Physical Activity Review vol. 4, 2016

Original Articles

DOI: http://dx.doi.org/10.16926/par.2016.04.02

A comparison of two aerobic training methods (running vs rope jumping) on health-related physical fitness in 10 to 12 years old boys

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Funds Collection

Hamid Arazi [1ACDE], **Aliakbar Jalali-Fard** [2BCDE], **Hamzeh Abdinejad** [1CD]

[1] Department of Exercise Physiology, Faculty of Sport Sciences, University of Guilan, Rasht, Iran.
[2] Department of Physical Education, Islamic Azad University, Rasht Branch, Rasht, Iran.

Abstracts. *The purpose of this study was to compare of two aerobic training methods on health-related physical fitness in 10 to 12 years old boys. Thirty-three male students (age 11.27±0.64 year, weight 40.58±9.03 kg, height 151.45±6.34 cm) were recruited from preliminary school and randomly were assigned into rope-jump training (n=12), running training (n=11) and control (n=10) groups. Due to the grouping, each for 8 weeks did the rope jumping or running. Before and after the 8-week training period, factors of health-related fitness, including flexibility, muscular endurance, aerobic power and fat Percentage of the subjects were measured. The results indicated a significant positive effect of rope-jumping training on aerobic power, muscular endurance and body composition and meaningful improvement of aerobic power and body composition by running training (p≤0.05). Due to increasing urbanization and lack of space in homes and schools, rope-jump training can be a good alternative rather than running for physical fitness promotion.*

Keywords: rope-jump, running, aerobic power, physical fitness

INTRODUCTION

Physical inactivity among youth and its relation to heightened incidences of disease, such as childhood obesity and type 2 diabetes mellitus, has become a global health concern [1]. Despite increasing public awareness about obesity and its complications, the prevalence of obesity in children continues to increase. Epidemiology studies show that the prevalence of obesity in children is about 25% higher than the prevalence in adults [2]. The increased prevalence of obesity in children in developed countries and developing has caused obesity to become a global issue. A study by the World Health Organization (WHO) in developing countries, the statistics of overweight children in the Middle East has been relatively high compared to other developing countries [2,3]. Some studies have reported that regular exercise and better physical fitness were associated with better selective attention in healthy adolescents

[3]. One potential approach to counteract childhood obesity is to increase physical activity (PA), which is associated with decreased risk factors of cardiovascular diseases (CVD) such as insulin resistance, hypertension, and adiposity [4]. Researchers in the past decade have revealed that young people are living sedentary lives and becoming more obese, which may affect their future health and habitual PA [5]. According to WHO, PA refers to any bodily movement requiring energy utilization such as walking, swimming and doing household chores [6]. PA is a lifestyle factor with an important role on health across the lifespan. In adolescence, several studies have reported that high levels of PA might have a beneficial impact in both fatness and fitness. [7]. Both cardiorespiratory and muscular fitness have shown to be associated with traditional and emerging CVD risk factors. The available information suggests that the deleterious consequences ascribed to high fatness could be counteracted by having high levels of cardiorespiratory fitness. In addition, both cardiorespiratory and muscular fitness seem to have a combined and accumulative effect on cardiovascular profile in young people [8]. Tolfrey et al concluded that the majority of intervention studies have suggested that regular aerobic exercise has little, if any, influence on the lipid and lipoprotein levels of children and adolescents [9].

Additionally, Regular participation in PA not only benefits adolescents and children by strengthening muscles, increasing bone mass, sustaining oxygen uptake, and reducing risk of cardiovascular disease and other chronic diseases, but also helps to improve self-esteem, increase self-consciousness and reduce anxiety and stress [10,11]. In other hand, participation in aerobic exercise improves overall cardiovascular risk and may prevent risk factor acquisition over time [12,13,14]. Gallahue believed that physical fitness was not limited to one kind of talent, skill, or ability. Physical exercises can help with health improvement, the expansion of physical activity types, and improvements of the quality of life. In contrast, a lack of exercise will result in the decrease of body muscle and functioning ability, in addition to being subject to chronic diseases. One can achieve a better quality of life through moderate exercises in order to improve or maintain physical fitness [15]. If sedentary alternatives are not available most young children will play or invent active ways of passing time that involve PA. Based on Janssen and LeBlanc children and youth 5-17 years of age should increase the time they spend on moderate-to vigorous intensity PA by 30 minutes per day, and over a 5 month period progress to adding an additional 90 minutes of daily PA [16]. When rope jumping, it is necessary to coordinate the upper and lower body to maintain balance and rhythm. Rope jumping can enhance the precise coordination of multiple muscle groups, which is why it is used widely in athletic training programs [17]. Rope jumping combines the angular momentum of the rope and vertical displacement of the body [18]. Also, rope jumping involves upper and lower synchrony (hand-foot coordination) where positioning and timing is critical [17,18]. The ability of time reproduction makes it possible to reproduce specified time periods with great precision [19]. Rope jumping skill involves good perception of time reproduction.

