Research Paper: The Relationship Between Physical Self-Efficacy and VO_2 Max in Healthy Weight Versus Overweight Female Adolescents

Ebrahim Norouzi[1*], Fatemeh Sadat Hosseini[1], Farzaneh Mikaeli Manee[2]

1. Department of Motor Behavior and Sport Events Management, Faculty of Sport Sciences, Urmia University, Urmia, Iran.
2. Department of Educational Psychology, Faculty of Literature and Humanities, Urmia University, Urmia, Iran.

Citation Norouzi E, Hosseini FS, Mikaeli Manee F. The Relationship Between Physical Self-Efficacy and VO_2 Max in Healthy Weight Versus Overweight Female Adolescents. Physical Treatments. 2017; 7(3):133-140. http://dx.doi.org/10.32598/ptj.7.3.133

doi: http://dx.doi.org/10.32598/ptj.7.3.133

Funding: See Page 139

Article info:
Received: 15 Mar 2017
Accepted: 20 Jul 2017
Available Online: 01 Oct 2017

Keywords:
Adolescent, Girls, Overweight, VO_2 max, Self-efficacy

ABSTRACT

Purpose: Overweight or obese children and adolescents face a lack of confidence in their physical abilities, and show poorer motor and fitness performances, compared to healthy weight peers. Therefore, the present study aimed to investigate the relationship between physical self-efficacy and VO_2 max in healthy weight versus overweight female adolescents.

Methods: This was a cross-sectional correlational study. The relationship between physical self-efficacy and aerobic capacity was examined in 60 Healthy Weight (HW) and 60 Overweight (OW) adolescent girls with a sedentary lifestyle in Iran. They were selected through cluster sampling method. The participants filled out a physical self-efficacy questionnaire developed by Ryckman et al. and underwent a treadmill progressive running test to determine their maximal oxygen uptake (VO_2 max) using a gas analyzer system. Independent t test was used to analyze data regarding between-group differences, whereas Fisher Z test was used to compare the calculated Pearson correlation coefficient between both outcome measures of OW vs. HW participants. SPSS V. 24 was used for data analysis.

Results: The results indicate that HW girls have higher physical self-efficacy, perceived physical ability and physical self-presentation confidence ($P \leq 0.01$). In addition, they have higher VO_2 max ($t=11.72$, $df=118$, $P=0.001$). Results also show a significant positive relationship between the maximum oxygen consumption (VO_2 max) and physical self-efficacy in both groups (HW: $r=0.77$, $P=0.001$; OW: $r=0.64$, $P=0.001$), with a significantly stronger association found in the HW adolescent girls ($Z=2.21$, $P=0.03$).

Conclusion: The findings confirm that OW adolescent girls have a significantly lower physical self-efficacy and poor performance on Bruce treadmill test; therefore, the special attention should be paid to psychological factors in the prevention of obesity in adolescence.

*** Corresponding Author:**
Ebrahim Norouzi, PhD Candidate
Address: *Department of Motor Behavior and Sport Events Management, Faculty of Sport Sciences, Urmia University, Urmia, Iran.*
Phone: *+98 (912) 9469087*
E-mail: *eb.norouzi@urmia.ac.ir*

1. Introduction

Overweight and obesity prevention is considered as a very important health economic issue due to high prevalence rates across the world both in adults and children [1, 2]. Many studies have examined a variety of factors that may influence the development, prevention and treatment of pediatric obesity [3, 4]. For example, it has been demonstrated that overweight or obese children and adolescents often suffer from lack of confidence in their physical abilities [1, 5] and actually display poorer motor and fitness performance, compared to healthy weight peers [6-10]. Consequently, they also show a less positive attitude towards physical activity and participation in sports activities [6].

