2007; Fenton, 2005; Moreno-Murcia, Coll, and Cervello-Gimeno, 2008; Spiegel and Foulk, 2006). Nevertheless, recent statistics indicate that many individuals around the world are insufficiently active to obtain these health benefits (Australian Bureau of Statistics, 2006; Ministry of Culture and Tourism, 2000; U.S. Center for Disease Control and Prevention, 2004).

Based on the awareness of the importance of regular physical activity and the lack of success of many approaches to promoting physical activity in daily life, theory-based intervention programs have been repeatedly encouraged (Kim, 2004; Plotnikoff, Hotz, Birkett, and Courneya, 2001; Woods, Mutrie, and Scott, 2002). Additionally, if a physical activity intervention over relies on the behavioral processes of change, it likely will not appeal to those people who are not ready to take action. In this regard, a more promising approach might be to offer interventions that appeal to the vast majority of people who are not ready to take action or to offer stage-matched interventions (Cardinal and Sachs, 1996). Though certainly not without its critics (Adams and White, 2005; West, 2005), stage-matched physical activity interventions based on the transtheoretical model (TTM) have shown some promise for increasing people's physical activity behavior (Blissmer and McAuley, 2002; Cardinal and Sachs, 1995, 1996; Kim, Hwang, and Yoo, 2004).

The central aim of the TTM is to offer a clear understanding of the stages and processes of behavior change (Prochaska and DiClemente, 1983). The TTM consists of

five main stages of change, referred to as the temporal and motivational aspects of change (*i.e.,* precontemplation, contemplation, preparation, action, and maintenance). In addition, several psychological and behavioral variables such as processes of change, self-efficacy, and decisional balance (*i.e*., pros and cons) have been shown to have predictable relationships with the stage of change construct, and are included as other constructs in the model (Prochaska and DiClemente, 1983). The basic and specific descriptions for the TTM constructs have been well documented in a number of previous studies (Cardinal, Kosma, and McCubbin, 2004; Kim, 2007; Si, 2006). TTM suggests that behavior change occurs over time in a series of stages, and that the mechanisms of change include the cognitive and behavioral processes that individuals engage in at different stages of change. Additionally, individuals will weigh the pros and cons of engaging in physical activity, and will generally experience increased self-efficacy as they advance through the stages of physical activity behavior change (Levy and Cardinal, 2006).

For over a decade, many TTM studies across a wide range of populations and settings have been conducted using cross-sectional designs. These studies have generally supported the stage construct of the model, and the relationship of the model with self-efficacy, decision balance, and change processes (Cardinal, Keis, and Ferrand, 2006; Kosma, Ellis, Cardinal, Bauer, and McCubbin, 2007; Spencer, Adams, Malone, Roy, and Yost, 2006). While cross-sectional studies support the relationship of model constructs to the various stages of physical activity behavior, stage-matched interventions remain to be tested across a similarly wide range of samples and settings (Clark, Hampson, Avery, and Simpson, 2004; Levy and Cardinal, 2006).

The TTM is based on the idea that people differ in their levels of readiness to change their physical activity behavior. Therefore, stage-matched interventions use different strategies and techniques to bring about physical activity behavior change. Specifically, stage-matched intervention programs attempt to employ strategies and techniques for physical activity behavior change that are most useful for individuals with different levels of motivational readiness to change (Marcus and Forsyth, 2003).

Several studies have supported stage-matched intervention as being useful for physical activity behavior change (Blissmer and McAuley, 2002; Griffin-Blake and DeJoy, 2006; Lippke, Ziegelmann, and Schwarzer, 2004). However, for the most part, these studies have been conducted in Western countries. Before generalizing the findings from such studies to other nations and cultures, it is imperative to determine their external validity (Nishimura and Chikamoto, 2005).

