Transtheoretical Model Based Exercise Counseling Combined with Music Skipping Rope Exercise on Childhood Obesity

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Purpose: The purpose was to evaluate the effects of a transtheoretical model (TTM) based exercise counseling offered with music skipping rope exercise on components of the TTM (stages of change, decisional balance, and self-efficacy), body mass index, glucose, and lipid profile of overweight/obese children in Korea.

Methods: This study used a nonequivalent pretest and posttest experimental study design. A total of 75 overweight/obese children participated in the study. Eight sessions of exercise counseling combined with music skipping rope exercise for 12 weeks were offered for children in the experimental group, while one session of exercise counseling with music skipping rope exercise for 12 weeks was offered for children in the control group. Outcomes were measured at baseline, and 6 months after the intervention.

Results: After the intervention, self-efficacy significantly improved among children in the experimental group (p = .049), while these children maintained their baseline BMI at 6-month follow-up (p > .05). Among children in the control group, BMI significantly increased (p < .05). Fasting blood sugar significantly increased for both groups after the intervention (p < .05). However, a greater increase was observed for the control group.

Conclusions: Our study partially supports the hypothesis that a TTM-based exercise intervention is effective in maintaining BMI and improving self-efficacy of overweight/obese children. The TTM-based counseling combined with exercise classes has potential to control weight among overweight/obese children, while involvement of parents and children in the development of the theory-based intervention may generate further benefits regarding health and well-being of overweight/obese children.

Introduction

Childhood obesity is a serious public health concern in that it has increased two-fold during the last decade in Korea [1]. Obese school-age children are vulnerable to multiple health problems including high blood pressure, high cholesterol, impaired glucose tolerance, asthma, and joint problems, as well as greater risk of psychological problems, such as poor self-esteem [2,3]. In addition, obese children are more likely to become obese adults, leading to a number of serious health problems, including cardiovascular disease, diabetes mellitus, and cancer [2]. Genetics, unhealthy dietary patterns, physical inactivity, and food and physical activity environments are some of the contributing factors of childhood obesity [2]. Physical activity has metabolic effects on childhood obesity including decreasing fat stores, increasing caloric expenditure, and increasing tolerance to glucose use, while improving lipid profile. Accordingly, exercise attenuates the damage associated with childhood obesity [4].

Despite efforts made to curtail increasing obesity among school-age children in Korea, intervention effects seem limited [3,8]. Researchers have offered school-based counseling programs for promotion of physical activity targeting overweight/obese school-age children, and found that the interventions were effective in decreasing body mass index (BMI) or body fat [3,5]. Oh [6], who evaluated a music rope-jumping exercise program offered to
overweight/obese school-age children, reported a significant decrease in BMI and body fat after the intervention. However, in these studies, only the short-term intervention effects were evaluated, while the combined effects of counseling and music skipping rope exercise have not been evaluated. In addition, theory-based programs have rarely been conducted, while the needs of participating children and their parents were not incorporated into development of the interventions [5].

Among the cognitive behavioral factors associated with physical activity, attitudes and perceptions about physical activity, lack of motivation, and perceived barriers contribute to reduced physical activity, while parental and social support increase physical activity in school-age children [7]. Former studies reported that physical activity interventions based on the transtheoretical model (TTM) were effective in decreasing BMI of obese school-age children [5], and promoting physical activity among young adults [8]. Thus, based on the TTM and a needs assessment of children and their parents, an intervention incorporating tailored exercise counseling combined with music skipping rope exercise was developed and administered to overweight/obese school-age children. The current study was designed to evaluate the long-term effects of the intervention using multiple dimensions of indicators to measure program outcomes.