Considering the importance of the psychological aspects of obesity, mental assessments are integral parts of a multidisciplinary approaches towards the treatment of obesity [11]. According to the Harter's motivation competence theory, actual athletic competence and personal perceptions of body condition are associated with successful performance, which is the first motivational factor for voluntary participation in any sport or physical activity. These perceptions of one's physical abilities develop over time and interact with the environment [12-14]. Researchers explored possible predictors of people's physical ability perception, including individual's past performance, social learning, successful experiences, goal setting and effective and positive communication [13-15]. Bandura's social cognitive theory supports the hypothesis that appropriate exercise training improves one's body image without a sense of failure, and therefore creates a motivational environment [16, 17].

A negative perception of one's physical ability and the awareness of a less desirable body condition are generally considered as barriers towards being physically active [13, 14]. Therefore, overcoming these barriers can be extremely useful in the prevention and treatment of overweight and obesity among the children and adolescent population [18]. Further studies investigating the relationship between psychological factors and physical performance factors are thus warranted. Fitness level of children and adolecents and their physical and mental well-being are inversely related to being overweight or obese [6, 19, 20]. More specifically, an increased Body Mass Index (BMI) is clearly associated with a reduced aerobic capacity within this population [21]. In addition, it has been shown that cardiorespiratory fitness level in childhood and adolescence is a significant predictor for becoming overweight or obese in later life.

The longitudinal study of Brien [22], for example, demonstrated that subjects with a higher VO_2 max at baseline reported less weight gain over a period of 16 years. As a measure of aerobic capacity, which is a key aspect of physical fitness, the maximal oxygen uptake (VO_2 max) refers to the physical activity criterion that is the most important predictor of physiological health including cardiovascular health [23]. Several studies have also indicated that people's perception of their physical abilities significantly impact their motivation and performance [24].

Black et al. [25] evaluated the use of walk-jog-run exercise testing in adolescents and the international physical activity questionnaire data (including perceived functional ability and level of physical activity) to estimate VO_2 max. The results of regression analysis could predict accurately VO_2 max through physical activity and sport and questionnaire data. Morano et al. [19] investigated the association between self-perceived physical ability, body image and actual motor performance of 260 Italian students, classified into three weight categories: healthy weight, overweight, and obese. Their results showed that the perception of a low(er) physical ability was associated with a weak(er) motor performance, with both aspects being inversely related with overweight and obesity. In another study [20], the relationship between body image, perceived physical ability and actual ability was examined in normal-weight and overweight boys participating in individual and team sports and showed that in individual sports, the overweight boys had the largest dissatisfaction of their body as well as their perceived physical ability and displayed a lower actual ability compared to their healthy weight peers.

Examining the relationship between body weight status, perception and self-concept of lean versus obese children, Rudolph and colleagues [26] demonstrated that children's self-concept is significantly lower in obese children, who were also more worried about their own weight compared to their lean counterparts. In another study by Shepherd [27] in adolescent boys and girls (12-17 years), it was found that their perceived functional ability assessed by means of a questionnaire yielded similar results as the sub-maximal exercise tests to predict VO_2 max levels. In contrast, Ulrich [28] did not find a relationship between perceived motor skill competence and participation in sports in younger children. As mentioned above, results of the research studies regarding the relationship between psychological and physical factors in OW and obese children are highly inconsistent and investigations to pay close attention to these two variables are necessary. What has remained largely unresolved so far is the amount of correlation between VO_2 max and physical self-efficacy, that the present study is aiming to determine.

It is generally acknowledged that HW adolescents have better physical and psychological qualities, but exploring the relationship between these two variables received less attention. It is also of our interest to have further insight into the physical self-efficacy by finding the relation between Ryckman et al. [29] comprehensive questionnaire and the accurate physical fitness assessment tool, which is Bruce treadmill test. Therefore, this study aimed to examine the relationship between physical self-efficacy and VO_2 max in normal-weight versus overweight female adolescents.