Rope jumping is a general activity. It usually used in recreation, sports, and physical education programs [20]. Rope jumping, an exercise of continuous and recurrent movement skills, is divided into the mid-air stage and the landing stage. For each hop, joints and muscles need to be involved in different roles, so that given the proper training they will contribute to the development of body muscles and bones. Rope jumping requires the coordination of several muscle groups to sustain the precisely timed and rhythmic movements that are integral to the exercise. It is the coordination of these muscle groups that increases the athlete's capacity for dynamic balance. It can also be used to develop the coordination of neuromuscular skills, muscular strength, and cardiovascular endurance [21,22]. Rope jumping burns calories and builds strength in the upper and lower body [22]. Researcher indicated that jumping rope involved the muscles of the arms and the legs, and improved cardiovascular functions and

metabolism. In addition, it helped develop coordination, balance, agility, rhythm, and speed in the lower limbs, and built static and dynamic muscular endurance; which were especially important for performing stable gestures and repetitive movements [23]. In general, the training effects associated with increased physical activity in children are considered small but positive [24], with the benefits outweighing the potential risks. It is clear that young children enjoy active play. Appropriate PA is one of the main determinants of fitness [25,26]. Living in areas distinguished by population size can be associated with differences in eating habits, access to sport facilities and opportunities for PA, among others. This environmental exposure might determine lifestyle behaviuor and cardiovascular risk [27,28] and it might be associated with fitness levels. Therefore, it is evident that a successful health intervention programme must be initiated at an early age, continued and repeated over time [29]. Specially, rope jumping training compared to commonly likely can accompanied by same adaptation related to physical fitness. Based these this study was design to compare of two aerobic training methods (running vs. rope jumping) on health-related physical fitness in 10 to 12 years old boys.

METHODS

Subjects

Thirty-three middle school male students (age 11.27±0.64 year, weight 40.58±9.03 kg, height 151.45±6.34 cm) were recruited from pre-high school and randomly were assigned into rope-jump training (n=12), running training (n=11) and control (n=10) groups. Due to the grouping, each for 8 weeks did the roping or running. Before and after the 8-week training period, factors of health-related fitness, including flexibility, muscular endurance, aerobic power and Percentage fat of the subjects were measured. Subjects were not participating in any regular physical activities except school physical education class. Subjects in the exercise group participated in jump roping exercise and running group participated in running exercise in addition to regular physical education class, while the control group participated in only a regular physical education class.

Measurements included physical fitness and body composition, body mass and percentage of body fat calculated from skin-fold thickness. Measurements of the musculoskeletal system included abdominal muscle endurance and trunk flexibility. All measurements were taken at the beginning of the programme and at the end of weeks 8 by the same examiner, who was an experienced tester, to minimize inter-tester variability and measurement error. The body flexibility test aimed to evaluate generalized flexibility of the shoulders, trunk and hips with a flexibility test device. The examiner provided instructions to the participants prior to the assessment. During the test, students sat on the floor with their head and upper body upright, and their legs placed together with full extension. Both feet were placed flat against the test device. Subsequently, the students inhaled and exhaled slowly while stretching the upper body, slowly bending forwarded as much as they can and pushing the measure guide with their middle fingers. The student maintained the full extension for a while and the distance was recorded from the measure guide. Each participant performed the extension three times with 30 seconds' rest in between. The greatest reach distance was used to represent. For abdominal muscle endurance, the maximum number of sit-ups that subjects performed in one minute was recorded. During the sit-up test, subjects assumed a crook lying position on a mat with both hands placed at the back of the neck. Their legs were stabilised above both ankles by the researcher. They had to raise their trunk completely off the mat until it made a 60° angle with the floor. Body fat was calculated from the prediction equation of Slaughter et al (1988) (percentage body fat = 0.610 x(sum of skin-fold of triceps and calf) + 5). Body mass of each subject was taken with a simple weighing scale that was calibrated before

