

Original article

Mental training can improve physical activity behavior in adolescent girls

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Abstract

Background: Lately, physical activity (PA) in young girls has been frequently discussed, thus we were interested to examine whether a mental training intervention can increase the level of PA in young girls.

Methods: A sample of 56 girls aged 15.4 ± 0.3 years (mean \pm SD) was assigned to either the intervention or control group. We then conducted a 6-week mental imagery training program on young female participants. PA was evaluated with objective accelerometer monitors. Physical self-concept was also assessed in all participants.

Results: Young females' PA increased after a course of mental training compared to female participants in control group. Furthermore, physical self-concept improved related to mental training program.

Conclusion: Exercise imagery may be an effective method of PA increase besides psychological enhancement in young girls.

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1. Introduction

Adolescents in high school years show a decline in level of physical activity (PA); whereas girls experience poorer state than boys. Several findings addressed a wide range of decrease in PA (64%–100%) across different populations, particularly in girls from developing societies.¹ Although several public health guidelines for PA have been established, a majority of young girls do not meet PA guideline² and in turn, the prevalence of metabolic disorders related to sedentary lifestyle is growing in young population groups such as girls of developing countries.³

Several home and community based interventions have been introduced to help young girls become more active.^{4–6} Most of the interventions are focused on school activities such as physical education classes and environmental changes to fulfill the requirements of PA programs.⁷ Surprisingly there are few data on PA interventions in high school

girls; while previous studies dominantly examined elementary children.⁵ Thus providing a novel solution to youth inactivity remains a major universal challenge.⁸

On the other side, psychological demands of PA in girls have been mostly overlooked. Regular PA is indicated as a determinant of physiological and psychological well-being.⁹ Studies showed that mental readiness is very critical to adopt a PA program.¹⁰ Recently, researchers have addressed the mental training programs to gain psychological or physical benefits of PA.^{11,12} They indicated that psychological exercises may help individuals to image themselves in better shape, more physically active or healthier. Indeed mental images including representations of goals, actions or behaviors may be rehearsed either as hypothetical events or reconstructions of real events. Similar to actual images, mental images can therefore be helpful to motivate individuals for the purpose of health behaviors.¹³

In that vein for several years, mental imagery techniques have been used by athletes to enhance the skills and motivation reaching their ultimate goals.¹⁴ Thus reasonable grounds exist to suggest that non-athlete exercisers can also benefit from mental imagery to imagine their success and enjoyment of

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the exercise process.¹⁵ Furthermore mental images related to goal or process of exercise may be particularly effective in enhancing motivation for physical exercise. Examining sedentary individuals, researchers discussed that increase in action planning or physical self-concept may underlie the influence of mental exercise imagery on level of PA.¹⁶ Based on study of Bandura,¹⁷ including vicarious modeling in the intervention would result in a higher exercise self-efficacy/concept. Vicarious modeling may involve either observation of an explicit exercise behavior or mentally imaging oneself exercising. Mental imagery can further recruit positive physiological and emotional outcomes related to the exercise, thus may strengthen the exercise self-concept attitude.¹⁸

Mental imagery has been demonstrated to have neurological basis that involves the activation of internal models of action. Mirror neurons in premotor and parietal cortex may be responsible for both perception and action of movement behavior.¹⁹ Furthermore, using brain imaging techniques, neuroscientists found a neural network involved in mental imagery including primary motor cortex, supplementary motor area, anterior cingulate cortex, inferior and superior parietal lobules, and the cerebellum.²⁰ Indeed recruiting a large area of brain regions during imagery related to sensory, intention reading, conflict resolution, and emotional regulation as well as planning skills highlights the possible contribution of mental imagery to enhance the health behaviors (i.e., PA) and related psychological skills.²¹

Although previous studies showed benefits of mental imagery to enhance exercise self-efficacy/concept in exercisers or even inactive people,²² so far there are very few imagery interventions with the specific aim to increase exercise self-concept in young females. The current study had 2 central aims: first, to investigate the effectiveness of exercise imagery in their ability to increase exercise behavior over a period of 6 weeks. The mental imagery intervention involves images related to exercise behavior and related psychological and physical outcomes. The second aim of the study refers to the evidence suggesting a link between imagery use and self-concept in exercisers in addition to association of exercise behavior and self-concept. We then hypothesized that girls attending imagery exercises about their PA, health status, appearance, and energy would improve their physical and/or psychological competence.