The TTM has been used to explain physical activity and diet behavior change in obesity [5,9]. The core constructs of the TTM include stages of change, processes of change, decisional balance, and self-efficacy. Stages of change explain behavior as a continuous process moving through five stages: pre-contemplation (having no intention of changing a behavior within the next 6 months), contemplation, preparation, action, and maintenance (having maintained the behavior for more than 6 months) [10]. The basic premises of the TTM include use of different processes and strategies to move from one stage to another; thus tailored interventions specific to the stages of change are needed. There are ten processes of change that people use to progress through five stages. For those in early stages (precontemplation, contemplation, and preparation stages), cognitive and affective processes (experiential processes) are more effective, whiles for those in later stages (action and maintenance stages), behavioral processes are useful [10]. Decisional balance is composed of pros and cons of change that weigh into the individual choice of behavior change. Regarding decisional balance, providing information on benefits (pros) will help individuals who are in early stages to foster motivation for behavior change, while learning strategies to overcome barriers (cons) will enable individuals who are in later stages to adopt and/or maintain behavior [10]. Self-efficacy refers to an individual's confidence in changing or maintaining a specific behavior in adverse situations [10]. Self-efficacy mediates the relationship between behavioral processes and stage of change, and between decisional balance and stages of change [11].

Studies using the TTM as the theoretical framework have been criticized in that interventions were tailored only to stages of change, while other components (decisional balance, processes of change, and self-efficacy) were neglected [12]. Other researchers contended that the TTM focuses on individual motivation for behavior change, without considering social and external factors [13]. The TTM-based physical activity intervention studies were primarily conducted with adults or patients in community or clinical settings [8,12], with only a few studies conducted in a school setting targeting overweight/obese children, especially in Korea [5]. TTM-based interventions combined with physical activity and diet interventions can produce significant outcomes in health behavior change [9]. Indeed, although TTM-based exercise counseling was offered to obese school-age children, researchers did not include exercise classes; they combined individualized counseling with group-based counseling, thus less amenable to stage-matched intervention [5].

The aim of our study was to examine the effects of eight sessions of TTM-based tailored exercise counseling offered with music skipping rope exercise classes in modifying stages of change, decisional balance, self-efficacy, and BMI, whether it would improve the glucose tolerance and lipid profile of overweight and obese school-age children.

Methods

Study design

Our study was an experimental study with a nonequivalent pretest and posttest design.

Setting and Sample

Overweight/obese children were recruited from a convenience sample of four elementary schools in one metropolitan area in South Korea, in which school health teachers and school administrators agreed to participate. Using cluster randomization, schools were randomly assigned to experimental (2 schools) and control groups (2 schools). Overweight/obese children were identified based on health screening results (which is conducted annually in schools by health teachers), and health teachers sent letters to parents of these children. The letters included the purpose of the study, and parental consent forms were attached. A total of 76 parents of overweight/obese children agreed that their children could participate in our study, however one child refused to give a blood sample at baseline data collection. Accordingly, 75 overweight/obese children participated in our study (experimental: n = 48, control: n = 27).

Inclusion criteria were those (a) with values equal to or greater than 85% BMI-for-age according to an age-specific and gender-specific reference growth chart for Korean children [14], (b) whose primary language is Korean, (c) enrolled in the third or upper grades in four participating elementary schools, and (d) without chronic health problems. Exclusion criteria were overweight/obese children (a) who have chronic diseases, (b) who were absent from school on the day of data collection, and (c) who refused to give blood samples.

Power analysis was performed using G*Power 3.1.9. With an effect size of 1.05, which was determined based on a previous study [5], 50 participants are required to produce 95.0% power (α = .05). Allowing for 30.0% attrition, 75 participants were recruited.

Ethical considerations

This study was approved by the Institutional Review Board of Inha University Hospital located in Incheon, Korea (No. 10-2093). Data were collected anonymously, and confidentiality of the participants was secured. Survey materials with written consent forms were stored in a locked file cabinet located in the principal investigator's office. Participants were informed that they could drop from the study any time they wanted without any consequences. Written consent was obtained from parents who agreed to participate, and verbal assent was obtained from children before pretest data collection.

Measurements

General characteristics included age and gender of children. BMI (kg/m²) was calculated from height (m) and weight (kg) measured using electronic scales (Dong Sahn Jenix, Seoul, Korea [DS-103],
with children wearing light clothes and no shoes. Physiological examinations included fasting blood sugar (FBS), total cholesterol, triglyceride, and high-density lipoprotein and low-density lipoprotein cholesterol, and were analyzed using standard enzymatic methods.