The present quasi-experimental study (Montero and León, 2007; Ramos-Alvarez, Moreno-Fernández, Valdés-Conory, and Catena, 2008) addresses this current void in the literature by applying the stage-matched intervention approach in Korea. Specifically, a preliminary trial of a stage-matched intervention for promoting physical activity levels and the use of psychological correlates positively associated with physical activity behavior change was assessed over a 16-week time period among a group of Korean adults. The research question addressed was: Would employees at a single worksite increase their physical activity behavior and their use of psychological correlates of physical activity behavior following a 16-week personalized, self-instructional stage-matched behavior change program that was entirely electronically delivered?

Method

Participants

Administrative staff from Seoul National University of Technology (SNUT) were recruited into this study using staff e-mail, a newspaper advertisement issued through the university, and recruitment flyers posted on the university website. Current exercisers, non-exercisers, and those not interested in exercising were encouraged to join in. People volunteering to participate were informed they would be eligible for a $100 drawing for each monthly questionnaire packet returned. Four hundred thirty-seven staff expressed interest in the study and were sent a consent form (study approved by the Research Committee of SNUT) and study questionnaires to complete. From this group, 409 (93.50%) people returned the informed consent form and the baseline questionnaires. The second questionnaire was sent to the 409 staff who completed the baseline questionnaire and after 8 weeks, 385 questionnaires were returned (94.10%). After 16 weeks, the same survey forms were provided to the 385 responding staff, and 378 (98.20%) of those people returned questionnaires. The final sample consisted of 378 staff (male: 233, female: 145), which represents 86.50% of the initial sample pool. Study participants ranged in age from 22-56 years old (M = 35.80, SD = 8.24). No differences in age or gender were detected between the staff who fully participated and those who did not.

Measures

The questionnaires used this study were originally developed in English and translated into Korean using the methodology outlined by Banville, Desrosiers, and Genet-Volet (2000). The full translation process has been described elsewhere (Kim, Cardinal, and Lee, 2006).

To assess physical activity behavior, Marcus, Selby, Niaura, and Rossi's (1992) questionnaire was used. Regular physical activity was defined as being active 4-7 days per week for at least 30 minutes per day, which is consistent with the American College of Sports Medicine's (2000) recommendation. Using this measure individuals were categorized into one of the five stages of behavior change described previously. Two-week test-retest reliability for the measure was .85.

The Processes of Change Questionnaire developed by Nigg, Norman, Rossi, and Benisovich (1999) was used to assess the processes of physical activity behavior change. The original questionnaire was comprised of 30 items that sought to measure the 10 hypothesized processes of change; however, in this study, six items with factor loadings below .50 were deleted from the original questionnaire (*i.e.*, the three self-liberation and three social-liberation items). The remaining 24 items and eight factors were used to assess the processes of change relating to physical activity behavior. Participants were asked to recall how frequently each of the processes was used during the past month with each item rated on a 5-point Likert-type scale ranging from 1 (*never*) to 5 (*repeatedly*). Cronbach's coefficient alpha ranged from .70 to .87 and 2-week test-retest reliability scores ranged from .69 to .89.

Nigg and Riebe's (2002) 18-item self-efficacy scale was used in this study. Each item was assessed on a 5-point scale ranging from 1 (*cannot do*) through 5 (*certain can do*).

Participants rated their confidence in performing physical activity regularly under various circumstances *(e.g.,* «When I am feeling tired or during bad weather»). Cronbach coefficient alpha for the scale was .91 and 2-week test-retest reliability was .86.

Plotnikoff, Blanchard, Hotz, and Rhodes's (2001) 10-item decisional balance scale was used in this study. There are five «pro» and five «con» items on the measure and each item was rated using a 5-point Likert-type scale ranging from 1 (*not at all important*) to 5 (*extremely important*). Cronbach's coefficient alpha was .85 for the pros and .78 for the cons, with 2-week test-retest reliability being .91 for the pros and .89 for the cons.

The Leisure Time Exercise Questionnaire (LTEQ, Godin and Shephard, 1985) was used to assess habitual weekly physical activity behavior. On this measure, participants reported how many times during a typical week they participated in strenuous (*e.g.,* running, vigorous cycling), moderate (*e.g.,* fast walking, easy swim), and mild (*e.g.,* yoga, golf) physical activity for more than 15 minutes. Using the information provided a score was calculated by multiplying each reported activity session by its metabolic equivalent (MET) value and summing the result -*i.e*., (strenuous x 9) + (moderate x 5) + (mild x 3). In the present study, 2-week test-retest reliability for the measure was .86.