2. Materials and Methods

Study participants

This was a cross-sectional correlational study. The statistical population consisted of all female high school students in Tehran. City, Iran. One hundrend and twenty students were selected through cluster sampling. The students (high-school students in Tehran) were divided into different clusters (areas). Then a number of clusters were selected using simple random sampling method. All samples were high-school students in Tehran with a sedentary life style. A total of 120 female adolescents, aged between 16 to 18 years (Mean±SD=15.75±1.28 y), voluntary participated in this study.

A sedentary life style was considered as the lack of performing regular exercise during the 12 months prior to the study. Half of the samples (n=60) had Healthy Weight (HW), while the other 60 girls were Overweight (OW). Based on the IOTF cut-off values equal to 24 for BMI internationally was used to categorize children and adolescents according to their weight status [30]. All participants read and signed the informed consent form, approved by the Local Ethics Board (Urmia University).

Measurements

The study participants were also asked to complete questionnaires on their health status prior to their inclusion in the study. Anthropometric measurements were measured by a highly experienced pediatrician, according to the recommendations of the International Society for Advancement of Kinanthropometry [31]. The research was conducted in two steps implemented consecutively on each participant on the same day. In the first phase, the participants completed the questionnairein and VO_2 max was measured in the second phase. Then, after completing the physical self-efficacy scale questionnaires, maximum oxygen consumption (VO_2 max) was taken from each subject. Bruce protocol and gas analyzer were used to determine VO_2 max.

Anthropometrics

Participants' standing height and body weight were measured to the nearest 0.1 cm and 0.1 kg using a Seca 213 stadiometer and a Seca 813 balance scale, respectively. The measures of height and weight were used to calculate the BMI (in kg/m^2) for each sample. Skinfold thickness was determined to the nearest 0.1 mm at the subscapular, calf and triceps sites using a Holtain skinfold caliper (Holtain Ltd, Crymych, UK). Body fat percentage was calculated by the relevent formula [32]. For the girls for whom (Tskf+Sskf)>35 mm, the body fat percentage=0.546(Tskf+Sskf)+9.7. Tskf stands for triceps skin fold thickness and Sskf for subscapular skinfold thickness.

Questionnaire

Demographic data and physical self-efficacy

Individual characteristics form: this form was used to obtain personal information, including age, frequency and intensity of regular physical activity and participants' medical history, including absence of any known, neuromuscular, motor and/or sensory disorders. Physical self-efficacy was evaluated using a questionnaire developed by Ryckman et al. [29], including a Perceived Physical Ability (PPA) subscale (i.e. 10 questions with a score range of 10-60) and a Physical Self-Presentation Confidence (PSPC) subscale (i.e. 12 questions with a score range of 12-72). Ryckman [29] reported the Cronbach α reliability coefficients of 0.85, 0.74 and 0.80 for PPA, PSPC and overall physical self-efficacy scores, respectively, representing a very good internal consistency of the questionnaire items.

Physical performance/ Aerobic capacity

Maximum oxygen consumption (VO_2 max) was measured using a treadmill (RodbyTM , RL 1600E, Enhorna, Sweden) and respiratory gas analysis device (Gas Analyzer System: Cortex Metalyzer 3B and Cortex Metamax 3B, Custo Med, Germany) and according to the following protocol. The participants must have started walking for 4 minutes on the treadmill at a speed of 4 km/h to warm-up, and then performed a Bruce test [33] in order to determine their VO_2 max .

In the Bruce protocol, the participants strated exercising on a treadmill speed of 2.9 km/h and an incline of 10% gradient for 3 minutes. Workloads were subsequently increased every 3 minute simultaneously. When achieving a heart rate of more than 90% of their maximum heart rate (according to the formula 220-age), a respiratory exchange ratio above 1.15 and or a plateau of oxygen consumption, the test was ended, in spite of increasing the training intensity. It should be noted that achieving at least two of the listed criteria was adequete to stop the protocol [34].