2. Materials and methods

2.1. Study design

The study measured pre–post differences in a 6-week exercise imagery program. High school girls in the intervention group completed demographic, physical self-concept questionnaires and assessed by accelerometer monitors at Weeks 0 (baseline) and 6 (post intervention). Anthropometrics were also measured at Weeks 0 and 6. Demographics, physical self-concept, accelerometry, and anthropometrics were assessed at baseline and Week 6 for control participants, too. All participants were asked not to change their routine physical education curriculum during the study period.

2.2. Participants

Fifty-six schoolgirls aged 15–16 years old were assigned to the study from 2 high schools in Tehran. While all participants received usual physical education programs, 28 girls were assigned to exercise imagery intervention and the other 28 girls in control group received only recommendations on PA promotion. Participants in 2 sex- and age-matched groups met inclusion criteria and were excluded if they reported any physical impairments that prevent them from PA. Girls and their caregivers provided a written informed consent before data collection. This study was approved by Ethics Committee of Tehran University of Medical Sciences.

2.3. Measures

2.3.1. PA

We used an ActiGraph GT3X monitor (ActiGraph, Pensacola, FL, USA) to assess the PA. The GT3X is a small and light monitor device that provides activity counts as the outcome measure of PA. Larger counts stand for the higher level of activity. This is a reliable and valid instrument based on previous data from healthy populations.²³ The accelerometer monitor was placed on the right hip using an elastic belt for 1 week.²⁴ Caregivers and teachers were asked to record the times that children woke up, wore the ActiGraph on/off and went to bed on a 7-day time sheet. The accelerometry data collected from waking hours were employed to analysis using the ActiLife™ software (ActiGraph). Based on previous studies, the accelerometers were programmed to collect data in 1 min intervals and the output was expressed based on vector magnitude (VM) score as counts per minute (cpm) or overall PA.²⁵ Other variables were provided by dividing the overall PA into 2 categories based on day-time, in-school (08:00–14:00) and after-school (16:00 to bedtime), seeking to examine time–activity patterns. To control for school's finish time, a 2 h gap between 14:00 and 16:00 was considered.

2.3.2. Physical self-concept

Physical Self-Description Questionnaire (PSDQ) with 11 subscales of endurance, strength, coordination, appearance, flexibility, PA, body fat, sports competence, health, global physical self-concept, and global self-esteem was used to assess physical-related psychological competence. There were 6 response options for participants from *strongly agree* to *strongly disagree*. The questions addressed physical perception of participants. For example, how good they are at coordinated movements, how often they do exercise or activities that make them breathe hard, whether they are overweight, and whether they are attractive for their age. The questionnaire showed a good test–retest reliability ($r = 0.83$) and also an acceptable factor validity in previous studies.²⁶

2.3.3. Mental imagery

The exercise imagery intervention was presented to improve participants' perception of PA outcomes. In order to enhance the interest of girls in PA using exercise imagery interventions, several features were proposed by previous studies such as

appearance, health, or energy imagery.²⁷ For example, “health” refers to feeling fresh and healthy; “energy” refers to feeling a sense of vigor and the ability to relieve pressures and stresses using exercise, and “appearance” refers to feeling a sense of good shape and fit body condition.²⁸

In other words, individuals in “health” or “appearance” imagery have experienced health related outcome of exercise (e.g., being in shape or strong). Furthermore, “energy” script included images of an individual drive to exercise, and being energized (e.g., psyched up) or being stress relieved. Each imagery script illustrated a full training session (from warm-up to cool-down) and focused on health or appearance benefits of exercise or energy and rewards obtained from exercise.²⁹

The imagery script was reviewed by the researchers face to face with 4 pilot study participants. Thus in the final script the best descriptions or image scenarios have been included and the script was audiotaped (about 5 min) in the final step. During the imagery practice sessions, the participants were asked to image as vividly, clear, and detailed as possible, and to make the experience personalized for them in the exercise environment where they imagine themselves running or jogging. Indeed they were instructed to begin with a simple image of themselves jogging, and progressively incorporating further details including emotions, body responses and every possible senses related to their exercise. To this end, participants were asked to image a previous experience that they either found exercise really energizing, pleasant or refreshing. Furthermore and for purpose of this study we instructed participants to use first person perspective via mental imagery practice for 2 reasons. First the imagery scripts involved statements related to subjective feeling of health and the positive psychological outcomes related the exercise behavior from the viewpoint of own performer; for example, “Think about feel energized” or “Think you feel fresh”. Second, previous data confirmed that the first person mental imagery (looking out through their own eyes) is more helpful when imaging body movements.