Procedures

The initial questionnaire packet contained the measure of stage of change, processes of change, self-efficacy, decision balance, and physical activity level. Demographic information including age and gender was also collected. Participants were asked to return the completed baseline questionnaire within 10 days via e-mail. If the questionnaires were not returned within this time frame, participants were prompted via e-mail to do so.

After returning baseline questionnaires, study participants were sent the stage-matched intervention materials via e-mail. After 8 weeks, all participants were e-mailed and asked to complete the same set of questionnaires completed at baseline. In an attempt to maximize response rates, a pre-notification e-mail alert was sent to all study participants notifying them that the second questionnaire would be forthcoming. It also reaffirmed the opportunity for the participant to be entered in the drawing. After receipt of this questionnaire, participants were again sent the appropriate intervention materials based on their current physical activity stage. The same procedures were followed at the end of 16 weeks.

Intervention

Banville *et al.* (2000) translation processes were followed in developing the Korean stage-matched intervention materials. These materials were also reviewed for content validity by an expert review and discussion panel comprised of three people. The expert group consisted of two exercise psychologists with knowledge of TTM and one health professional with knowledge about physical activity. The experts reviewed the following components of the stage-matched materials: a) intervention goals and objectives, b) recommended behavior change strategies, and c) physical activity examples. From their recommendations, small wording and/or phrasing changes were made to the stage-matched materials.

The study protocol was based on the premise that people make physical activity change in stages, and that different interventions are required at each stage of change. Participants received personalized, self-instructional stage-matched materials delivered via campus e-mail on a monthly basis. The materials were based on the study participants' current stage of change classification and they were accompanied by a short, personalized, stage-matched cover letter. The letter referred to the participants by name, referenced their previous activity levels, and indicated that the material was developed to help them become more active or maintain their current activity level. Essentially, the materials used in this study were behavior change manuals developed on the basis of previous studies (Blissmer and McAuley, 2002; Cardinal and Sachs, 1996) and they employed the most appropriate behavioral and cognitive strategies for each stage of change.

Precontemplation: Individuals in this stage are currently not active and are not thinking about becoming active. The goal of an intervention for individuals in this stage is to help them begin thinking about becoming physically active and to gather more information about physical activity. At this stage it is also important to assess an individual's perceptions of pros and cons of becoming physically active. An example of a strategy is reading an article about the benefits of physical activity.

Contemplation: Individuals in this stage are not currently physically active but are considering the prospect of becoming active. The goal of an intervention for individuals in this stage is to increase the person's likelihood of steps to become physically active. Therefore, the materials focused on minimizing the cons of activity, increasing emotional awareness, gathering more information, and creating a new self-image as an active person. An example of a strategy for a contemplator is buying a good pair of walking shoes and talking to a family member about her/his plans to become physically active.

Preparation: Individuals in this stage may be engaging in physical activity, but not at the recommended levels or they may be seriously preparing to become more physically active. The goal of an intervention for individuals in this stage is to increase their physical activity participation to the recommended levels (*i.e.,* 30 minutes or more of moderate-intensity physical activity on most or all days of the week). The materials here focused on further reinforcing an active self-image, gathering social support for activity, and making a commitment to activity. An example of a strategy is recording the number of minutes of physical activity being engaged in each day on a monthly calendar or alternatively, utilizing a detailed log containing frequency, duration, type, and intensity of activity.

Action: Individuals in this stage are physically active at the recommended levels, but they have only been so for less than six months. The goal of an intervention for individuals in this stage is to keep them moving towards their active lifestyle. Therefore, the materials focus was on making healthy substitutions, avoiding situations that lead to inactivity, and developing some simple rewards for being physically active. An example of a strategy is rewarding oneself with positive words and thoughts such as «Good going» and «I can do it», when he/she successfully avoided a situation that may have previously lead to inactivity.

