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The Influence of Birth Weight on Physical Fitness in Children Between 8 to 10 Years

8 ile 10 Yaş Arasındaki Çocuklarda Doğum Ağırlığının Fiziksel Uygunluğa Etkisi

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ABSTRACT

Objective: The aim of this study was to investigate the influence of birth weight on the physical fitness parameters of children.

Materials and Methods: The sample consisted of 180 (90 boys and 90 girls) children aged between 8-10 years. Participants were grouped as low (n = 60), normal (n= 60), and high (n= 60) birth weight groups based on their birth weight and gestation weeks. In the research, anthropometric measurements (height, weight, and BMI) and Eurofit test battery (flamingo balance, plate tapping, sit and reach, standing broad jump, handgrip strength, 30s sit-ups, bent-arm hang, and *10x5*m shuttle run tests) were performed.

Results: No statistically significant difference was found between the birth weight groups in terms of the results of anthropometric measurements and scores of Eurofit physical fitness tests ($p > .05$).

Conclusion: It was determined that birth weight has no influence on the measured anthropometric and physical fitness parameters of children aged 8 to10 years.

Keywords: Birth weight, Eurofit, performance, physical fitness

ÖZ

Amaç: Araştırmanın amacı 8-10 yaş aralığındaki çocuklarda doğum ağırlığının fiziksel uygunluk parametrelerine olan etkisini incelemektir.

Gereç ve Yöntemler: Araştırma örneklemini 8-10 yaş aralığında 90 kız ve 90 erkek olmak üzere gestasyon haftası ve doğum ağırlıklarına göre belirlenen 60 düşük, 60 normal ve 60 yüksek doğum ağırlıklı toplam 180 gönüllü oluşturmaktadır. Araştırma kapsamında katılımcıların boy uzunluğu, vücut ağırlığı ve beden kitle indeksleri belirlendi. Fiziksel uyguluğun değerlendirilmesi için Eurofit test bataryasında yer alan flamingo denge, disklere dokunma, otur eriş, durarak uzun atlama, kavrama kuvveti, 30s mekik, bükülü kol asılma ve 10x5 mekik koşusu testleri uygulandı.

Bulgular: Düşük, normal ve yüksek doğum ağırlıklı çocuklardan oluşan araştırma gurupları arasında antropometrik ölçüm ve fiziksel uygunluk test sonuçlarına göre istatistiksel olarak anlamlı bir farklılık olmadığı tespit edildi ($p > 0.05$).

Sonuç: Bu araştırmanın örnekleminden elde edilen bilgilere dayanarak, doğum ağırlığının 8 ile 10 yaş aralığındaki çocuklarda antropometrik özellikler ve fiziksel uygunluk düzeyinde herhangi bir farklılığa neden olmadığı görülmüştür.

Anahtar Sözcükler: Doğum ağırlığı, Eurofit, fiziksel uygunluk, performans

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INTRODUCTION

Physical fitness is one of the most important indicators of health and wellness (1). Physical fitness has been defined as "*the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies*" (2). There are a lot of measurable components of physical fitness. The components of physical fitness are cardiorespiratory endurance, muscular endurance, muscular strength, body composition, power, speed, flexibility, agility, balance, reaction time, and coordination. These factors may vary with individual efforts except for age, gender, and genetic factors (3).

Scientific studies have mostly examined a number of factors influencing both physical fitness and health (4,5). These researches have revealed that there were consistent and strong relationships of physical fitness with obesity, cardiovascular disease, and all-cause mortality rates. Poor physical fitness and sedentary lifestyle are considered as risk factors which cause significant morbidity, obesity, and cardiovascular diseases in childhood and later in life (6-7). Therefore, World Health Organization (WHO) and many international organizations seek to encourage all the people to adopt healthy lifestyle habits and being physically active (1). First of all, the determination of people's physical fitness level is the first step to creating a healthy community. Numerous test batteries have been developed for assessing physical fitness related to health and sports performance in young people. The most widely applied test batteries are the Eurofit test battery in Europe and the Fitnessgram test battery in the USA (8,9).

Although the majority of cardiovascular diseases manifest in adulthood, the risk of disease can begin in utero or childhood (4). Intrauterine environment, genetic structure, maternal and placental factors such as fetal growth restriction or excessive growth cause severe health problems in the later life (10). Therefore, it is necessary to identify the risk factors that effect on both physical fitness and health in the early years of life and childhood (4,5). Due to the increased prevalence of these risk factors among children and adolescents and the emergence of symptoms of metabolic and cardiovascular diseases during these periods, it is required to determine the factors affecting health and physical fitness in preadolescent and adolescent children (11). Recently, many researchers have focused on the association between early life events (birth weight, gestational age, intrauterine and neonatal growth, etc.), the normal trajectory of growth, body composition, physical activity, physical fitness and the risk of adult disease (12-16).