We recommended participants to conduct the imagery sessions in a comfortable place then use the basic directions about where, when, and how to imagine themselves. Participants were also allowed to make images in their own abilities or preferences. Young girls in intervention group have participated in 6 imagery sessions (once per week). An instructor supervised each session while the girls were listening to audiotaped script. To achieve best and most functional images, they were asked to provide feedback and any probable problems with making real images; and finally they were recommended to continue the imagery practice at least 3 times in a week at home or elsewhere they felt comfortable.

To control the imagery use in intervention group, we recruited a self-report manipulation check of imagery use that previously confirmed to use with the students. The participants were instructed to record whenever they commenced an imagery session either supervised or by themselves; also on a 7-point response scale (*very hard to very easy*) they would indicate how easy the images were portrayed in the imagery script. To provide a similar condition in control group (active control group) but with no known effects of exercise imagery,

an audiotaped script including recommendations on health benefits of exercise (e.g., guidelines for PA, or cardiovascular and/or mental benefits) was presented in control group. The girls in control group also listened to the scripts on weekly basis similar to the intervention group.

2.4. Statistical analysis

Descriptive data for general records were reported (mean \pm SD). To assess the effect of imagery interventions, repeated measure analysis of variances (ANOVAs) (2 Groups \times 2 Periods) were conducted for either PA measures or psychological variables. Furthermore effect size (partial η^2) was reported for each analysis. Finally, we conducted ANOVA to examine how possible covariates (body mass index (BMI) and baseline PA) may influence the effects of imagery intervention on PA outcomes. The significant level of 0.05 was used to consider outcome meaningful. Analyses were performed using the SPSS Version 17.0 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

Table 1 shows characteristics of participants at the baseline of study. Only 1 participant from intervention group was missed from analysis due to incomplete data. Analyzing manipulation check results showed that participants in imagery group made 15–30 (23.2 ± 3.7) practice records that was not statistically different from control group ($p = 0.15$). Girls in the imagery group indicated that they could easily develop proper health or appearance images during the training sessions.

ANOVA revealed a main effect of period for VM of PA ($F(1, 53) = 7.879, p = 0.007$), which increased significantly during intervention period. There was an interaction of group and period ($F(1, 53) = 30.190, p < 0.001$), with participants in control group showing no change while participants in the imagery group showed significant improvement in PA. Further analysis showed main effect of period for both PA counts in-school ($p = 0.01$) and after-school ($p < 0.001$). There were interactions between period and group for in-school ($p = 0.002$) and after-school ($p < 0.001$) PA. As shown in Table 2, in-school and after-school PA increased in imagery group but not in control group participants.

Furthermore examining within- and between-group modifications of psychological variables, repeated ANOVAs showed a main effect of period ($F(1, 53) = 7.334, p = 0.009$) for total PSDQ that increased significantly in imagery group during

Table 1
Characteristics of participants completing baseline assessments (mean \pm SD).

	Group	
	Intervention ($n = 27$)	Control ($n = 28$)
Age (year)	15.4 \pm 0.4	15.7 \pm 0.5
Height (m)	1.5 \pm 8.1	1.5 \pm 8.6
Weight (kg)	46.6 \pm 7.9	48.0 \pm 8.9
BMI (kg/m ²)	18.6 \pm 3.0	18.9 \pm 3.2
Waist-to-hip ratio	0.75 \pm 0.05	0.76 \pm 0.06

Abbreviation: BMI = body mass index.

Table 2
Within- and between-group modifications of physical activity (PA) variables (mean \pm SD).

	Group	<i>n</i>	Period (baseline)	Group \times Period (post intervention)	<i>p</i>	η^2
Vector magnitude (cpm)	Imagery	27	1139.0 \pm 301.6	1257.7 \pm 312.6	<0.001	0.314
	Control	28	1130.8 \pm 322.9	1144.4 \pm 341.3		
In-school PA (cpm)	Imagery	27	1098.5 \pm 282.3	1215.9 \pm 294.3	0.002	0.224
	Control	28	1104.1 \pm 311.5	1112.6 \pm 326.4		
After-school PA (cpm)	Imagery	27	1180.4 \pm 331.4	1308.0 \pm 338.9	<0.001	0.334
	Control	28	1158.7 \pm 349.6	1163.6 \pm 354.2		

6-week period of study. There was also a significant interaction between period and group ($F(1, 53) = 32.186, p < 0.001$), indicating girls in imagery group showed an increase in psychological well-being but those in control group remained unchanged. Examining subscales of PSDQ, results showed significant improvement of health, PA, global physical self-concept, appearance, and self-esteem subscales in imagery group but not in control group (Table 3).