After completion of the Bruce test, the participants walked at a speed of 3 km/h for 3 minutes on the treadmill and performed 5 to 10 minutes of supervised stretching in order to cool down. During the whole VO_2 max testing session, the participants' heart rate was controlled by an electric pulse meter (Sport-tester Polar Electro OY, Finland). Moreover, feeling of pressure (physical, motivational, emotional) was measured by using Borg scale relative classification developed in 1985 by the Borg internal reliability is (r=0.93) and test-retest reliability (r=0.83, 0.94) [35], was used to modulate or refine the prescribed exercise intensity.

Statistical analysis

The SPSS V. 24 was used to analyze the data. In addition to obtaining descriptive statistics, Kolmogorov-Smirnov tests was performed to determine the normality of the data. The Independent samples t test was used to examine differences in all of the anthropometric, demographic, physical self-efficacy and aerobic capacity outcome variables between the HW and OW group of female adolescents. The Pearson correlation coefficients were calculated to investigate the relationship between participants' PPA, PSPC and overall physical self-efficacy scores and the VO_2 max. By means of Fisher Z tests, the strength of these Pearson correlation coefficients was also compared between both weight status groups.

3. Results

Table 1 presents sample characteristics for demographic characteristics (age), anthropometric measures (height, weight, BMI, skinfold thicknesses, estimated body fat percentage, lean and fat mass), as well as the data about physical self-efficacy questionnaire and amount of VO_2 max. There were no differences between HW and OW groups, in terms of age (t=0.678, df=118, P=0.51) and height (t=0.721, df=118, P=0.31), but there were differences in other parameters between HW and OW girls (all, P≤0.01) and OW adolescent girls gave a significantly poorer anthropometric values.

Table 1 indicates that HW girls had higher physical self-efficacy scores, perceived physical ability and physical self-presentation confidence (all, P≤0.01). Moreover, Table 1 shows Mean (SD) VO_2 max values of the subjects, in which the HW group have higher VO_2 max Mean±SD values (t=11.72, df=118, P=0.001). As presented in Table 2, according to Pearson correlation coefficient and significance level; the significant relationship between the amount of VO_2 max and physical self-efficacy is confirmed. Table 2 indicates a significant and strong positive relationship between amount of VO_2 max and physical self-efficacy in the healthy weight group, (r=0.77, P=0.001). In addition, the results also showed a significant strong positive relationship between the amount of VO_2 max and perceived physical ability (r=0.72, P=0.001) and physical self-presentation confidence (r=0.73, P=0.001) subscales. Moreover, Table 2 indicates a significant moderate positive relationship between the amount of VO_2 max and physical self-efficacy in overweight girls (r=0.61, P=0.001). The results also show a significant positive relationship between the amount of VO_2 max and perceived physical ability (r=0.57, P=0.02) and physical self-presentation confidence in overweight girls (r=0.63, P=0.01).

There is a significant correlation between the VO_2 max and physical self-efficacy (Z=2.21, P=0.01) and perceived physical ability (Z=2.04, P=0.02) and the amount of correlation coefficients of the VO_2 max and physical self-efficacy subscales in overweight group less than healthy weight group (Table 3). But there are no significant difference between healthy weight and overweight girls in respect with the correlation between VO_2max and physical self-presentation confidence (Z=1.78, P=0.06).

4. Discussion

The current study was designed to investigate the relationship between the aerobic capacity (or amount of VO_2 max) and physical self-efficacy in HW versus OW adolescent girls. The results indicate a significant moderate to strong positive relationship between the maximal oxygen uptake and physical self-efficacy in adolescent girls. However, this association was found to be more pronounced in HW girls compared to their OW counterparts. This result was consistent with the previous studies [1, 6, 10, 17].