Maintenance: Individuals in this stage are physically active at the recommended levels and have been for six or more months. The goal for these individuals was to maintain their physical activity participation. The intervention materials focused on dealing effectively with setbacks, continually using a healthy substitute for bad habits, and reinforcing physical activity as a part of one's life. An example of a strategy is, when going on vacation, to make certain to bring along exercise clothes and investigate beforehand whether where they were staying had fitness facilities or walking or running maps available.

Analysis

Frequency analysis was initially conducted to examine the stage transitions of physical activity behavior over the 16 weeks. A mixed model repeated measures MANOVA with time (three levels) as the within-subjects factor and stage of change (five levels) as the between-subjects factor was conducted to examine changes in the levels of physical activity (*i.e.,* MET score) and the TTM constructs (*i.e.,* self-efficacy, pros, cons, cognitive processes of change and behavioral processes of change) over 16 weeks. Post hoc Bonferroni-corrected tests were used to identify significant differences between each of the three time points. All statistical analyses applied in this study were performed using SPSS Win 12.0.

Results

Stage transitions in physical activity behavior over the 16-week intervention

Table 1 indicates the stage transitions of study participants over the 16-week intervention. Overall, 67.20% of the study participants reported being inactive (*i.e.,* precontemplation or contemplation) or irregularly physical active (*i.e.,* preparation) at baseline, however this gradually decreased through the intervention (55.90% at 8 weeks, 49.30% at 16 weeks). In contrast, the number of regularly active participants (*i.e*., action or maintenance) gradually increased across the three different time points (32.80% at baseline, 44.20% at 8 weeks, and 50.60% at 16 weeks). The study participants initially from the precontemplation stage were the most significantly changed (14.10% at baseline, 7.70% at 8 weeks, 2.10% at 16 weeks). A McNemar chi-square (χ^2) test was conducted to examine the differences in stage of change over the 16 weeks and revealed significant differences between each of the three time points (McNemar χ^2 values = 49.72 between baseline and 8 weeks; 117.87, between baseline and 16 weeks; 53.10, between 8 weeks and 16 weeks, all $df = 7$, $p < .001$).

TABLE 1. Stage transitions of physical activity behavior over 16 weeks time periods *(N* = 378)

Stage transitions over 16 weeks						
	PC	*CO*	*PR*	*AC*	*MA*	*Total*[a]
Baseline – 8 weeks						
PC	23	30	0	0	0	53 (14.10)
CO	6	31	29	15	0	81 (21.40)
PR	0	9	68	40	3	120 (31.70)
AC	0	3	12	30	9	54 (14.30)
MA	0	0	0	3	67	70 (18.50)
Total[b]	29 (7.70)	73 (19.30)	109 (28.80)	88 (23.30)	79 (20.90)	378 (100)
8 Weeks – 16 weeks						
PC	4	23	2	0	0	29 (7.70)
CO	4	27	29	13	0	73 (19.30)
PR	0	14	59	21	15	109 (28.80)
AC	0	1	21	64	2	88 (23.30)
MA	0	0	3	9	67	79 (20.90)
Total[c]	8 (2.10)	65 (17.10)	114 (30.10)	107 (28.40)	84 (22.20)	378 (100)

Notes. All values are reported as frequencies with percentages reported in parentheses, [a]Frequencies indicate the sum of stage of change distribution at baseline, [b]Frequencies indicate the sum of stage of change distribution at 8-week time period, [c]Frequencies indicate the sum of stage of change distribution at 16-week time period, PC = precontemplation; CO = contemplation; PR = preparation; AC = action; MA = maintenance.

Differences in the TTM constructs and physical activity across the three time points

Table 2 shows the means, standard deviations, and the results of a mixed model repeated measures MANOVA with Bonferroni post-hoc contrasts for the TTM constructs (*i.e.,* self-efficacy, pros, cons, cognitive processes and behavioral processes) and the physical activity levels (*i.e.,* METs) across the three different time points.