Table 1. Rope-Jump and running training program

Intensity			Exercise details			
Week	Intensity (jumping /min)	Intensity (HRmax %)	Warm up (10 min)	Rope jump training	Running training	Cool down (5 min)
1	65	60	Stretching	65 rep × 3 min with 1.30 min rest (21 min exercise)	5set × 200m with 3 min rest (1000m running)	Stretching
2	65	60		65 rep × 3 min with 1.30 min rest (24 min exercise)	7set × 200m with 2 min rest (1400m running)	
3	70	65		70 rep × 4 min with 2 min rest (24 min exercise)	4set × 400m with 3 min rest (1600m running)	
4	70	65		70 rep × 5 min with 2 min rest (30 min exercise)	5set × 400m with 2 min rest 2000m running)	
5	80	70		80 rep × 6 min with 2 min rest (30 min exercise)	3set × 800m with 3 min rest (2400m running)	
6	80	70		80 rep × 6 min with 1.30 min rest (30 min exercise)	2set × 800m with2 min rest (1600m running)	
7	85	75		85 rep × 7 min with 2.30 min rest (42 min exercise)	2set × 1200m with 3 min rest (2400m running)	
8	85	75		85 rep × 7 min with 2 min rest (42 min exercise)	2set × 1200m with 3 min rest (2400m running)	

and after the study. The 20m shuttle run test measures cardiorespiratory fitness. Subjects were required to run back and forth on a 20m course and be on the 20 m line at the same time a beep is emitted from a tape, until subjects can no longer reach the line on time; the last completed stage was the test score. The maximal oxygen uptake (VO2 max) was estimated using these results and the equations of Léger et al. The reliability and validity of this test for determining the VO2 max in children and adolescents has been widely demonstrated.

The rope-jump training group (RJT) and running group underwent 8 weeks training (30-60 min/d, 3 d/wk). The study protocol was approved by local authorities of the school including the school director, the teacher's committee council, the parent's committee council and student representative. Informed consent was obtained from the parents to allow students to participate in the study.

Rope jump training

Subjects in the training group participated in supervised interval endurance rope training three times per week, 15-50 min/d for 8 weeks. The detailed exercise training program is summarized in table 1.

Running training

The running training and detailed descriptions of subject's exercise intensity have been reported. All subjects participated in an 8-week, 3 days/week. Table 1 show the detailed exercise protocols and total exercise duration.

Statistical Analysis

Normality of distribution of data was evaluated using Kolmogorov-Smirnov test. Descriptive statistics was used in order to report the average and the dispersion index data. Also, paired t-tests to compare data pre and post training within group and one way ANOVA with tukey post-hoc test to compare data between three groups. Data was analyzed using SPSS version 20 at significant level of $p \leq 0.05$.

RESULTS

Thirty-three participants were assessed in three groups. At baseline, no significant difference was found in percentage fat, aerobic power, flexibility, muscular endurance between groups. At baseline, no significant difference was found in BMI, body fat, aerobic power, flexibility and muscular endurance between the three groups. The 8 week rope jump training significantly ($p<0.05$) improved aerobic power and muscular endurance compared to control group. The aerobic power was also significant ($p<0.05$) in running training group compared to control group. Descriptive data (Mean±SD) is present on physical fitness in table 2.