**Stages of change**

Stages of change in exercise were measured with one question aimed at classification of the participants to one out of five categories, developed by Marcus and Owen [15]. Our study used a Korean version of the stages of change question, which was translated and modified for use with Korean children [16,17]. Students were asked to select the response category that most accurately described their current exercise behavior or their intention for exercise. An example question included, “I am not performing regular exercise currently and I will not start exercise within the next 6 months” for precontemplation. In measuring exercise stages of change, those who performed any type of exercise for more than 30 minutes per session, and 3 days or more per week were considered to be performing regular exercise, except for time spent in physical education classes in schools. The test-retest reliability of the instrument over a 2-week period was verified in a study targeting Korean adolescents (kappa index = 0.85) [18].

**Pros and cons of exercise**

Fourteen items of decisional balance, developed by Marcus and Owen [15], were used to measure pros and cons of exercise. This instrument was translated and modified by Korean researchers for Korean children [16]. A 5-point Likert scale was used to measure pros and cons of exercise (from 1 = strongly disagree to 5 = strongly agree). Example questions included, for pros of exercise, “Regular exercise will increase energy and interest in school life” and “It is difficult to find time for exercise” for cons of exercise. Higher scores indicated perception of more benefits (pros) and barriers (cons) to regular exercise. Park et al [17] found that Cronbach α ranged from .81 to .87. In the current study, Cronbach α ranged from .85 to .87.

**Self-efficacy**

Five questions developed by Marcus and Owen [15] were used to measure exercise self-efficacy, which was translated and modified by Korean researchers for Korean children [17]. Children were asked whether they have confidence in performing regular exercise in various negative situations, such as negative emotions and bad weather. An example question included “I am confident that I could continue to exercise in bad weather such as snow or rain.” Questions were scored on a 5-point Likert scale (from 1 = strongly disagree to 5 = strongly agree). Cronbach α was .84 in the current study and .86 in the previous study [17].

Two experts in the field of child health nursing were invited to assess content validity of the study instruments. They also examined age-matched appropriateness, and readability and comprehensibility of the study instruments. The instruments were modified for use in the current study based on the experts’ recommendations.

**Interventions**

The experimental group was offered a TTM-based exercise counseling consisting of eight sessions during a 3-month period (4 consecutive weeks for the first month, and every other week for the last 2 months). Two trained nurse intereners visited schools in the experimental group after school hours and provided individualized counseling to each participant for eight sessions in empty classrooms. The two intereners took a 2-day, 15-hour counseling training program provided by the Counseling Psychological Institute in Seoul, Korea. The counseling session lasted approximately 30 minutes for each student per session.

Before developing counseling intervention, a needs assessment was conducted using a focus group technique [19]. Two focus group meetings were conducted with nine parents and six children separately, and the focus group results were incorporated into development of the intervention. Focus group meetings were held in conference rooms located within participating schools. An expert researcher experienced in qualitative research facilitated the focus groups. The principal investigator and a research assistant accompanied the focus group, and probed the questions as needed. Questions for the focus group included concerns of parents and children regarding obesity, barriers to physical activity, and expectations and needs of the counseling program. An example question for parental focus group included “What are barriers and/or difficulties to perform regular exercise for your obese children?” Qualitative data from focus group interviews were analyzed using qualitative content analysis [20]. The results of the focus group were incorporated into the intervention, such as music skipping rope exercise classes, activities that children could do with parents, and strategies to overcome barriers to physical activity.

TTM-based counseling booklets were produced by the research team and exercise counseling was offered using the booklet. Based on the TTM premises, these are the contents of the counseling for each week:

- **(a) Week 1:** Baseline information on obesity and exercise such as causes and problems of overweight/obesity and benefits of exercise (consciousness raising & pros of changing);
- **(b) Week 2:** An assessment of self-image as a physically active or inactive person (self-reevaluation);
- **(c) Week 3:** Identify problem health behaviors and resulting problems (dramatic relief);
- **(d) Week 4:** Strategies overcoming barriers to exercise (cons of changing);
- **(e) Week 5:** Commitment to change using a written pledge and evaluating exercise plans (self-liberation);
- **(f) Week 6:** Parental involvement strategies and giving assignments to perform exercise with parents (helping relationships);
- **(g) Week 7:** Discussion of efforts to overcome barriers to exercise (cons of changing);
- **(h) Week 8:** Self-reflection of past efforts to promote exercise and feedback from intereners (reinforce management).