Self-efficacy. Significant main effects for stage of change ($F_{(4, 373)} = 124.10$, partial $\eta^2 = .35$, $p < .001$) and time ($F_{(4, 373)} = 44.08$, partial $\eta^2 = .14$, $p < .001$), and a significant interaction ($F_{(2, 373)} = 5.63$, partial $\eta^2 = .05$, $p < .001$) were observed. Simple main effects were explored to further clarify the transitional shift interaction and revealed significant differences among the stages at baseline ($F_{(4, 373)} = 145.58$, partial $\eta^2 = .28$, $p < .001$), 8 weeks ($F_{(4, 373)} = 181.06$, partial $\eta^2 = .33$, $p < .001$), and 16 weeks ($F_{(4, 373)} = 161.52$, partial $\eta^2 = .31$, $p < .001$). Those in precontemplation and contemplation reported significantly less self-efficacy for physical activity than did those in the other stages at each of the three time points ($p < .001$). Those in preparation and action indicated significantly less self-efficacy than those in maintenance at all three time points ($p < .001$).

Pros. A significant interaction ($F_{(4, 373)} = 10.06$, partial $\eta^2 = .03$, $p < .001$), as well as significant main effects for stage of change ($F_{(4,373)} = 52.92$, partial $\eta^2 = .13$, $p < .001$), and time ($F_{(2, 373)} = 26.76$, partial $\eta^2 = .02$, $p < .001$) were observed. An examination of simple main effects revealed significant differences in stage of change at each of the three time points time (baseline $F_{(4,373)} = 21.25$, partial $\eta^2 = .05$; 8 weeks time ($F_{(4, 373)} = 77.69$, partial $\eta^2 = .17$; 16 weeks time ($F_{(4, 373)} = 47.86$, partial $\eta^2 = .12$, all $p < .001$). At baseline and 8 weeks, physical activity pros significantly increased from

precontemplation to maintenance ($p < .001$). At 16 weeks, those in precontemplation and contemplation reported significantly fewer pros of exercise than the rest of other stages ($p < .05$), while those in maintenance reported significantly more pros than those in all other stages ($p < .001$).

Cons. A significant interaction ($F_{(4, 373)} = 4.90$, partial $\eta^2 = .02$, $p < .001$), and significant main effects for stage of change ($F_{(4, 373)} = 33.57$, partial $\eta^2 = .09$, $p < .001$), and time ($F_{(2, 373)} = 19.24$, partial $\eta^2 = .03$, $p < .001$) were observed. Physical activity cons significantly decreased over time ($p < .05$). Participants in precontemplation had significantly more physical activity cons than did those in maintenance ($p < .001$).

Cognitive processes of change. A significant main effects for stage of change ($F_{(4, 373)} = 84.77$, partial $\eta^2 = .35$, $p < .001$) and time ($F_{(4, 373)} = 7.56$, partial $\eta^2 = .01$, $p < .001$), and a significant interaction ($F_{(2, 373)} = 7.22$, partial $\eta^2 = .02$, $p < .001$) were observed. Simple main effects were examined to further clarify the interaction and this analysis revealed significant differences in each stage at baseline ($F_{(4, 373)} = 52.46$, partial $\eta^2 = .12$, $p < .001$), 8 weeks ($F_{(4, 373)} = 85.00$, partial $h2 = .18$, $p < .001$), and 16 weeks ($F_{(4,373)} = 74.43$, partial $\eta^2 = .17$, $p < .001$). Participants in precontemplation and contemplation used significantly less cognitive processes of change than did those in the other stages at each of the three time points ($p < .001$).

Behavioral processes of change. A significant interaction ($F_{(4, 373)} = 4.50$, partial $\eta^2 = .02$, $p < .001$) and a significant main effect for stage of change ($F_{(4, 373)} = 196.95$, partial $\eta^2 = .35$, $p < .001$) were observed. No significant main effect for time was found ($p > .14$). An examination of simple main effects revealed significant differences in stage of change at each of the three time points (baseline $F_{(4, 373)} = 21.25$, partial $\eta^2 = .05$; 8 weeks time ($F_{(4, 373)} = 77.69$, partial $\eta^2 = .17$; 16 weeks time ($F_{(4,373)} = 47.86$, partial $\eta^2 = .12$, all $p < .001$). An examination of simple main effects revealed significant differences in each stage at baseline ($F_{(4, 373)} = 162.99$, partial $\eta^2 = .30$, $p < .001$), 8 weeks ($F_{(4,373)} = 194.62$, partial $\eta^2 = .34$, $p < .001$), and 16 weeks ($F_{(4, 373)} = 120.38$, partial $\eta^2 = .25$, $p < .001$). Use of the behavioral processes of change significantly increased from precontemplation through preparation to maintenance at all three time points ($p < .001$).