Several studies have shown that overweight and obese children display poorer motor and fitness performances,

Table 1. Demographic, anthropometric, physical self-efficacy questionnaire scores and amount of VO_2 max in HW and OW adolescent girls

Variable	Group	Mean±SD	df	t	P
Demographics age (y)	HW OW	16±1.92 16±1.72	118	0.678	0.51
Anthropometrics measures Height (cm)	HW OW	163±8.32 161±5.65	118	0.721	0.31
Weight (kg)	HW OW	54±6.89 71±12.3	118	16.32	0.001
BMI (kg/m²)	HW OW	19.99±1.92 28.21±4.54	118	17.41	0.001
Subscapular skin fold thickness (mm)	HW OW	14.98±4.65 24.54±5.98	118	24.33	0.001
Calf skin fold thickness (mm)	HW OW	15.56±5.92 22.31±7.87	118	17.29	0.001
Triceps skin fold thickness (mm)	HW OW	15.21±3.1 22.18±4.97	118	18.13	0.001
Body fat percentage (%)	HW OW	21.671±8.43 32.78±9.32	118	33.83	0.001
Lean mass (kg)	HW OW	44.89±5.41 51.54±10.02	118	18.17	0.001
Fat mass (kg)	HW OW	12.98±4.82 24.67±8.40	118	18.11	0.001
Physical self-efficacy scale Physical self-efficacy	HW OW	108.3±8.94 80.92±10.98	118	49.10	0.001
Perceived physical ability	HW OW	45.9±5.6 34.3±4.43	118	21.54	0.001
Physical self-presentation confidence	HW OW	60.44±6.78 45.7±5.47	118	23.41	0.001
Aerobic capacity VO_2 max	HW OW	38.40±3.1 31.16±3.14	118	11.72	0.001

PHYSICAL TREATMENTS

compared to healthy weight counterparts [1, 7, 8, 10, 17]. On the other hand, previous studies showed that obese children also perceived physical/motor competence less than their peers [6, 10, 20, 36, 37]. This observation is in agreement with the findings of the present study.

Our findings are, nonetheless, in contrast to the findings of Morano et al. [20] that show no significant differences between obese and HW groups in terms of perceived physical ability (in the team). This contrast could be due to the methodology of studies, because Morano examined team sports participants; whereas in the present experiment, subjects were non-athletes and the activity included running on the treadmill in laboratory.

Our findings are in contrast to those of Ulrich [28] who used the 9-item motor competence assessment battery for motor skill assessment. This contrast may be attrib-

Table 2. The correlation between amount of VO_2max and physical self-efficacy in the HW and OW adolescent girls

Variable	Group	Statistics	Physical Self-Efficacy	Perceived Physical Ability	Physical Self-Presentation Confidence
Amount of VO_2max	HW	r	0.77**	0.72**	0.73**
		Sig.	0.001	0.001	0.001
		n	60	60	60
	OW	r	0.61*	0.57*	0.63*
		Sig.	0.01	0.02	0.01
		n	60	60	60

* P≤0.05; ** P≤0.001

PHYSICAL TREATMENTS

uted to differences in procedure applied in both studies. Our participants were examined by Ryckman et al. [29] comprehensive questionnaire and the Bruce treadmill test, which is an accurate physical fitness assessment tool. Moreover, In the present experiment, participation in the organized sport programs was not examined.

Based on Bandura's theory [15], there are predicting factors in the perception of physical abilities and it seems that these factors may include unsuccessful motor experiences and ineffective communication with peers, which also can be explained because of overweight people's low physical self-efficacy in the present study. Furthermore, sport psychology reseearch with total predictive power of self-efficacy beliefs is examined upon the individuals' performance due to its great importance to athletes and coaches [24]. This study was conducted by assessing the predictable power of the perceived physical ability on VO_2 max in adolescences who indicated a decent perdictability [25, 27]. Black et al. [25] showed that VO_2 max can be accurately predicted through physical activity questionnaire data (including perceived functional ability and level of physical activity) and data athletic.

