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The Comparison of Functional Movement Screening Tests Score between Students with Different Body Mass Index

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Introduction: Ideal functional performance requires the fundamental and basic performance skills that usually such skill in children with abnormal body mass index is more limited. The aim of this study was to compare the functional movement screening scores of students with different body mass indexes.

Materials and Methods: 100 school children aged 7-10 years were selected and were divided in to three groups based on their body mass index. Functional performance was measured using the functional movement screening tests (including 7 tests: squats, step Hurdle, Lunge, shoulder mobility, straight leg raise, swimming trunk stability and rotational stability).

Results: Results showed that there are between groups differences in test scores (Deep squat (P=0.041), Hurdle step (P=0.040), Lunge (P=0.040), Shoulder mobility (P=0.020), straight leg raise (P=0.031), Trunk stability Push-up (P=0.037), Rotary stability (P=0.026) and sum (P=0.004)). According to Tukey Post-hoc test results, there is a significant difference between scores of the second and third groups in terms of functional movement screen scores (composite score) (P=0.002) but there was no significant difference between the first group and the second group (P=0.079) and between the first group third group (P=0.105).

Conclusions: The result of this study showed that there are significant association between body mass indexes with functional movement screening scores. On this basis, these children's requires more care from their parents for improvement of own performance and prevention of incoming injury.

Keywords: Fundamental movement, Injury, Performance.

Introduction

The prevalence of overweight and obesity is considered as one of the biggest public health problems (Daniels et al, 2005). Obesity in children is also considered as a chronic problem threatening their health which can be the basis for obesity in adulthood and have a significant impact on their physical and mental health (Dehghan et al, 2005; Tapia, 2007; Castetbon, 2012; Hills et al, 2002). Childhood obesity can cause impaired motor function and social and economic damage in the future (Castetbon, 2012). A number of studies show the effect of behaviors such as inactivity (sedentary lifestyle) and food habits in weight gain but there are very few researches about structure and functional limitations of obesity. These studies are mostly carried out on adult samples and very few data have been observed for the pediatric population (Hills et al, 2002; Duncan et al, 2012; Schneiders et al, 2011).

On this basis we can say that appropriate movement performance requires basic and foundational motor skills which are usually weaker and more limited in these children (Duncan et al, 2013). On the other hand, failure of these children in physical activities may be a barrier to their participation in these activities which are an integral part of human life and be a context for reduction of motor development and learning or even loss of their motivation and thus, they will get caught in a perpetual unhealthy cycle of physical inactivity (Castetbon, 2012; Vameghi and Shams, 2013; Cliff et al, 2010).

Suboptimal movement patterns resulting from overweight and obesity in childhood may lead to orthopedic abnormality in later life and inability to complete tasks of daily living. It has therefore been suggested that minimizing impaired movement patterns evident in obese and overweight children should be treated at the earliest opportunity (Duncan et al, 2013; Wrontn et al, 2006; Sorenson, 2009; Cook and Burton, 2006). However, few studies appear have examined these associations in children. Studies of gait in pediatric samples have identified differences between overweight/obese and normal weight children. These studies documented increased joint moments for overweight children compared to normal weight children and larger joint powers in obese children during walking at 2 different cadences. These studies suggested that the kinematic changes seen in overweight children may have long-term orthopedic implications and that the lower joint powers seen in obese children contribute to difficulty performing locomotor tasks and potentially decrease motivation to exercise (Duncan et al, 2013; Cook and Burton, 2006).

Moreover, several studies have identified that, although different to functional movement, fundamental movement skills, locomotor (running, hopping, jumping) and object-control (catching, throwing) skills are negatively influenced by overweight. It can be argued that good functional movement is needed in order for children to perform these fundamental movement skills and prior studies have consistently reported poorer fundamental movement skills in overweight and obese children indicating that childhood obesity might have adverse effects on gross motor development. It is also important to note that the term 'FMS' has been used by different authors to represent 'fundamental movement skills' e.g. or 'functional movement screen' (Duncan et al, 2013).