Table 2. Descriptive data (Mean±SD) on three study groups

Variables	Group	(M±SD)	
		Pre	Post
Body fat (%)	Rope-jump	21.48±4.74	19.38±4.09*
	Running	20.43±3.66	18.34±3.09*
	Control	18.73±4.55	18.52±3.75
Aerobic power (ml/kg/min)	Rope-jump	39.39±5.05	42.52±5.17§*
	Running	41.11±3.47	44.60±4.11*¥
	Control	44.02±3.45	43.17±2.69
Flexibility (cm)	Rope-jump	24.33±7.01	26.00±7.72
	Running	23.59±8.91	22.40±9.46
	Control	19.05±7.45	18.50±7/82
Muscular endurance (repetition)	Rope-jump	31.50±7.77	35.33±7.80*§
	Running	31.27±6.23	33.81±6.27
	Control	31.70±9.48	28.60±10.82

*Significant difference between Pre and Post ($p<0.05$), ;§ Significant difference between rope jumping and control group; ¥ Significant difference between rope jumping, running and control group.

DISCUSSION

The aim of this study was to examine the effect of aerobic training, running and rope jumping on body composition, flexibility, muscular endurance, and aerobic power in 10 to 12-years-old male student. Several randomized or clinical controlled trials have been conducted to study the effects of physical exercise programs on cardiorespiratory fitness and other physical fitness components, such as muscular fitness, speed and agility. In school-aged children, the results are consistent and show that different types of physical exercise programs (including or not diet intervention) are successful in improving cardiorespiratory fitness, as well as muscular

fitness and speed/agility. The results showed that rope jump training significantly improve aerobic power and muscular endurance compared to control group. The aerobic power was also improved significantly in running training group compared to control group. This showed positive effect of rope training, in the aerobic power and muscular endurance, and body composition. Also, running training significantly affect on aerobic power and body composition of the subjects. However, there was no significant difference between the effects of rope exercise and running on physical fitness factors. Greene and Ignico reported significant increase in the number of sit-ups in one minute after ten weeks of exercise training in children. The present study has also demonstrated significant improvement in the number of sit-ups in one minute in the exercise group. Although the control group had no significant improvement throughout the study period, there was an increase in the number of sit-ups performed in one minute. The present results revealed significant difference in sit-and- reach of either group. This is similar to a previous study that demonstrated that ten weeks of a physical fitness programme had significantly improved trunk flexibility in children [30]. This could be due to the nature of the stretching exercise, because the present study adopted a general stretching to the neck, shoulder, trunk and leg muscles, whereas the sit-and-reach test specifically measured the hamstrings and low back flexibility. The stretching programme may not have been specific enough to improve hamstrings and low back flexibility. Flexibility is joint specific and a profile of the major joints should be included in the testing. The insignificant changes in sit and- reach flexibility did not preclude the possibility that flexibility in other body parts could have improved with training. The results of multiple studies show that fitness exercises, independent of its type, to improve the fitness indicators. These findings are accordance with Chao- Chien and Yi-Chun (2012) demonstrated that the 12-week rope jumping training significantly affects on cardiovascular endurance, flexibility, muscular strength and endurance in students with intellectual impairment [31]. Also, our finding are consistent with previous studies reported that jumping rope training significantly improved balance, cardiovascular endurance, muscular strength, body composition, and flexibility [32,33,34]. Partavi indicate that rope jump training for 7 weeks is a feasible and effective method for improving cardiovascular endurance and agility performance in adolescent boys [35]. In the literature it was reported that while the skipping with rope had positive effects on the cardio-circulatory adaptation [36], it was a remarkable application in the muscular endurance and on the construction and maintaining of the cardiovascular system and it developed the feet movements by helping the preparation of the sports discipline.

The results of this study, demonstrated that rope jumping and running training had significant effect on reducing body percentage fat and improving body composition students participating in the study, so that both groups were reduced about 2-3% of the amount of fat under the skin of subjects respectively. The changes in percentage fat content were not observed in the control group. Evidence suggests that during the exercise, the catecholamine and growth hormone increases your rate of lipolysis will be increased. On the other hand, the effect of aerobic exercise on beta-adrenergic receptor density increased on the adipose tissue. As a result, their sensitivity improves the process of lipolysis [37]. Although in this study the possible mechanisms rope training on lipid profile effect has not been investigated, but in general we can be said that the exercises with a rope jumping could be an appropriate treatment is to reduce the fat content. Overweight school children are more sedentary and perform less moderate-to-vigorous PA than normal-weight ones [38]. A systematic review established a high correlation between lack of PA and unfavorable body composition and low physical fitness. All 232 reviewed studies associated a sedentary lifestyle with risk factors for CVD and increased health risks [39]. Body composition, physical fitness and PA levels are strongly associated with cardiovascular disease and mortality [39,40]. Therefore, the identification of risk groups is

crucial for the development of intervention strategies. Changes in lifestyle and the regular practice of PA through parental initiatives and social support interventions are important strategies to fight against childhood obesity and physical inactivity [41]. Early adaptation to optimally increased PA and exercise has always prevented excessive adiposity and contribute to the optimal development of vital organs, muscle and skeletal tissue, etc [42].