Exercise METs. A significant interaction ($F_{(4, 373)} = 5.70$, partial $h2 = .02$, $p < .001$), as well as significant main effects for stage of change ($F_{(4, 373)} = 286.01$, partial $\eta^2 = .44$, $p < .001$), and time ($F_{(2,373)} = 8.68$, partial $\eta^2 = .01$, $p < .001$) were observed for exercise METs. Simple main effects significant differences among the stages at baseline ($F_{(4, 373)} = 200.77$, partial $\eta^2 = .35$, $p < .001$), 8 weeks ($F_{(4,373)} = 184.38$, partial $\eta^2 = .33$, $p < .001$), and 16 weeks ($F_{(4, 373)} = 117.27$, partial $\eta^2 = .24$, $p < .001$). Exercise MET scores significantly increased in all stages over time. At each of the three time points, participants in precontemplation and contemplation were significantly less active than those in the other stages ($p < .001$). At baseline, those in preparation and action were significantly less active than those in maintenance ($p < .05$). Similarly, at 8 weeks and at 16 weeks those in preparation were less active than those in action ($p < .05$) and maintenance ($p < .01$), while those in action were less active compared to those in maintenance ($p < .05$).

TABLE 2. The TTM constructs and exercise METs across and within stage of change over time.

	Stage of change					
Variable	*PC (n = 8)*	*CO (n = 65)*	*PR (n = 114)*	*AC (n = 107)*	*MA (n = 84)*	*Post hoc[a] (p < .05)*
Self-efficacy						
Baseline	2.38 (.40)	2.65 (.52)	2.95 (.56)	3.04 (.54)	3.51 (.49)	PC,CO<PR, C<MA
8 weeks	2.47 (.56)	2.66 (.48)	2.93 (.51)	3.12 (.56)	3.53 (.46)	PC,CO<PR,AC<MA
16 weeks	2.51 (.39)	2.73 (.48)	3.00 (.53)	3.28 (.55)	3.58 (.49)	PC,CO<PR,AC<MA
Pros						
Baseline	2.50 (.77)	3.01 (.58)	3.66 (.74)	3.66 (.73)	3.70 (.68)	PC<CO<PR,AC,MA
8 weeks	2.91 (.71)	3.34 (.70)	3.66 (.73)	3.66 (.78)	3.65 (.68)	PC<CO<PR,AC,MA
16 weeks	3.11 (.84)	3.34 (.67)	3.68 (.71)	3.70 (.65)	3.98 (.75)	PC,CO<PR,AC<MA
Cons						
Baseline	2.22 (.51)	2.13 (.45)	1.98 (.48)	1.88 (.53)	1.75 (.48)	PC,CO,PR<AC,MA
8 weeks	2.15 (.67)	1.96 (.52)	1.96 (.50)	1.83 (.47)	1.77 (.42)	PC<AC,MA
16 weeks	2.08 (.52)	1.98 (.44)	1.99 (.38)	1.89 (.53)	1.81 (.52)	PC<MA
Cognitive processes						
Baseline	2.43 (.40)	2.59 (.45)	3.03 (.59)	3.27 (.51)	3.38 (.55)	PC,CO<PR,AC,MA
8 weeks	2.56 (.49)	2.73 (.41)	3.19 (.49)	3.27 (.46)	3.39 (.48)	PC,CO<PR,AC,MA
16 weeks	2.70 (.28)	2.99 (.41)	3.25 (.48)	3.30 (.47)	3.51 (.59)	PC,CO<PR,AC<MA
Behavioral processes						
Baseline	2.37 (.36)	2.82 (.49)	3.23 (.57)	3.25 (.48)	3.60 (.54)	PC<CO<PR,AC<MA
8 weeks	2.41 (.38)	2.59 (.45)	3.12 (.43)	3.26 (.54)	3.52 (.49)	PC,CO<PR,AC<MA
16 weeks	2.59 (.40)	2.74 (.48)	3.09 (.48)	3.35 (.59)	3.74 (.52)	PC,CO<PR<AC<MA
Exercise METS						
Baseline	6.93 (11.12)	9.60 (9.32)	16.34 (14.10)	21.16 (12.48)	34.47 (16.28)	PC,CO<PR,AC<MA
8 weeks	8.61 (12.46)	11.19 (11.96)	18.79 (13.24)	22.14 (13.68)	36.85 (15.27)	PC,CO<PR<AC<MA
16 weeks	11.70 (12.80)	11.76 (10.28)	19.67 (12.28)	24.86 (14.73)	37.43 (17.48)	PC,CO<PR<AC<MA