Birth weight is an important predictor of survival and health in the early life. While low birth weight (LBW) is closely associated with fetal and prenatal mortality and morbidity, inhibited growth and cognitive development, and chronic diseases, high birth weight (HBW) is associated with an increased risk of obesity and metabolic problems later in life (17). Over the last years, large population based-studies have been revealed that the prevalence of LBW and HBW increased among newborns (18,19).

Scientific researches have shown that cognitive, psychological, and physical development can also be influenced by the birth weight (20-23). The results of these researches showing the various influences of birth weight on human health and growth have brought to mind the question of whether physical fitness components influenced by birth weight in the later years of life or not. Birth weight may be a significant biological determinant of physical fitness and health in childhood and adulthood. In this context, numerous researchers have focused on the association between birth weight and the normal trajectory of growth, body composition, physical activity levels and physical fitness (13,15,18,20,21). However, these researchers revealed inconsistent and contrary results with some researchers reporting no influence of birth weight on body composition, physical fitness parameters and activity levels in childhood and later life. In order to make an accurate inference about the influence of birth weight on physical fitness and health, it is necessary to investigate the different age and population groups (1). To this end, the influence of birth weight on physical fitness parameters of 8 to10 years old children has been investigated.

MATERIAL AND METHODS

Subjects

This study was conducted in the city of Malatya, Turkey, in 2014. "The formula number of individuals known sample width of population" was used to determine the sample size of this study. According to the data of Turkey Statistical Institute, the population of the research was 24754 children, aged 8 to 10 years old, living in the central district of Malatya (24). The prevalence of the LBW children was reported as 10.6% and HBW's as 10.5% respectively in Turkey Demographic and Health Surveys-2008 (25). The number of LBW and HBW children aged 8 to10 years and lived in Malatya was estimated to be 2624 and 2599 respectively. The sample of study was determined by using the proportionate stratified sampling technique. Our strata criteria were gender (male and female) age groups (8, 9 and 10 years old) and birth weight (LBW, NBW, and HBW). The birth data of children who participated in the study were obtained from their birth certificates. Participants were classified into three groups according to intrauterine growth chart, developed by Kurtoğlu et al. (26). In this chart, newborns are classified according to their gestation week and birth weight: LBW is defined as a birth weight below the 10th percentile, normal birth weight (NBW) is defined as a birth weight between 10th and 90th percentile, HBW is defined as a birth weight above the 90th percentile. Finally, a total of 180 children (LBW= 60, NBW= 60 and HBW= 60) aged 8 to10 years old (8 age= 60, 9 age= 60 and 10 age= 60), 90 boys and 90 girls were involved in this study.

Procedure

All the subjects were convenient for research criteria which were to be clinically well and willing to participate in research. Written informed consent was obtained from each parent and subject. The study was approved by the Ethics Committee of the İnonu University and met the conditions of the Helsinki Declaration. The physical fitness tests and anthropometric measurements were performed during a physical education session and administered by researchers who had been specifically trained to administer the fitness test battery. Prior to these tests, we used *"Physical Activity Readiness Questionnaire (PAR_Q)"* to determine the safety or possible risk of exercising for participants based upon their answers to specific health history questions (27). The participants were fully familiarized with the testing procedures.

Data Collection

Anthropometric measurements (height, body weight and BMI) and eight tests from the Eurofit physical fitness test battery; flamingo balance (FB; static balance in seconds), plate tapping (PT; speed of limb movement, in seconds), sit-and-reach (SR; flexibility, in cm), standing broad jump (SBJ; explosive strength, in cm), handgrip (HG; static strength, in kg), sit-ups in 30 seconds (SP; abdominal muscular power), bent arm hang (BAH; muscular endurance, in seconds) and 10 x 5 meter shuttle run (SR; speed and agility, in seconds) were performed to determine the physical fitness levels of participants. These tests carried out by using the procedures of the

Eurofit directive (9, 28). All tests were performed in an indoor sports hall between 09:00 to 16:00 hours.

Statistical Analysis

Data analysis was performed with the SPSS (SPSS Inc., Chicago, IL, USA) trial version 17.0 statistical package. Means (SD) were calculated for all the variables included in this research. All values are expressed as Means ± SD unless otherwise indicated. The Kolmogorov-Smirnov test was used to assess whether the data had a normal distribution. The differences between groups were analysed with one-way analysis of variance (ANOVA) and post-hoc Tukey's test for multiple comparisons, when appropriate. For all analyses, the level of statistical significance was set at 0.05.