In the Shepherd [27] study, scores of physical activity questionnaires and the rating of perceived functional ability were able to predict VO_2 max levels. Both of these studies are analogous with the present study in respect of using treadmill tests and being performed on adolescents. In addition, Shepherd mentioned that the model for the women's questionnaire provided more accurate results. This is probably due to lower physical ability to perform these activities and unwillingness to pressure self-bearing exercises in the adolescent girls. In addition probably, the adolescent girls' self-efficacy information in the present study was obtained from observing adolescents with healthy weight in society and comparig this information with their capabilities; however, implementation of motor tasks may affected their aerobic capacity. It was observed that changes in specific aspects of physical self effecicy can be facilitated by exercise interventions. Overall, these findings reveal that psychological factors such as physical self-efficacy is very important for actual motor performance and these results should be considered as psychological factors in the prevention of obesity in adolescence.

Our findings were in line with the results of Deforche et al. and D'Hondt et al. that showed a significant difference between obese and normal weight in motor performance and lower physical self-perceived respectively [6, 10]. Therefore, perceived physical ability is influenced by obese and overweight individuals. On the other hand,

Table 3. Correlation coefficient of the VO_2max and physical self-efficacy subscales between healthy weight and overweight girls

Group	n	Variable	r	Z	Level of Significance
HW	60	Physical self-efficacy/ VO_2max	0.77	2.21	0.01
OW	60		0.61		
HW	60	Perceived physical ability/VO_2max	0.72	2.04	0.02
OW	60		0.57		
HW	60	Physical self-presentation confidence/ VO_2 max	0.70	1.78	0.06
OW	60		0.63		

PHYSICAL TREATMENTS

obesity affects children; self-perception when turning to adolescence, especially in girls [38].

These findings are widely supported by the theory of motivation competence [12], which states that perceived physical competence is dependent on the successful execution and the main motivational factors underlying in the voluntary participation in any sport or physical activity. Perceived physical ability (perception of physical ability developed over time as a result of cumulative interactions with the environment) and physical competence are two goal-oriented and self-perception structures [24]. In addition, based on motivation theory, increasing physical activity participation among OW adolescents is to enhance their self-perception and enjoyment by increasing their actual and perceived motor skill competence [14]. The cross-sectional research method used in the present investigation is recommended for future studies, however, longitudinal methods should be considered, too.

The important implication of this study is that in order to demonstrate any interventions aimed at increasing physical activity participation among OW adolescents, several factors that co-exist with obesity should be measured such as low physical self-efficacy, low perceived physical ability and lower aerobic capacity (or amount of VO_2 max). Overall, it is recommended to the coaches take physical activity programs in many individual aspects; this is whilst the researchers should not focus on physical self-presentation confidence to improve a person's physical self-efficacy.

Ethical Considerations

Compliance with ethical guidelines

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Funding

This research was funded by Urmia University.

Conflict of interest

The authors certify that they have no affiliation with or involvement in any organization or entity with any financial interest, or non- financial interest in the subject matter or materials dismissed in this manuscript.

Acknowledgments

The authors would like to thank all nurses who kindly participated in this study.

References

[1] Colella D, Morano M, Robazza C, Bortoli L. Body image, perceived physical ability, and motor performance in nonoverweight and overweight Italian children. Perceptual and Motor Skills. 2009; 108(1):209-18. [DOI:10.2466/pms.108.1.209-218] [PMID]

[2] Tremblay MS, Katzmarzyk PT, Willms JD. Temporal trends in overweight and obesity in Canada, 1981-1996. International Journal of Obesity and Related Metabolic Disorders. 2002; 26(4):538-43. [PMID]

[3] Wardle J, Cooke L. The impact of obesity on psychological well-being. Clinical Endocrinology & Metabolism. 2005; 19(3):421-40. [DOI:10.1016/j.beem.2005.04.006] [PMID]

[4] Olds T, Maher C, Zumin S, Péneau S, Lioret S, Castetbon K, et al. Evidence that the prevalence of childhood overweight is plateauing: Data from nine countries. International Journal of Pediatric Obesity. 2011; 6(5-6):342-60. [DOI:10.3109/17477166.2011.605895] [PMID]

[5] Morano M, Colella D, Rutigliano I, Fiore P, Pettoello-Mantovani M, Campanozzi A. Changes in actual and perceived physical abilities in clinically obese children: A 9-month multi-component intervention study. PLOS One. 2012; 7(12):e50782. [DOI:10.1371/journal.pone.0050782] [PMID] [PMCID]