Notes. PC = precontemplation; CO = contemplation; PR = preparation; AC = action; MA = maintenance. METs: metabolic equivalents - equation: Total METs = (strenuous x 9) + (moderate x 5) + (mild x 3)-. [a]Mean differences using Bonferroni post-hoc contrasts ($p < .05$). All values are reported as means with standard deviations reported in parentheses.

Discussion

A preliminary trial of a stage-matched physical activity intervention delivered using electronic means was examined among Korean adults at a single worksite. Participants were initially classified by their stage of change for physical activity behavior and then offered intervention materials specifically targeting their stage of readiness to change. The study occurred over 16-weeks, with assessments occurring at baseline, week 8, and week 16. At each time period exercise behavior was assessed, along with each construct from the TTM (*i.e.,* behavioral processes of change, cognitive process of change, cons, pros, self-efficacy, stage of change). Among those initially recruited into the study, 86.50% completed the study.

Prior to the study, 32.80% of the study participants reported being in the action or maintenance stage of change for physical activity, whereas after the intervention 50.60% of the participants were ($p < .001$). There was a corresponding decrease in the number of participants that were in the inactive and/or insufficiently active stages of change for physical activity behavior (*i.e.,* precontemplation, contemplation, or preparation).

Accompanying the increase in stage of readiness for change, the participants also experienced increases in their physical activity behavior. Specifically, those in precontemplation at the start of the study experienced the greatest gains in their weekly leisure-time exercise METS (+4.77), followed by those in action (+3.70), preparation (+3.33), maintenance (+2.96), and contemplation (+2.16). A > 3 MET increase on this particular measure of physical activity equates to at least one additional mild exercise session per week with the session lasting > 15 minutes in duration. These are very positive increases in physical activity behavior that can, if sustained, profoundly improve the participants' long-term health and wellbeing (Haskell *et al.,* 2007). The amount of stage of change variance accounted for (Cohen, 1977) by Exercise METs was large (*i.e.,* $\eta^2 = .44$), which is similar to the amount of variance (*i.e.,* $\eta^2 = .40$) reported among a sample of adults in the US using the exact same measure (Cardinal, 1997), and which further supports the construct validity of the stage of change measure within a unique sample of Korean adults.

During the intervention, the sample as a whole also experienced increases in their physical activity self-efficacy, pros, and the use of the cognitive and behavioral processes of change, with decreases in their cons for being physically activity (*i.e.,* all main effects for time were $p < .001$). This is important to document because many physical activity intervention studies have failed to document changes in the theoretical variables that served as the basis of the physical activity intervention in the first place (Hallam and Petosa, 2004).