Where FMS form the prerequisites for sport competence and other forms of physical activity, functional movement skill refers to the underlying movement patterns which underpin performance in all other movements.

Researchers have suggested that people with greater and very less body mass index (BMI) are more susceptible to injuries of different sports (Knapik, 2015). In a way that FMS scores have significantly inverse relationship with BMI of children and these individuals have weaker scores compared to their peers with normal BMI (Duncan et al, 2013). In few studies conducted in this area, scores of test between different groups of BMI have not been considered by considering cut-off point score. The preventive approach has also not been considered in the existing researches. Carrying out researches with consideration of full feature of functional screening tests as well as expression of preventive views can greatly help researchers and athletic trainers. Thus, despite a few studies in this field, the objective of this study is comparison of screening scores of children with different BMI which can provide valuable information in relation to students at risk of damage.

Materials and Methods

The population of this research was students 7 to 10 years old in primary schools of Karaj city among which 100 available healthy students (58 females and 42 males) without injury prior to the event were selected. Equipment needed for measurement included Scales, tape measure, two-meter bars, an obstacle for the tests and the data collection form. Habitual physical activity or physical readiness level for all participants was same (using baecke questionnaire) and all subjects scored 11-13. Medical history and dietary intakes (in days which functional performance was measured) controlled. Participants were collected from Karaj city- Iran schools.

Based on the formula below the sample size was calculated to be about 80 but to overcome the loss of some subjects during the research, the 100 subjects were considered.

$$N=\left[\left(Z_{1\text{-}alpha}/2+Z_{1\text{-}beta}\right)^2\left(S_1^{\,2}+S_2^{\,2}\right)\right]/(M_1-M_2)^2$$

$Z_{1\text{-}alpha}/2$ for sig 0.05=1.96

$Z_{1\text{-}beta}$ for power 80%=0.84

Exclusion criteria included the following:

- The use of mobility aids,
- Existence of musculoskeletal injuries up to 6 weeks before the test (Duncan et al, 2013),
- Children with developmental disorders (Hyperactivity, autism, impaired coordination, and reading and writing)

Body mass (kg) and height (m) were measured to the nearest 0.5 kg and 0.5 cm respectively, using a stadiometer and weighing scales (Seca Instruments, Germany, Ltd). Children were assessed in bare feet and lightly clothed (in their Physical Education kit) and measurements were taken by anthropometrists accredited by the International Association for the Advancement of Kinanthropometry (ISAK) and using the standard ISAK protocol for such measurements. From this, BMI was determined as kg/m2.

After measuring the height and weight and age of the subjects and determining their BMI, they were divided into Three BMIs including fewer than 18 (60%) (Group I), normal BMI (20%) (Group II) and BMI over 20 (20%) (Group III) (Castetbon, 2012; Duncan et al, 2013).

Method of performing tests

The FMS is a fairly reliable tool which seems to be useful for predicting the risk of injury (Teyhen et al, 2012). The validity of this test has been reported to be in range of 0.83 to 0.95 (Chorba et al, 2010; Nantel et al, 2011).

FMS is the series of seven tests which is combination of muscular strength, flexibility, range of motion, coordination, balance and proprioception and evaluates the ability of individuals to perform basic movement patterns (Duncan and Stanley, 2012; Castetbon, 2012). These tests include squats, step Hurdle, Lunge, shoulder mobility, straight leg raise, swimming trunk stability and rotational stability (Sorenson, 2009). The maximum scores in this test is 21 and based on researches score less than 14 represents individuals at risk (Bardenett et al, 2015). Each participant is evaluated 3 times at each level of test and the highest score of 3 performances is considered. In this rating which has been determined from 0-3, 3 is the highest score and zero is the lowest score and higher score indicates better performance of a person (Cook and Burton, 2006). Scoring is as follows:

- Score 3: Proper implementation and full-motion,
- Score 2: incomplete implementation of motion and with compensation motions
- Score 1: inability to perform full motion or losing balance
- Score 0: existence of pain during motion

Cook and Burton (2006) introduced FMS test in efforts to develop a functional assessment before participating in sports activities. This series of tests was designed to evaluate the mobility and stability using seven motion tests. This series of tests can be performed in 5 to 10 minutes and that is why it can be easily used by coaches for evaluation of pre-season. Above collection includes tests such as deep squats, step Hurdle, launch, shoulder mobility, straight leg raise, swimming trunk stability and rotational stability.