Although rope jumping exercise involves different joints and muscles, but the effect is mainly in the lower limbs part; it has a relatively small role in abdominal muscle training. ACSM pointed out that health-related physical fitness includes aerobic capacity, muscular fitness, flexibility and body composition [43]. In line with the results of Aung Sung and colleagues in their study on 26 obese and 14 lean boys found a 6 week period rope exercises can improve body composition, insulin resistance index and adiponectin in their levels. Ozer et al. assessed the effects of a 12-week "rope jumping" and "weighted rope jumping" training programs on functional parameters including multi-joint coordination and proprioception, strength, endurance in adolescent female volleyball players. They demonstrated significant improvement in physical fitness variables [44]. in addition, Takai, et al., reported the 8-week body mass-based squat training (100 reps/day, 45 sessions) significantly decreased percent body fat (4.2%) and significantly increased the lean body mass (2.7%), muscle thickness (3.2%) and strength of the knee extensors (16.0%), compared to control group [45]. In conclusion, the current findings indicate that 8 weeks rope jump training is a feasible and safe training method for improving cardiovascular endurance body fat and muscular endurance in middle school student boys. Chao-Chien Chen and Shih-Yen Lin indicated that 10 weeks of rope jumping exercise training could have a significant effect on improving the flexibility and aerobic capacity of visually impaired students. The rope jumping exercise can help overcome movement restrictions and learning limitations of visually impaired students. It is easy to carry out and not subject to many time, space, or equipment restrictions. Researchers can also use more variety of testing methods to investigate the rope skipping training's results on other muscle groups.

CONCLUSSION

Based on the results of this study, it seems that rope jump training can be a good alternative rather than running training in confined spaces. Due to the increase in urbanization and lack of space in homes and schools rope training can be a good alternative for running training in homes, schools and educational centers with space limitation for health-related physical fitness promotion specially in childhood.

ACKNOWLEDGEMENTS

Authors hereby express gratitude to all the participants and all those who helped in this study.

REFERENCES

1. Garland JR., H. Schutz, M.A. Chappell, B.K. Keeney, T.H. Meek, L.E. Copes, et al: The biological control of voluntary exercise, spontaneous physical activity and daily energy expenditure in relation to obesity. Human and rodent perspectives, J. Exp. Biol. 214; 2011: 206–229. Doi: http://dx.doi.org/10.1242/jeb.048397
2. De Onis, M, and M Blössner: Prevalence and trends of overweight among preschool children in developing countries. Am Clinical nutr 72.4, 2000; 1032-1039. Doi: http://dx.doi.org/10.3945/ajcn.2010.29786
3. Malina, R.M: Physical activity and fitness: pathways from childhood to adulthood. Am J Human Biol 13.2, 2001; 162-172. Doi: http://dx.doi.org/10.1002/1520-6300(200102/03)13:2%3C162::aid-