In this study those in the action stage of change experienced the largest increases in self-efficacy. Those in the precontemplation and maintenance stages of change experienced the largest increases in their pros for being active. Those in the precontemplation and contemplation stages of change experienced the largest gains in their use of the cognitive processes of change. Those in the contemplation and preparation stages of change reported slight decreases in their use of the behavioral processes of change, whereas the other groups each reported increases. Those in preparation and maintenance reported the biggest decreases in the cons associated with being physically active. These data, coupled with the theoretically consistent patterns of improvement observed for each psychological construct at each of the three time points of the study (*i.e.*, all main effects for stage of change were $p < .001$), further supports the construct validity of the stages of change. Specifically, a large proportion of variance (Cohen, 1977) was observed for the behavioral processes of change ($\eta^2 = .35$), the cognitive processes of change ($\eta^2 = .35$), and self-efficacy ($\eta^2 = .35$), with moderate proportions of variance being accounted for by the pros ($\eta^2 = .13$) and the cons ($\eta^2 = .09$) associated with physical activity participation. These findings contribute to the growing body of evidence regarding the conceptual strategies that most relate to the specific stages of change, which is a fundamental tenet of the transtheoretical model of behavior change framework (Prochaska and DiClemente, 1983). Furthermore, such strategies may be applicable in appropriately targeting physical activity intervention strategies to specific stages of change across a wide variety of settings (Cardinal and Sachs, 1995, 1996; Kosma, Gardner, Cardinal, Bauer, and McCubbin, 2006; Spencer *et al.,* 2006), which is in direct opposition to the arguments against the transtheortical model that were put forth by Adams and White (2005) and West (2005).

The medium of intervention in this study was electronic (*i.e.,* e-mail). This remains a rather novel and understudied intervention modality within the physical activity domain (Kosma, Cardinal, and McCubbin, 2005; Suminski and Petosa, 2006). Whether this modality is as effective as other modalities (*e.g.,* face-to-face, group settings) remains to be seen and this would be an interesting line of future inquiry. One nice feature of this modality is that it is reasonably well adapted to TTM interventions where the intervention program can truly be tailored to each person's stage of readiness for change. On the downside, with minimal contact between the intervention program deliverers and among the intervention program participants the participant may need to develop a strong sense of physical activity independence and/or they may develop the feeling that physical activity is something that they must do on their own in relative isolation. This may be maladaptive for long-term adherence in a culture with a strong collectivism *vs*. individualism history (Elliot, Chirkov, Kim, and Sheldon, 2001). However, in cultures with a strong individualism history there is some evidence that this approach may actually be beneficial. That is, people who are regularly active are less reliant on social support in comparison to their inactive or irregularly active counterparts (Eyler *et al.,* 1999). Moreover, employees from cultures that emphasize individualism might actually prefer to be active on their own rather than in groups (King, Taylor, Haskell, and DeBusk, 1990). Evaluating the study participants' preferences for or receptivity to different mediums or modalities of physical activity interventions might be an interesting line of future research.

In considering the findings of the present study, several limitations should be kept in mind. First, this was a quasi-experimental study employing a pretest-posttest, one-group design. Without having a control group it is impossible to know whether the changes observed were due exclusively to the intervention or whether there were other factors that contributed to the observed changes (*e.g.,* attention, history, maturation). That said, this was a real-world study occurring in a real-world setting, which we view as the strength of the study. Second, while the measures used in this study were psychometrically sound, they were all self-report measures and therefore item interpretation, recall, and social desirability were not controlled for. Third, the psychological variables examined in this study relied on ordinal/quasi-interval level data and, therefore, there were floor and ceiling effects that suppressed the full range of responses one may get when using interval or ratio level measures. Fourth, while the overall sample size was reasonably large (particularly for an intervention study), the number of participants in the precontemplation stage at baseline was quite small. Recruiting people who, by definition, are not interested in physical activity remains a challenge (Kosma, Cardinal, and McCubbin, 2004).

Within the context of these limitations, to our knowledge this is the first trial to fully employ the transtheoretical model of behavior change as an organizing framework with the program being delivered using an emerging intervention technology (*i.e*., e-mail) among Korean adults employed at a single worksite. The study's retention rate was quite high (*i.e.,* 86.50%) across the 16-week intervention, which is indirect evidence supporting the participants' receptivity to this intervention modality. This novel application has resulted in preliminary support for this intervention modality within a non-western

sample, provided further support for the construct validity of the transtheoretical model, and opened new lines of future inquiry.

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