Tian et al. (2012) reported moderate to good rater and inter-rater reliability for these tests (Minicik et al, 2010). CORBA and colleagues (2010) also reported this test as a test with sufficient validity for predicting the damage in a way that Score less than 14 in this test makes athletes four times more prone to injury (Duncan et al, 2013). The maximum score in this test is 21 and score less than 14 make a person prone to injury based on researches (Duncan et al, 2013).

Functional screening tests

Scoring method

- ✓ Performing move without compensation movements: 3 score
- ✓ Performing move with compensation movements: 2 score
- ✓ Inability to perform move without compensation movements: 1 score
- ✓ Feeling pain while performing move or performing detector test : 0 score

Deep squat test

- ✓ Upper body is parallel to the tibia
- ✓ Thighs are parallel to the ground
- ✓ Knees are directly above the feet
- ✓ Bar is parallel to the ground

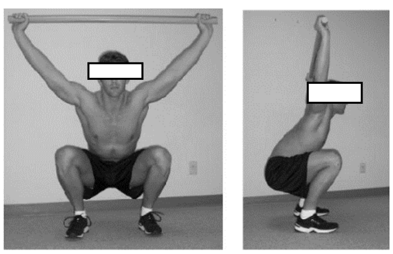

Figure 1. Deep squat test

Hurdle stepping test

- ✓ hip, knee and ankle are in one direction in the sagittal
- ✓ No movement happens in the waist area
- ✓ Bar and Hurdle are parallel

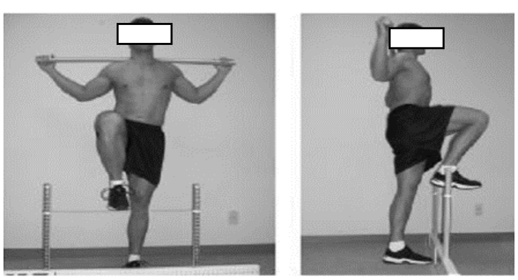

Figure 2: Hurdle stepping test

Lunge test

- ✓ Bar is in contact with the spinal column is in the open position
- ✓ No movement happens in the trunk area
- ✓ Bar and feet remain on the sagittal
- ✓ knee touches the back of the heel of the front foot

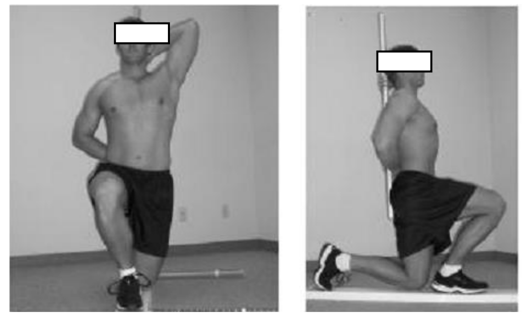

Figure 3: Lunge test

Shoulder Mobility test

- ✓ fists are at distance of 20 cm (3 score)
- ✓ fists are at distance of 30 cm (2 score)
- ✓ fists are at a distance more than 30 cm (1 score)

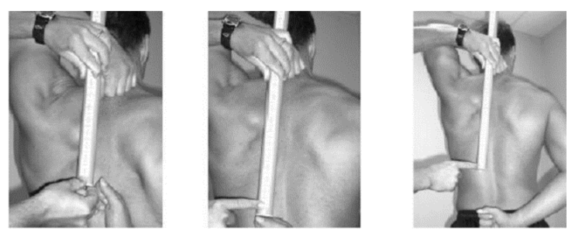

Figure 4: Shoulder Mobility test

Figure 5: discrimination test

Active straight leg raising test

- ✓ Ankle or top of bar is at midpoint of thigh and brushed upper anterior (3 score)
- ✓ Ankle or top of bar is at midpoint of thigh and the middle of Patella or the knee joint (2 score)
- ✓ Ankle or top of bar is at lower part of Patella or knee joint line (1 score)