ajhb1025%3E3.3.co;2-k
4. Ruegsegger, G.N., et al: Reduced metabolic disease risk profile by voluntary wheel running accompanying juvenile Western diet in rats bred for high and low voluntary exercise. Physiol & Behav 152, 2015; 47-55.
5. Armstrong, N, et al: Physical activity patterns and aerobic fitness among prepubescents. Euro Phys Edu Rev 2.1, 1996; 19-29. Doi: http://dx.doi.org/10.1016/j.physbeh.2015.09.004
6. Klainin-Yobas, P, Hong-Gu H, and Y. Lau: Physical fitness, health behaviour and health among nursing students: A descriptive correlational study. Nurse Edu today, 2015. Doi: http://dx.doi.org/10.1016/j.nedt.2015.06.014
7. Kemper, Han CG, et al: Adolescent motor skill and performance: is physical activity in adolescence related to adult physical fitness? Am J Human Biol 13.2, 2001; 180-189. Doi: http://dx.doi.org/10.1002/1520-6300(200102/03)13:2%3C180::aid-ajhb1027%3E3.3.co;2-i
8. Ortega, F. B., et al: Physical fitness in childhood and adolescence: a powerful marker of health. Int J Obesity 32.1, 2008; 1-11. Doi: http://dx.doi.org/10.1038/sj.ijo.0803774
9. Tolfrey, K, Andrew M. Jones, and I.G. Campbell: The effect of aerobic exercise training on the lipid-lipoprotein profile of children and adolescents. Sports Med 29.2, 2000; 99-112. Doi: http://dx.doi.org/10.2165/00007256-200029020-00003
10. Ekeland, Eilin, et al: Can exercise improve self-esteem in children and young people? A systematic review of randomised controlled trials. Br J Sports Med 39.11, 2005; 792. Doi: http://dx.doi.org/10.1136/bjsm.2004.017707
11. Mota-Pereira, J, et al.: Moderate exercise improves depression parameters in treatment-resistant patients with major depressive disorder. Psychiat Res 45.8, 2011; 1005-1011. Doi: http://dx.doi.org/10.1016/j.jpsychires.2011.02.005
12. Li, L: People can live longer by having more physical activity. Sport and Health Sci 1.1, 2012; 7-8. Doi: http://dx.doi.org/10.1016/j.jshs.2012.02.001
13. Scully, D, et al: Physical exercise and psychological well-being: a critical review. Br J Sports Med 32.2, 1998; 111-120. Doi: http://dx.doi.org/10.1136/bjsm.32.2.111
14. Brown J.D., S.P. Naples, F.W. Booth: Effects of voluntary running on oxygen consumption, RQ, and energy expenditure during primary prevention of diet-induced obesity in C57BL/6N mice. J Appl Physiol. 113, 2012; 473–478. Doi: http://dx.doi.org/10.1152/japplphysiol.00668.2011
15. Gallahue, D.L: Instructor's Manual and Test Item File to Accompany Developmental Physical Education for Today's Children. Brown & Benchmark, 1996.
16. Janssen, I, and Allana G. LeBlanc: Review Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr and Phys Act 7.40, 2010: 1-16. Doi: http://dx.doi.org/10.1201/b18227-14
17. Lee, B: Jump rope training. Human Kinetics, 2010.
18. Pitreli, J, and Pat O'Shea: SPORTS PERFORMANCE SERIES: Rope Jumping: The biomechanics, techniques of and application to athletic conditioning. Strength & Cond J 8.4, 1986; 5-13. Doi: http://dx.doi.org/10.1519/0744-0049(1986)008%3C0005:rjtbto%3E2.3.co;2
19. Toplak, M.E., Colleen D, and R, Tannock: Temporal information processing in ADHD: findings to date and new methods. J Neurosci meth 151.1, 2006; 15-29. Doi: http://dx.doi.org/10.1016/j.jneumeth.2005.09.018
20. Newell, K. M: Constraints on the development of coordination. In: MG, Wade, & HT, Whiting (Eds.), Motor development in children: Asp coord and cont, 1986; 341-361 Doi: http://dx.doi.org/10.1007/978-94-009-4460-2_19
21. Solis, K: Aerobic Requirements for and Heart Rate Responses to Variations in Rope Jumping Techniques. Phys and Sports Med 16.3,1988.
22. Trampas, A, and A, Kitsios: Exercise and manual therapy for the treatment of impingement syndrome of the shoulder: a systematic review. Phys therap Rev 11.2, 2006; 125-142. Doi: http://dx.doi.org/10.1179/108331906x99065
23. Hubisz, J.L: Sport Science: Physical Laws and Optimum Performance: Peter J. Brancazio. The Physics Teacher 42.5, 2004; 318-318. Doi: http://dx.doi.org/10.1119/1.1737986
24. Payne, V.G, James R. and Morrow J.R. Exercise and VO2max in children: A meta-analysis. Res Q Exerc & Sport 64.3, 1993; 305-313.
25. Gutin, B, et al.: Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. The Am J Clin Nutr 81.4, 2005; 746-750.
26. Ruiz, J.R., et al: Relations of total physical activity and intensity to fitness and fatness in children: the European Youth Heart Study. Am J Clin Nutr 84.2, 2006; 299-303.
27. De Vries, Sanne I., et al: Determinants of activity-friendly neighborhoods for children: results from the