To examine which girls may benefit more from the mental imagery intervention, a generalized linear model (GLM) was created and included the VM PA counts as dependent variable, group as fix factor and baseline BMI, waist-to-hip ratio (WHR), total PSDQ, and level of PA as covariates. Results showed that individuals with lower BMI ($F(1, 51) = 8.215, p = 0.001$) or higher psychological scores ($F(1, 51) = 312.256, p = 0.009$) were more likely to have increased PA than those with high BMI or low psychological competence.

4. Discussion

Mental training offered a potential solution to increase psychological well-being. However we found that exercise imagery can improve not only psychological variables including physical self-concept but also the level of PA in school girls.

There are recent studies that indicated positive influences of mental imagery on PA outcomes.^{16,30,31} The exercisers who imagine being fitter and healthier might improve their expectancy from workout program. On the other side, regular

exercisers will improve their imagery ability and easily use appearance or energy images during or after workout sessions.³² Exercise imagery about a healthier body may have a motivational effect on the exercisers. It can decrease the exercise-related stress and increase sense of accomplishment after a workout. Mental imagery of health and appearance might increase young girls' abilities to deal with obstacles to exercising such as time constraints, negative attitude, and lack of motivation.³³

Another possible explanation for the beneficial effect of imagery on PA may be related to the affective response to exercise imagery. Stanley and Cumming³⁴ showed that exercisers using mental imagery would experience a post-exercise emotional enhancement. Indeed exercise imagery (e.g., energy imagery) could result in significantly higher valence and revitalization during or after exercise session. It may suggest that mental imagery produces emotional benefits in addition to exercising.³⁴ In other words, exercise imagery makes it possible to feel more effective (e.g., via emotional enhancement) in executing a physical exercise behavior.¹⁷ In particular, individuals desiring to enhance their exercise-induced feeling states may wish to focus on exercise feelings imagery, combined with appearance-health imagery (e.g., to increase revitalization and harmony).³⁵ To explain the mechanisms underlying effectiveness of exercise imagery, both actual physiological and psychological responses have been discussed. Indeed during imagery, an exerciser involves imaging responses related to his/her workout. If images are emotionally clear, they will present a strong connection between physiological responses (e.g., heart

Table 3
Within- and between-group modifications of psychological variables (mean \pm SD).

	Baseline		Post intervention		Group \times Period	
	Imagery (<i>n</i> = 27)	Control (<i>n</i> = 28)	Imagery (<i>n</i> = 27)	Control (<i>n</i> = 28)	<i>p</i>	η^2
Health	33.5 \pm 4.6	32.7 \pm 4.8	36.9 \pm 4.9	33.0 \pm 4.9	<0.001	0.213
Coordination	26.1 \pm 5.1	26.6 \pm 4.7	27.6 \pm 5.6	25.3 \pm 4.7	0.07	0.101
PA	23.2 \pm 4.6	23.4 \pm 5.9	28.7 \pm 4.8	22.6 \pm 5.6	<0.001	0.235
Body fat	27.9 \pm 4.2	27.3 \pm 3.8	28.4 \pm 4.5	26.4 \pm 3.5	0.12	0.065
Sports competence	28.4 \pm 5.7	28.8 \pm 5.1	28.9 \pm 5.6	27.3 \pm 5.0	0.24	0.053
Global physical self-concept	26.0 \pm 5.3	25.8 \pm 4.6	32.5 \pm 5.6	24.9 \pm 4.3	<0.001	0.294
Appearance	26.3 \pm 4.9	25.9 \pm 5.2	30.6 \pm 5.1	25.9 \pm 5.1	0.001	0.145
Strength	25.9 \pm 5.3	26.2 \pm 4.5	26.7 \pm 5.3	26.0 \pm 4.3	0.16	0.060
Flexibility	23.7 \pm 5.0	23.5 \pm 5.3	25.1 \pm 5.0	23.1 \pm 5.2	0.09	0.089
Endurance	24.1 \pm 6.4	24.7 \pm 6.0	24.3 \pm 6.5	24.2 \pm 5.8	0.35	0.048
Self-esteem	33.6 \pm 4.8	32.9 \pm 5.4	36.8 \pm 5.2	31.8 \pm 5.3	0.001	0.187
Total score of PSDQ	301.6 \pm 38.1	297.8 \pm 36.9	326.5 \pm 38.7	290.7 \pm 36.1	<0.001	0.335