Although the main contents were developed for each week, tailored counseling was offered based on stage of change of each participant, as assessed by intereners in each counseling session. For those who were in the physically inactive stages (pre-contemplation, contemplation, and preparation stages), experiential processes (e.g., consciousness raising, dramatic relief, and self-reevaluation) and decisional balance (benefits and barriers to exercise) were emphasized, whereas for those in the physically active stages (action and maintenance stages) behavioral processes (self-liberation, helping relationship, and reinforcement management) and self-efficacy were emphasized. During the initial counseling session, goals and expectations of children were explored, and the session also established goals and physical activity plans for week 1. From the second session, intereners evaluated whether students have met their goals, and reviewed exercise practices. They
reestablished goals for the following weeks with students. To build self-efficacy, students were encouraged to establish short-term incremental goals in each counseling session [10]. For students in the control group, trained nurse interveners visited schools and provided counseling booklets and one session of counseling (identical to week 1 intervention for the experimental group) for each student.

Two professors in child health nursing and two school health teachers were invited to verify the validity of the counseling program and booklet. Experts' recommendations included inserting introductory sections at the beginning of the program with purpose, contents, and expected outcomes of the program. They suggested avoiding negative terms such as “irregular” or “unhealthy”, and including a lifestyle checklist for children to review their problem behaviors. The program and counseling booklet were modified for use in the current study based on their recommendations. To maintain intervention fidelity, the principal investigator visited participating schools each week while counseling and music skipping rope exercise classes were conducted to monitor the intervention, and monthly conference meetings were convened with the principal investigator and interveners for discussion and evaluation of the counseling process.

In the counseling program, a weekly 60-minute session of music skipping rope exercise was provided to students in both groups for 3 months (12 sessions). Four professional instructors (one for each school) led a music skipping rope exercise. Study participants in each school gathered after school hours in the school playground or in a gym within the school to participate in the music skipping rope exercise classes on Wednesdays. To increase participation in music skipping rope exercise classes, research assistants made phone calls or sent text messages to parents of participating children 1 day prior to exercise classes each week. Upon completion of the 3-month counseling program, participants were provided certificates that confirmed completion of the eight sessions of counseling program. Booster telephone counseling was provided for children in the experimental group after 3 months of intervention.

Procedure

The principal investigator directly contacted school health teachers via telephone using the list provided by the city office of education. Most schools refused to participate in our study because they have part-time or no health teacher, school administrators did not allow participation, or health teachers were too busy. We were able to recruit four schools that employed full-time health teachers. Using the school newsletters, health teachers of the four participating schools identified and provided contact information for eligible children and their parents who agreed to participate. Research assistants made phone calls to parents of eligible children and provided detailed information regarding data collection procedure and intervention schedule. Among the 75 children who participated in the baseline data collection and experimental and control interventions, four children did not participate in the posttest data collection at the 6-month follow up. Reasons for not completing the posttest data collection included transfer to another school, refusal of blood draw, illness, or did not skip breakfast for blood test. Accordingly, 71 children participated in the posttest data collection (experimental group, n = 48; control group, n = 23) (Figure 1).

Self-report questionnaires were used for measurement of general and psychosocial characteristics. Height and weight measurement was performed by trained nurses after completion of the survey. Blood samples were drawn after overnight fasting by medical technicians dispatched from the Planned Population Federation of Korea (PPFK) and sent to a clinical laboratory within the PPFK for blood testing. PPFK is a nonprofit organization providing services for the health of family, youth, and the elderly.

Survey data collection, anthropometric measurement, and drawing of blood samples were performed in the school health clinic located within each school before class began in the morning. Research assistants made phone calls to parents of participating children prior to blood tests and instructed parents that students should skip breakfast for blood testing on the day of data collection and should not eat anything after 9 o'clock on the day before undergoing blood tests. Breakfast was provided after taking the blood samples, and each participant received a $5.00 gift card. Those collecting data were blinded to the group assignment. Baseline data collection was conducted between April and May 2011, and posttest (at 6 months) was conducted in December 2011.

Data analysis

IBM SPSS 20.0 for Windows was used for data analysis (IBM Corp, Armonk, NY, USA). Independent t tests and chi-square tests compared baseline characteristics between groups. Paired sample t tests and Fisher's exact test assessed changes in physiological and psychosocial variables, and BMI before and after the intervention. Wilcoxon signed-rank tests and Mann-Whitney U tests were used if the data violated the assumption of normal distribution. Two-tailed null hypotheses of no difference were rejected if p values were less than .05.