SPACE study. Am J Health promot 21.4s, 2007; 312-316. Doi: http://dx.doi.org/10.4278/0890-1171-21.4s.312
28. Roemmich, J.N., et al.: Association of access to parks and recreational facilities with the physical activity of young children. Preventive Med 43.6, 2006; 437-441. Doi: http://dx.doi.org/10.1016/j.ypmed.2006.07.007
29. Demetriou, Yolanda, et al: The effects of school-based physical activity interventions on students' health-related fitness knowledge: A systematic review. Edu Res Rev 16, 2015; 19-40. Doi: http://dx.doi.org/10.1016/j.edurev.2015.07.002
30. Greene, J.C: The effects of a ten-week physical fitness program on fitness profiles, self-concept, and body-esteem in children. 1993
31. Chen, Chao-Chien, and Yi-Chun Lin.: Jumping rope intervention on health-related physical fitness in students with intellectual impairment. Human Res & Adult Learn 8.1, 2012; 234-238.
32. Chen, H. M: The Effects of rope skipping on health-related physical fitness in student with mild intellectual disability: A case study. Unpublished Master's Thesis. Taipei: National Taiwan Normal University, 2010.
33. Tsai, Y. H: Effect of rope jumping training on the health related physical fitness of students with amblyopia. Unpublished Master's Thesis. Taipei: National Taiwan Normal University, 2009
34. Yeh, H. C: The role of vision in rope skipping training for balance development in the mental retardation. Unpublished Master's Thesis/. Taipei: National Taiwan Normal University, 2007
35. Partavi, S: Effects of 7 weeks of rope-jump training on cardiovascular endurance, speed, and agility in middle school student boys. Sport Sci 6.2, 2013
36. Humbert, L: CAHPERD Scholar Address: Carpe Diem-A challenge for us all. Phys & Health Edu 71.3, 2005; 4
37. Purnell, J.Q., et al: Effect of Weight Loss with Reduction of Intra-Abdominal Fat on Lipid Metabolism in Older Men 1. J Clin Endocrinol & Metab 85.3, 2000; 977-982. Doi: http://dx.doi.org/10.1210/jcem.85.3.6402
38. Herman, Katya M., et al: Sedentary behavior in a cohort of 8-to 10-year-old children at elevated risk of obesity. Preventive Med 60, 2014; 115-120. Doi: http://dx.doi.org/10.1016/j.ypmed.2013.12.029
39. Tremblay, M.S., et al: Systematic review of sedentary behavior and health indicators in school-aged children and youth. Int J Behav Nutr Phys Act 8.1, 2011; 98. Doi: http://dx.doi.org/10.1186/1479-5868-8-98
40. Timpka, S, et al: Muscle strength in adolescent men and risk of cardiovascular disease events and mortality in middle age: a prospective cohort study. BMC Med 12.1, 2014; 62. Doi: http://dx.doi.org/10.1186/1741-7015-12-62
41. Rauner, A, Filip M, and A. Woll: The relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000. BMC pediatr 13.1, 2013; 19. Doi: http://dx.doi.org/10.1186/1471-2431-13-19
42. Flodmark, C.E, et al: New insights into the field of children and adolescents' obesity: the European perspective. Int J obesity 28.10, 2004; 1189-1196. Doi: http://dx.doi.org/10.1038/sj.ijo.0802787
43. American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription (4th ed.). Philadelphia: Lea & Febiger,1991
44. Ozer, D., et al: The effects of rope or weighted rope jump training on strength, coordination and proprioception in adolescent female volleyball players. Sports Med & Phys Fit 51.2, 2011; 211.
45. Takai, Y, et al: Effects of body mass-based squat training in adolescent boys. Sports Sci & Med 12.1, 2013; 60

Address for correspondence:

Hamid Arazi - Department of Exercise Physiology, Faculty of Sport Sciences, University of Guilan, Rasht, Iran. E-mail: hamidarazi@yahoo.com

Recevied: 09.11.2015; Accepted: 27.01.2016; Published online: 22.02.2016