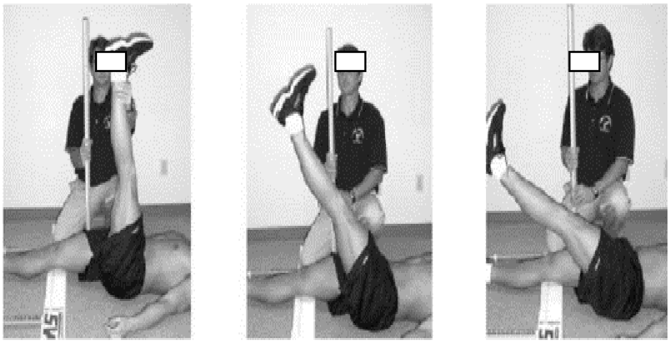

Figure 6: Active straight leg raising test

Trunk stability push up test

- ✓ Males performing one repeat in situation where hands are parallel to forehead (3 score)
- ✓ Females performing one repeat in situation where hands are parallel to chin (3 score)
- ✓ Males performing one repeat in situation where hands are parallel to chin (2 score)
- ✓ Females performing one repeat in situation where hands are parallel to collarbone (2 score)
- ✓ Males and females do not make backbone in line with lower limb (1 score)

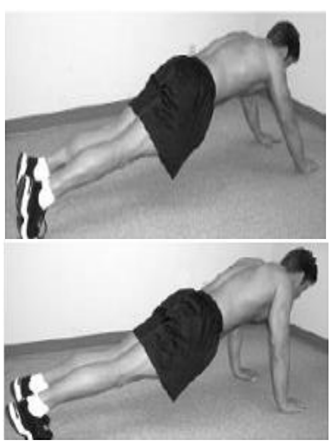

Figure 7: Trunk stability push up test

Figure 8: discrimination test

Rotational stability test

- ✓ Performing one correct replication while spine is parallel to the ground
- ✓
- ✓ knees and elbows come into contact with each other

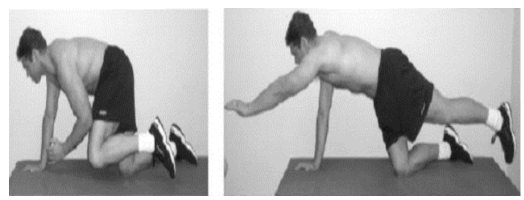

Figure 9: Rotational stability test

Figure 10: discrimination test

Statistical analysis

Descriptive statistics was used to report the mean and standard deviation. The Shapiro–Wilk statistical test was used for data normality distribution testing. One-way ANOVA and Tukey's tests were also used for data analysis and comparisons between groups in SPSS version 20 (at a significance level of 0.05).

Findings

The number of subjects who were 100 and their FMS score data was analyzed disaggregated by BMI. The mean and standard deviation of demographic characteristics of the subjects have been listed in table below.

Table 1: The mean and standard deviation of demographic characteristics of the subjects

Statistics Groups	Age (years)	Height (cm)	Weight (kg)	BMI
Group 1 (n=31)	**8.816±1.185**	**130.216±9.798**	**26.916±4.927**	**16.93±2**
Group 2 (n=34)	**9.55±1.276**	**141.35±10.194**	**37.650±5.869**	**19.1±1.99**
Group 3 (n=35)	**9.15±1.039**	**139.7±10.824**	**42.9±8.2**	**23.4±3.59**

Comparison of FMS test scores in three groups

Results of one-way ANOVA test to compare the performance of screening tests scores in three groups have been shown in table two.

T test results revealed that there was no significant differences between girls and boys in total FMS score (P=0.125).