Results

Homogeneity test for general characteristics and outcome variables

The mean age was 10.77 years (SD = 1.17 years, range 8–13) for the experimental group and 10.26 years (SD = 0.86 years, range
8–12) for the control group. Boys comprised 56.3% of the experimental group and 55.6% of the control group. The mean BMI was 24.35 kg/m² (SD = 2.73 kg/m²) for the experimental group and 24.22 kg/m² (SD = 2.24 kg/m²) for the control group. FBS for the experimental group (Mean ± SD = 97.72 ± 9.83 mg/dL) was higher than that for the control group (Mean ± SD = 90.12 ± 6.67 mg/dL), and differed significantly between groups at baseline (p < .001). The mean self-efficacy was 15.75 (SD = 5.76) for the experimental group and 16.93 (SD = 4.57) for the control group (range 5–25). Of the experimental group, 35.4% (n = 17), and 48.1% (n = 13) of the control group were in action and maintenance stages (physically active) at baseline (p > .05). Other than FBS, general, physiological, and psychosocial variables, and BMI did not differ significantly between groups at baseline (p > .05) (Table 1).

**Changes in physiological variables and BMI after intervention**

FBS increased significantly 6 months after the intervention for both groups (p < .05), while other physiological variables did not change at posttest (p > .05). BMI increased significantly at posttest in the control group (p = .010), but did not change in the experimental group (Table 2).

**Changes in psychosocial variables after intervention**

Compared with pretest, self-efficacy significantly increased among children in the experimental group (p = .049), while that of the control group was not significant. Pros and cons of exercise did not significantly change after the intervention for both groups (p > .05). Regarding stages of change, 36.2% of experimental group compared with 17.4% of control group had advanced their exercise behavior by at least one stage. However, these differences were not statistically significant (Table 3).

### Discussion

Our study examined the effectiveness of eight sessions of TTM-based exercise counseling combined with a 12-week music skipping rope exercise intervention in modifying stages of change, decisional balance, self-efficacy, and BMI, while improving glucose tolerance and lipid profile of overweight/obese school-age children compared to those who received music skipping rope exercise intervention.

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**Table 1** Homogeneity Test for General Characteristics and Outcome Variables (N = 75).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control (n = 27)</th>
<th>t or Z (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>27 (56.3)</td>
<td>15 (55.6)</td>
</tr>
<tr>
<td>Female</td>
<td>21 (43.7)</td>
<td>12 (44.4)</td>
</tr>
<tr>
<td>Stages of change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precontemplation</td>
<td>2 (4.2)</td>
<td>1 (3.7)</td>
</tr>
<tr>
<td>Contemplation</td>
<td>17 (35.4)</td>
<td>8 (29.6)</td>
</tr>
<tr>
<td>Preparation</td>
<td>12 (25.0)</td>
<td>5 (18.5)</td>
</tr>
<tr>
<td>Action</td>
<td>5 (10.8)</td>
<td>6 (22.2)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>8 (16.6)</td>
<td>7 (25.9)</td>
</tr>
<tr>
<td>n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>25.6 (4.2)</td>
<td>26.2 (5.6)</td>
</tr>
</tbody>
</table>

Note: BMI = body mass index; HDL = high-density lipoprotein; LDL = low-density lipoprotein
Unanswered responses were excluded from analysis.