[6] Deforche B, De Bourdeaudhuji IM, Tanghe AP. Attitude toward physical activity in normal weight, over weight and obese adolescents. Journal of Adolescent Health. 2006; 38(5):560-68. [DOI: 10.1016/j.jadohealth.2005.01.015] [PMID]

[7] Gentier I, D'Hondt E, Shultz S, Deforche B, Augustijn M, Hoorne S, et al. Fine and gross motor skills differ between healthy-weight and obese children. Research in Developmental Disabilities. 2013; 34(11):4043-51. [DOI:10.1016/j.ridd.2013.08.040] [PMID]

[8] D'Hondt E, Deforche B, Gentier I, De Bourdeaudhuij I, Vaeyens R, Philippaerts R, et al. A longitudinal analysis of gross motor coordination in overweight and obese children versus normal-weight peers. International Journal of Obesity. 2013; 37(1):61-7. [DOI:10.1038/ijo.2012.55] [PMID]

[9] D'Hondt V, Deforche B, Vaeyens R, Vandorpe B, Vandendriessche J, Pion J, et al. Gross motor coordination in relation to weight status and age in 5 to 12 year-old boys and girls: A cross-sectional study. International Journal of Pediatric Obesity. 2011; 6(3):e556-64. [DOI: 10.3109/17477166.2010.500388] [PMID]

[10] D'Hondt E, Deforche B, De Bourdeaudhuij I, Lenoir M. Relationship between motor skill and body mass index in 5-to 10-year-old children. Adapted Physical Activity Quarterly. 2009; 26(1):21-37. [DOI:10.1123/apaq.26.1.21]

[11] Carr D, Friedman MA. Is obesity stigmatizing? Body weight, perceived discrimination, and psychological well-being in the United States. Journal of Health and Social Behavior. 2005; 46(3):244-59. [DOI:10.1177/002214650504600303] [PMID]

[12] Harter S. Self-perception profile for children: (Revision of the perceived competence scale for children). Denver: Universidad de Denver; 1985.

[13] Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor competence and its effect on positive developmental trajectories of health. Sports Medicine. 2015; 45(9):1273-84. [DOI:10.1007/s40279-015-0351-6] [PMID]

[14] Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C, et al. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Journal of Quest. 2008; 60(2):290-306. [DOI:10.1080/00336297.2008.10483582]

[15] Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review. 1977; 84(2):191-215. [DOI:10.1037/0033-295X.84.2.191] [PMID]

[16] Bandura A. Social foundations of thought and action: A social cognitive theory. Upper Saddle River, New Jersey: Prentice Hall; 1986.

[17] Nicholls JG. Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. Psychological Review. 1984; 91(3):328-46. [DOI:10.1037/0033-295X.91.3.328]

[18] O'Dea JA. School-based health education strategies for the improvement of body image and prevention of eating problems: An overview of safe and successful interventions. Health Education. 2005; 105(1):11-33. [DOI:10.1108/09654280510572277]

[19] Morano M, Colella D, Robazza C, Bortoli L, Capranica L. Physical self-perception and motor performance in normal-weight, overweight and obese children. Scandinavian Journal of Medicine & Science in Sports. 2011; 21(3):465-73. [DOI:10.1111/j.1600-0838.2009.01068.x] [PMID]

[20] Morano M, Colella D, Capranica L. Body image, perceived and actual physical abilities in normal-weight and overweight boys involved in individual and team sports. Journal of Sports Sciences. 2011; 29(4):355-62. [DOI:10.1080/02640414.2010.530678] [PMID]

[21] Truter L, Pienaar AE, Toit DD. Relationships between overweight, obesity and physical fitness of nine-to twelve-year-old South African children. South African Family Practice. 2010; 52(3):227-33. [DOI:10.1080/20786204.2010.10873979]

[22] Brien SE, Katzmarzyk PT, Craig CL, Gauvin L. Physical activity, cardiorespiratory fitness and body mass index as predictors of substantial weight gain and obesity: The Canadian physical activity longitudinal study. Canadian Journal of Public Health. 2007; 98(2):121-4.