Table 2: Results of one-way ANOVA test to compare the performance of screening tests scores in three groups

variable	Group1 N=31	Group2 N=34	Group3 N=35	P-values
Deep squat (M ±SD) Range	**2±0.22 (1.8-2.2)**	**2.28±0.5 (1.7-2.7)**	**2.3±0.5 (1.8-2.8)**	**0.041***
Hurdle step(M ±SD) Range	**2.04±0.1 (1.9-2.2)**	**2.12±0.13 (1.9-2.3)**	**1.5±0.31 (1.2-1.8)**	**0.04***
Lunge(M ±SD) Range	**2±0.19 (1.9-2.2)**	**2.17±0.28 (1.9-2.5)**	**1.3±0.28 (1-1.6)**	**0.04***
Shoulder mobility(M ±SD) Range	**1.18±0.1 (1.1-1.3)**	**2.00±0.3 (1.8-2.3)**	**2.18±0.1 (2-2.2)**	**0.02***
Active straight leg raise (M ±SD) Range	**2±0.5 (1.5-2.5)**	**2.44±0.3 (2.1-2.8)**	**1.01±0.4 (0.7-1.5)**	**0.031***
Trunk stability Push-up(M ±SD) Range	**1.9±0.3 (1.6-2.2)**	**2±0.17 (1.8-2.2)**	**1.1±0.45 (0.7-1.55)**	**0.037***
Rotary stability(M ±SD) Range	**1.9±0.36 (1.6-2.3)**	**2.17±0.48 (1.7-2.6)**	**2.3±0.22 (2.1-2.5)**	**0.026***
composite score(M ±SD) Range	**13.416±3.715 (9-17)**	**15.4±3.267 (12-19)**	**11.55±3.119 (8-14.5)**	**0.004***

*** Existence of a significant difference**

Results showed that there are between groups differences in test scores (Deep squat (P=0.041), Hurdle step (P=0.040), Lunge (P=0.040), Shoulder mobility (P=0.020), straight leg raise (P=0.031), Trunk stability Push-up (P=0.037), Rotary stability (P=0.026) and sum (P=0.004)).

Evaluation of Between-group differences

Results of Tukey Post-hoc test for between-group differences have been provided in table three.

Table 3: between-group differences (using Tukey Post-hoc test)

Statistics Groups		**standard error**	**Significant**	**Mean difference**
Group 1	**Group 2**	**-1.983**	**0.909**	**0.079**
Group 1	**Group 3**	**1.866**	**0.909**	**0.105**
Group 2	**Group 3**	**3.850**	**1.113**	***0.002**

* Existence of a significant difference

According to Tukey Post-hoc test results, there is a significant difference between scores of the second and third groups in terms of FMS scores (composite score) (P=0.002) but there was no significant difference between the first group and the second group (P=0.079) and between the first group third group (P=0.105).

Discussion

The objective of the present study was the comparison of FMS test scores of school children with different BMI. The results showed that Children with normal BMI had better performance in the implementation of FMS tests e compared to other groups and this difference was reported to be significant between the groups of children with normal BMI and higher but there was no significant difference between children with low BMI and other two groups. The obtained results confirm the results of previous researches on pediatric population which indicates the inverse relationship between higher BMI scores and FMS scores (Duncan and Stanley, 2012; Duncan et al, 2013). It is also in line with other researches which consider obesity as one of the motor function limiting factors (Hills et al, 2002; Minicik et al, 2010).

It is suggested to the sport teachers of students using the pre session screening of the students predispose to injury and consider the preventive sport strategies.

In recent years, prevention of damage has been considered as one of the significant scientific principles among researcher. Required conditions and effective factors should be determined accurately in the design of preventive programs and ideal conditions should be studied and eventually the program must be designed carefully based on specific requirement of individuals (Wrontn et al, 2006). Carried out studies have reported multifactorial mechanisms for damage which are generally divided into two groups of internal factors (anatomical, hormonal, neuromuscular, BMI and postural biomechanical differences between men and women, etc.) and external factors (physical and visual disturbances, bracing, type of shoe soles, floor level, etc.). Thus, strategies and preventive exercises should be completely reviewed in design of interventions in prevention of damage by considering different risk factors such as BMI so that those can completely affect required variables (Fong et al, 2011).