Abbreviations: PA = physical activity; PSDQ = Physical Self-Description Questionnaire.

rate) and exercising situation. Thus when exercisers use exercise-related imagery, they can make best use of their positive emotional and physiological responses to an exercise bout in the actual situation.³⁵ Emotion and cognitive responses elicited by exercise imagery would in turn facilitate an individual's motivation and ability to adhere an exercise program over a long-term period.³⁶

Previous data also indicated that imagery practice could help exercisers to develop their self-concept or efficacy related to PA or their body in exercise. For example, using health or energy imagery, exercisers would show an increase in their self-confidence to exercise even under challenging situations. Furthermore, exercise imagery might result in an increase in coping type skills.³⁷ Correspondingly, by imaging exercise movements, exercisers would report greater self-reliance to complete different aspects of the exercise task (i.e., task competence). Studies from sports literature also supported the hypotheses and showed that using imagery in young recreational athletes was a significant predictor of greater self-confidence to sport experiences.³⁸ In line with abovementioned assumptions, current study showed that exercise imagery was linked to an improvement in task competence, endurance and strength, health and appearance, and finally global physical self-concept related to exercise tasks.³³

The present results also showed that the individuals with lower BMI or higher psychological competence would benefit more from exercise imagery to increase their PA. It means that the healthy weight may contribute in outcome of exercise imagery. Previous findings indicated the negative effect of weight status on children's self-concept or self-esteem for school children.³⁹ However less active female adolescents may be more likely to increase physical self-concept following an exercise intervention.⁴⁰ Also research has indicated that those individuals who have lower BMI have more positive body attractiveness perceptions than those with higher BMI.⁴¹ On the other hand, the overweight people usually underestimated themselves on perceived appearance and even global physical self-concept.⁴² One can argue that positive physical perception related to actual body weight may increase the interest to stay with mental training practices and in turn achieve positive psychological outcomes.

With regard to strengths of this study, to improve PA we used a mental skill technique that was easy to perform, with good adherence and wide-ranging psychological and/or physical benefits. Another novelty of the study is use of mental skills in school setting that may help fulfill routine physical education curriculum. Although the psychological variables related to exercise were assessed by subjective metrics (the commonest approach), we used an objective assessment tool (i.e., accelerometer) to examine the PA behavior. The accelerometry could provide objective measures of PA related to imagery intervention while they were not influenced by subjective errors such as memory biases or familiarization effects.

The present results indicated that exercise imagery can lead to improving both in-school and after-school levels of PA. Although examining the patterns and types of PAs that participants involved in was beyond the scope of this study, current findings suggested that practitioners may benefit from adding

imagery into school-based PA interventions. Further research is warranted to examine what types of school activities will benefit more from imagery training. Another area recommended for future research was to examine which time spaces (e.g., recess/lunch time or physical education class) are more appropriate for imagery training in school system.

However, there are some caveats to this study. The intervention period of this study was not long enough to improve a wide range of PA outcomes. We did not objectively monitor (e.g., electromyography) exercisers during imagery training, while it could help to know whether there were small muscle contractions during imagery of exercising. Particularly it could be helpful to monitor the participants in active control group during listening to the audiotape script. However electromyographic assessment for all the training sessions would likely disrupt the training. These results must be interpreted and generalized with caution since the sample was not representative of all the young school girls. And eventually further studies are needed to confirm these findings, particularly by using long-term imagery programs in larger samples. In conclusion, we indicated that exercise imagery may facilitate both the PA and the psychological well-being in young girls.

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Authors' contributions

MGN contributed to the study design, acquisition of data, analysis and interpretation of data and drafting of manuscript; AHM contributed to the study design, helped to draft the manuscript and contributed to critical revision; RK contributed to study conception and design, drafting of manuscript and critical revision; MAE contributed to acquisition of data and also critical revision; MS contributed to analysis and interpretation of data, drafting of manuscript and critical revision. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

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