[23] Schubert MM, Washburn RA, Honas JJ, Lee J, Donnelly JE. Exercise volume and aerobic fitness in young adults: the Midwest Exercise Trial-2. Springer Plus. 2016; 5(1):1-9. [DOI:10.1186/s40064-016-1850-0] [PMID] [PMCID]

[24] Feltz DL, Short SE, Sullivan PJ. Self-efficacy in sport. Champaign: Human Kinetics; 2008.

[25] Black NE, Vehrs PR, Fellingham GW, George JD, Hager R. Prediction of VO_2 max in children and adolescents using exercise testing and physical activity questionnaire data. Research Quarterly for Exercise and Sport. 2016; 87(1):89-100. [DOI:10.1080/02701367.2015.1124969] [PMID]

[26] Rudolph H, Blueher S, Falkenberg C, Neef M, Körner A, Würz J, et al. Perception of body weight status: A case control study of obese and lean children and adolescents and their parents. Obesity Facts. 2010; 3(2):83-91. [DOI:10.1159/000295495] [PMID]

[27] Shepherd BA. Predicting maximal oxygen consumption (VO_2 max) levels in adolescents [MSc. thesis]. Utah: Brigham Young University; 2012.

[28] Ulrich BD. Perceptions of physical competence, motor competence, and participation in organized sport: Their interrelationships in young children. Research Quarterly for Exercise and Sport. 1987; 58(1):57-67. [DOI:10.1080/02701367.1987.10605421]

[29] Ryckman RM, Robbins MA, Thornton B, Cantrell P. Development and validation of a physical self-efficacy scale. Journal of Personality and Social Psychology. 1982; 42(5):891-900. [DOI:10.1037/0022-3514.42.5.891]

[30] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. The BMJ. 2000; 320(7244):1240. [DOI:10.1136/bmj.320.7244.1240] [PMID] [PMCID]

[31] Norton K, Olds T, Olive S, Craig N. Anthropometry and sports performance. In: Norton K, Olds T, editors. Anthropometrica. Kensington: UNSW Press; 1996.

[32] Slaughter MH, Lohman TG, Boileau R, Horswill CA, Stillman RJ, Van Loan MD, et al. Skinfold equations for estimation of body fatness in children and youth. Human Biology. 1988; 60(5):709-23. [PMID]

[33] Bruce R, Kusumi F, Hosmer D. Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. American Heart Journal. 1973; 85(4):546-62. [DOI:10.1016/0002-8703(73)90502-4]

[34] Kraus RM, Stallings HW, Yeager RC, Gavin TP. Circulating plasma VEGF response to exercise in sedentary and endurance-trained men. Journal of Applied Physiology. 2004; 96(4):1445-50. [DOI:10.1152/japplphysiol.01031.2003] [PMID]

[35] Borg G. Borg's perceived exertion and pain scales. Champaign: Human Kinetics; 1998.

[36] Southall JE, Okely AD, Steele JR. Actual and perceived physical competence in overweight and nonoverweight children. Pediatric Exercise Science. 2004; 16(1):15-24. [DOI:10.1123/pes.16.1.15]

[37] Sung RY, Yu CW, So RC, Lam PK, Hau KT. Self-perception of physical competences in preadolescent overweight Chinese children. European Journal of Clinical Nutrition. 2005; 59(1):101-6. [DOI:10.1038/sj.ejcn.1602044] [PMID]

[38] Franklin J, Denyer G, Steinbeck KS, Caterson ID, Hill AJ. Obesity and risk of low self-esteem: A statewide survey of Australian children. Pediatrics. 2006; 118(6):2481-7. [DOI:10.1542/peds.2006-0511] [PMID]