Most of the studies in this field believe that people with FMS tests scores lower than 14 are more prone to injury especially in lower limb area (Letafatkar et al, 2014). This information makes incompatibility of functional patterns of overweight and obese children who are not able to perform activities of daily living more prominent. These movement patterns will be faced with the impact of overweight on joints in many cases which can lead to orthopedic abnormalities in long-term (Duncan and Stanley, 2012). Increased Musculoskeletal problems will increase movement restrictions and obesity and overweight are among the factors to accelerate this change. Knee is one of the most common areas of pain in children and causing abnormal load on it while walking can be associated with changes in walking pattern in the long run. Changes in the distribution of varus force and power also increases the pressure on the medial compartment of the knee which leads to complications such as chronic pain, hip replacement and osteoarthritis in future (Letafatkar et al, 2014). Some of the studies about children and adolescents have mentioned visible changes in the structure and distribution of plantar pressure when walking and standing among complications of overweight and obesity which is the result of weaknesses in functional movement patterns (Duncan et al, 2013). Unsatisfactory performance patterns (suboptimal) prevent health and increasing physical activity. Greatest concern of these disorders is that these compensation and false patterns remain until higher ages and change the life-style which causes a wide range of problems including functional decline and injuries (Vameghi and Shams, 2013).

There have been a few studies in the field of injury prevention in students both inside and outside of the country. One of the main reasons for the lack of adequate research is that researchers are looking for ways to have minimal intervention and the most convenient and low-risk assessments for the most vulnerable age range. In the present research, the researchers tried to carry out initial evaluations for preparation of sufficient information for planning damage prevention programs for this group with a simple but authoritative assessment (Chorba et al, 2010; Nantel et al, 2011). Thus, given the fact that the present study has only considered one of the risk factors in students in the field of prevention of injury, we hope that future research consider other risk factors and those general information be used for designing injury prevention programs.

According to surveys conducted, FMS cannot stand alone as the best or only way to assess the quality of children's movement patterns and low scores of children in these test do not mean decline in motor function or clinical and musculoskeletal problems but since the collection of FMS tests have been evaluated in other age groups and different sports, these tests seem to be also useful for children's age group.

Limitations

There are also potential confounding variables that may have influenced the results presented in the present study. Habitual physical activity may represent one such confounding variable and the lack of assessment of this variable should be considered as a limitation in the current study. Other individual variables such as socio-economic status and ethnic group may also potential influence functional movement and were also not accounted for in the current study.

The present sample did not have a sufficient balance of ethnic groups nor was it drawn across multiple socio-economic status groups for these confounding variables to be accounted for. It may also be important for future studies to assess or control for such confounders when considering the impact of overweight/obesity on functional movement in children.

Furthermore, longitudinal designs would be welcome to understand whether overweight/obesity leads to a lack of physical activity and subsequent poorer functional movement or whether suboptimal functional performance actually restricts ability to engage in health enhancing physical activity and leads to subsequent unhealthy weight gain. This exploratory study is also limited by a small sample size and larger scale studies would be welcome to verify the claims made here. In addition, cause and effect in relation to weight status and functional movement could not be determined in the present sample.

Conclusion

The results of this study suggest that obesity and overweight are significantly condition correlated with poor performance. We can say according to scores obtained in FMS tests of these children that FMS can identify changes in movement patterns in children and prevent those to be transferred to older ages. Thus, it can be said that most of today's children need more attention and care for performance improvement and achieving this goal requires awareness of parents, schools, and recreational facilities and sports programs. It is suggested to the sport teachers of students using the pre session screening of the students predispose to injury and consider the preventive sport strategies.

Many different factors can affect the results of this research among which level of physical or sport activity, or family socioeconomic status and race can be mentioned which can affect motor performance in children.

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