RESULTS

A summary of the anthropometric characteristics of birth weight groups is illustrated in Table 1. The mean values for body height, weight, and BMI were; LBW group: 142.5±9.2 cm, 39.7±9.9 kg and 19.4±3.4 kg/m^2, NBW group: 143.1±7.3 cm, 38.1±7.8 kg and 18.5±3 kg/m^2, HBW group: 142.7±8.7 cm, 39.3±10 kg and 19±3.1 kg/m^2, respectively. All groups demonstrated height within the normal range of WHO international growth references (WHO, 2007), but BMI within the overweight range (≥85th percentile). The comparison of groups according to anthropometric measurements was given in Table 1. ANOVA analysis showed that there were no statistically meaningful differences in the mean values of body weight ($F(2,176) = 0.48$, $p = .62$, $\eta^2 = .005$), height ($F(2,176) = 0.09$, $p = .92$, $\eta^2 = .001$), and BMI ($F(2,176) = 1.14$, $p = .32$, $\eta^2 = .013$) among birth weight groups. As expected, because of using percentile curves of intrauterine growth developing by Kurtoğlu et al. (2011), the mean values of birth weight among the groups differed statistically significantly ($F(2,176) = 31.3$, $p = .001$, $\eta^2 = .261$). Likewise, we found significant differences in the mean gestational age among birth weight groups. The mean gestational age of LBW group (35.7±3 week) was significantly lower than NBW (38.7±1.2 week) and HBW (37.7±1.8 week) groups. The mean gestational age was significantly highest in NBW group ($p < .01$).

Table 1. ANOVA analyses of anthropometric measurements according to birth weight.

	Group					
	LBW (n= 60)	**NBW (n= 60)**	**HBW (n= 60)**	**F (2, 176)**		
Variable	M(SD)	M(SD)	M(SD)		*p*	η^2
Gestation Age (week)	35.7 (3.0)^{ac}	38.7 (1.2)^{b}	37.7 (1.8)^{bc}	31,3	.001*	0,261
Body Weight (kg)	39.7 (9.9)	38.1 (7.8)	39.3 (10.0)	0,48	0,62	0,005
Height (cm)	142.5 (9.2)	143.1 (7.3)	142.7 (8.7)	0,09	0,92	0,001
BMI (kg/m^2)	19.4 (3.4)	18.5 (3.0)	19.0 (3.1)	1,14	0,32	0,013

LBW: *Low birth weight*, NBW: *Normal birth weigh,* HBW: *High birth weight,* BMI: *Body mass index*
*Statistically significant difference p < .05
^{a}Group differs statistically significantly from type (in row) where ^{b} is indicated.
^{b}Group differs statistically significantly from type (in row) where ^{c} is indicated.

The results of Eurofit tests of birth weight groups were compared and presented in Table 2. The physical fitness parameters; balance, speed of limb movement, running speed, abdominal, static, explosive and functional strength were assessed by using the Eurofit tests battery. ANOVA analysis of these data showed that there were no statistically significant differences in among the birth weight groups in terms of the results of Eurofit Tests ($p > .05$).

Table 2. ANOVA analyses of the results of Eurofit tests according to birth weight.

	Group						
	LBW (n= 60)	**NBW (n= 60)**	**HBW (n= 60)**	**F (2,176)**			
Variable	M(SD)	M(SD)	M(SD)		*p*	η^2	Post-hoc
FB (n)	14.9 (6.9)	13.3 (5.0)	16.5 (7.2)	2.84	.06	.004	N/A
PT (sec)	13.7 (1.9)	13.5 (2.3)	13.3 (1.8)	0.61	.55	.007	N/A
SR (cm)	17.1 (4.5)	16.9 (6.4)	16.7 (5.6)	0.07	.93	.001	N/A
SBJ (cm)	120.8 (19.0)	121.2 (21.9)	116.1 (26.5)	0.91	.40	.010	N/A
HG (kg)	17.1 (5.4)	16.1 (4.7)	15.7 (4.7)	1.31	.27	.015	N/A
SP (n)	14.5 (4.7)	13.1 (4.4)	12.7 (4.8)	2.35	.09	.026	N/A
BAH (sec)	41.7 (30.4)	36.0 (27.9)	37.38 (26.9)	0.67	.51	.008	N/A
SR (sec)	222.4 (24.4)	220.9 (25.8)	225.3 (23.1)	1.06	.35	.006	N/A

LBW: *Low birth weight*, NBW: *Normal birth weigh,* HBW: *High birth weight,* BMI: *Body mass index,* FB: *Flamingo balance,* PT: Plate tapping, SR: *Sit-and-reach*, SBJ: *Standing broad jump,* HG: *Hand grip*, SP: *Sit-ups*, BAH: *Bent arm hang* SR: *Shuttle run* N/A*: Not applicable.*

DISCUSSION

This study investigated the influence of birth weight on physical fitness parameters in 180 children aged 8 to10 years old. It is a crucial issue to investigate the influence of birth weight as a biological factor on physical fitness and health, in order to introduce preventive policies and guidelines for infant, child, and adult health. The present study was the first reported study that assessed the influence of birth weight on the physical fitness of preadolescent children in Turkey.