**Table 2** Changes in Physiological Characteristics and BMI after Intervention (N = 71).

<table>
<thead>
<tr>
<th>Physiological variables</th>
<th>Group</th>
<th>Baseline (Mean ± SD) (n = 48)</th>
<th>Post-test (Mean ± SD) (n = 23)</th>
<th>t or Z (p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting blood sugar (mg/dL)</td>
<td>Experimental</td>
<td>99.72 (9.83)</td>
<td>100.07 (8.94)</td>
<td>-3.00 (.003)</td>
</tr>
<tr>
<td>Control</td>
<td>90.12 (6.07)</td>
<td>101.55 (6.72)</td>
<td>-8.10 (.001)</td>
<td></td>
</tr>
<tr>
<td>Total cholesterol (mg/dL)</td>
<td>Experimental</td>
<td>175.49 (29.24)</td>
<td>172.57 (29.29)</td>
<td>-0.85 (.397)</td>
</tr>
<tr>
<td>Control</td>
<td>171.40 (19.87)</td>
<td>178.36 (29.48)</td>
<td>-1.26 (.223)</td>
<td></td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>Experimental</td>
<td>106.32 (48.77)</td>
<td>114.11 (47.46)</td>
<td>-1.18 (.238)</td>
</tr>
<tr>
<td>Control</td>
<td>129.68 (52.25)</td>
<td>132.91 (64.29)</td>
<td>-0.20 (.846)</td>
<td></td>
</tr>
<tr>
<td>HDL cholesterol (mg/dL)</td>
<td>Experimental</td>
<td>46.55 (11.17)</td>
<td>45.74 (9.82)</td>
<td>-1.08 (.280)</td>
</tr>
<tr>
<td>Control</td>
<td>43.88 (9.19)</td>
<td>45.95 (11.20)</td>
<td>-1.26 (.223)</td>
<td></td>
</tr>
<tr>
<td>LDL cholesterol (mg/dL)</td>
<td>Experimental</td>
<td>104.35 (21.01)</td>
<td>103.76 (24.49)</td>
<td>-0.02 (.981)</td>
</tr>
<tr>
<td>Control</td>
<td>101.60 (15.94)</td>
<td>105.86 (22.77)</td>
<td>-1.21 (.241)</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>Experimental</td>
<td>24.35 (2.73)</td>
<td>24.37 (2.73)</td>
<td>-0.02 (.981)</td>
</tr>
<tr>
<td>Control</td>
<td>24.22 (2.24)</td>
<td>24.99 (2.55)</td>
<td>-2.50 (.010)</td>
<td></td>
</tr>
</tbody>
</table>

Note: BMI = body mass index; HDL = high-density lipoprotein; LDL = low-density lipoprotein

* Wilcoxon Signed-rank test.
classes only. The study results showed that after the intervention, self-efficacy significantly improved among children in the experimental group, while these children maintained their baseline BMI 6 months after the intervention compared to those in the control group, whose BMIs significantly increased. The results of our study indicate that combined approach of TTM-based exercise counseling and exercise classes was more beneficial to overweight/obese children than exercise classes alone. In addition, development of the theory-based intervention incorporating information obtained from the needs assessment of children and parents increased the intervention effectiveness.

The TTM has been criticized in that it does not appear to have long-term effects, and is difficult to apply to complex health behaviors such as physical activity [21]. However, demonstration of significant differences between the experimental and control groups in BMI and self-efficacy at posttest (6 months after the intervention) indicates that our study partially supports the effectiveness of the TTM-based exercise intervention.

An evaluation of a 12-week music skipping rope exercise intervention immediately after the intervention found that body weight and body fat decreased among obese children [22]. However, they did not investigate the long-term effects of the interventions. Without theory-based behavior modification approaches, immediate treatment effects taper over time when the intervention is removed [23]. Therefore, positive effects at 6 months after the intervention in our study may indicate that TTM-based exercise counseling combined with music skipping rope exercise has the potential to produce long-term health benefits among overweight/obese children.

Self-efficacy improved significantly after the intervention among students in the experimental group, in agreement with other studies [5,16]. Change in mediators such as self-efficacy, as a result of school-based physical activity intervention, has long-term effects on improving exercise participation among obese children in Netherlands [24]. Thus, many programs aimed at enhancement of behavior modification have adopted self-efficacy programs [5,11]. In our study, intervention components for enhancement of self-efficacy included establishment of weekly behavior goals and strategies for overcoming barriers to exercise. These strategies may have resulted in successfully increasing self-efficacy of children, contributing to weight management among children in the experimental group.

Regarding BMI change, the current study was partially successful. Although no significant changes in BMI were observed among children in the experimental group, those in the control group showed significantly increased BMI after 6 months. BMI increases continuously among elementary children as they go from first to sixth grade [25], and seasonal variations in BMI occur among elementary school children. BMI increases during winter among all children, and increases during summer as well among obese children [26]. Changes in lifestyle behavior such as insufficient physical activity and excessive food consumption during cold weather, and use of air conditioning in summer that encourages children to stay indoors may lead to weight gain [26].