This study examined the body weight, height and BMI differences among the birth weight groups, and no statistically significant difference was found between the groups. Our findings have been corroborated by many previous studies reported that there were no evidence for an association of birth weight with body weight (29), height (30), BMI (21,23,31) later in life. Throughout childhood, a diversity of complementary hormonal processes and environmental factors (diet and physical activity) may strongly regulate growth and tissue formation and differentiation as independent from birth weight. It has been also suggested that individuals may offer an adequate plasticity to adjust their growth and developmental trajectories according to their environments (13,32). Additionally, numerous researches indicated that early LBW and LBW infants demonstrated catch up growth later within the years of their life (30,33,36). In this context, the results of the present study are logically supported by those researches. Our analysis revealed that the LBW group was born 3 weeks earlier than the NBW group (*p<0.01*). In literature, many researchers reported that there was a strong relationship between the birth weight and gestational age. These reports show that majority of low birth weight infants are premature (born before 37 weeks of pregnancy) (35-37). Our findings are consistent with these reports.

We revealed that the dynamic muscle endurance (sit-ups and bent arm hang), static and explosive strength (handgrip and standing board jump), flexibility (sit and reach), static balance (flamingo balance), speed of limb movement (plate tapping) and speed and agility (10 x 5 meter shuttle run) were not significantly different in children with LBW, NBW, and HBW. Our results about physical fitness parameters and birth weight are compatible with some previous reports (14,15). In a previous similar study, Moura Dos Santos et al. reported that children with LBW were not significantly different from their NBW peers in standing long jump, dynamic muscle endurance (curl-ups), flexibility, and agility (13). Van Deutekom et al. suggested that birth weight was not associated with standing board jump and handgrip strength after adjusting for current height and BMI in children aged 8-9 years old (16). These findings of researchers were consistent with our findings about physical fitness parameters and birth weight. The other study in this field reported that genetic factors were most likely to be important in the association between birth weight and adult hand grip strength (15).

In literature, some researchers have suggested results opposite to our findings. Burns et al. stated that physical fitness level of very LBW children aged 11-13 years was significantly lower than the control group (38). Touwslager et al. found that there was an association between birth weight and physical performance (strength, balance, and VO_{2max}) in adolescents (39). In another study, Moura Dos Santos et al. proclaimed that LBW children (aged 7-10) had significantly shorter stature, lower lean body mass, muscle strength, and speed than NBW group. They also reported a very interesting result regarding the influence of birth weight on physical fitness (13). They observed LBW children had a higher aerobic capacity than NBW group, but this finding was inconsistent with both the findings of previous studies and ours. Ylihärsilä et al. examined 2,000 men and women born between the years 1934 to 1944, and asserted that 1 kg increase in birth weight caused 4.1 kg increase of adulthood muscle mass in men and 2,8 kg in women. They also found that there was a significant positive relationship between birth weight and handgrip strength (40). Hack et al. noted that there were significant differences between very LBW and NBW children aged 8 years old in mean height, weight and BMI ($p<0.001$), however, the final conclusion of this study stated that very LBW females catch up to the growth rate of their normal weight peers by 20 years (20). These discrepancies with our results may be explained by the possibility which physical fitness may be more influenced by genetic, environmental and behavioral factors in the sample of this study. Overall, we found a general inclination to higher BMI (19.±3.1 kg/m^2) within the groups in this study. It is well known that higher body weight is negatively associated with running, jumping and during other events (14). Therefore, participants' body weight also might mask a potential association between birth weight and physical fitness parameters, as measured in this study. There is lack of clear evidence in the literature due to inconsistent and opposite results of researches investigating the influence of birth weight on physical fitness level and parameters. Therefore, the mechanisms underlying the association between birth weight, intrauterine growth, and later physical development may remain speculative.

CONCLUSION

As a result of this study, it is determined that low or high birth weights have no influence on the measured anthropometric and physical fitness parameters of children aged 8 to 10 years old. Physical fitness parameters are influenced by many factors such as; age, gender, genetic heritage, socio-economic status and personal behaviors (physical activity level and eating habits). Therefore, these factors or a combination of all the factors may have caused the lack of significant difference between birth weight groups for all physical fitness parameters and anthropometric characteristics. Future researches should examine the greater numbers of participants and employ longitudinal designs.

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