In our study, baseline data collection was performed in spring, and posttest data collection was performed in winter. Therefore, seasonal variations in BMI (increase in BMI during summer and winter) may have led to no change in BMI among children in the experimental group despite the counseling intervention, while BMI in the control group significantly increased without counseling intervention in our study. Therefore, in terms of control and preventing aggravation of obesity, exercise counseling combined with music skipping rope exercise classes was more effective in weight management rather than providing exercise classes alone.

As mentioned before, earlier studies mostly examined the short-term effects of weight management interventions and reported decrease in BMI among overweight/obese children [3,5]. However, studies of prolonged effects of obesity control efforts have been scarce, especially with 6 months of observation. Significant weight decrease after 24 months of weight management intervention has been reported [23]. However, the authors did not observe significant weight change before the end of 24 months. They argued that weight loss is an outcome of multiple behavior changes, and suggested that those in earlier stages may take longer to progress to action stages, while taking even longer to demonstrate significant weight loss [23].

Our study found that a higher proportion of children in the experimental group (36.2%) advanced their exercise behavior by at least one stage compared to the control group did (17.4%), but the difference was not significant. Measurement of stages of change was centered on exercise behavior. Thus, provision of 12-week music skipping rope exercise for both groups might have influenced the result of the exercise stage. On the other hand, stages of change measures people’s intention to take action during the next 6 months or modification of behavior during the past 6 months [10]. Therefore, evaluation of intervention outcome after 6 months may have undermined the intervention effects in terms of changes in exercise behavior over the 6-month period.

The results of the current study showed that none of the biomarkers changed at posttest except for FBS. FBS significantly increased for both groups, although a greater increase was observed for the control group. FBS and impaired fasting glucose are significantly higher in winter and lower in spring. Cold temperature may decrease leisure time physical activity, and induce changes in eating patterns, possibly explaining seasonal differences in FBS [27]. As mentioned before, baseline blood tests were performed in spring, and follow-up blood tests were performed in winter. Therefore, seasonal variations in FBS may have affected the study results since increased FBS was observed at postintervention period for both groups in our study.

Similarly, seasonal differences in serum lipid levels (cholesterol, LDL, and triglyceride) occur among Koreans, with lipid concentrations lower in spring and summer, and elevated in fall and winter [28]. Thus, our failure to find statistically significant results may have been due to seasonal variations in serum lipid levels. At baseline, all biomarkers were within normal range for both groups. As such, as long as these children were within the healthy range to start with, there was limited range for change.

Contrary to our findings, a study reported a significant decrease in FBS after a 9-month exercise intervention in obese children [29]. Exercise lowers serum glucose by increasing insulin sensitivity, and exercise stimulates cells to consume glucose and use it for energy [30]. Therefore, overweight/obese children and their parents should be informed of the importance of regular exercise in controlling serum glucose as well as obesity.

The study limitations included generalizability limited to overweight/obese children in Korea. The current study used cluster randomization at school level, which might have reduced the risk of contamination of treatment. However, groups were not equivalent at baseline due to use of cluster randomization rather than random assignment at the individual level. In addition, our study did not control for confounding variables that might have affected intervention outcomes such as school environmental and/or familial characteristics that might limit the study results.

**Conclusion**

Our study partially supports the effectiveness of the TTM-based exercise intervention, and found that combination of theory-based
counseling and exercise classes was effective in improving self-efficacy of overweight/obese children, while it yielded long-term effects on BMI. Despite criticism of the TTM regarding its complexity and difficulties in intervention application, there are certain advantages of using the components of the TTM (stages of change, processes of change, decisional balance, and self-efficacy) in behavior modification interventions as identified in our study. The increasing prevalence of overweight/obesity among children poses a significant threat to health and well-being of children [2]. Community-based interventions for promoting physical activity in children have potential for prevention and control of obesity among children. Future studies are needed to verify prolonged effects of weight management intervention after 24 months, and to investigate long-term change in growth rates, as well as to evaluate improvements in physiological and psychological health among overweight/obese children as a result of weight control efforts.

**Conflicts of interest**

The authors declared no potential conflicts of interest.

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