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Soccer Impact on the Physiological Profile of Beginners

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Abstract

The study examined the longitudinal impact of soccer training on the physiological profile of soccer beginners. Anthropometrical (e.g. body mass index, body fat) and physiological characteristics (e.g. speed, agility, vertical jump, VO₂max) were measured at the beginning, middle and end of the season. Seventeen soccer beginners aged from 10 to 15 years old (12.41 ± 1.734) participated in the study. They all had less than one year of soccer training experience. The results confirmed the impact of soccer training on anthropometrical and physiological variables of the beginners. The peak performance of some variables such as speed, agility and VO₂max achieved in the middle of the season that training sessions were combined with soccer games. Therefore it is of great importance for youngsters to participate to a soccer team with regular training sessions and games so as to improve their physiological as well as their health profiles.

Keywords: Soccer, health, physiological, anthropometrical, youngsters

Introduction

The World Health Organization has defined physical activity as every body movement produced by skeletal muscles that requires energy expenditure. At the same time physical inactivity has been identified as the fourth leading risk factor for global mortality causing an estimated 3.2 million deaths globally. Any physical activity of regular intensity such as walking, jogging, cycling, team sports, has a major impact on health. Exercise effects on various body systems are well established. For instance, physical activity is associated to cardiovascular diseases, type II diabetes, colon and breast cancer, as well as depression. Moreover regular exercise programs reduce the risk of a hip or vertebral fracture and help control weight (WHO, 2014). Specifically, soccer training prevents or treats obesity and its comorbidities (Moreno, León, Serón, Mesana, & Fleta, 2004). Concerning the cardiovascular system it has been found that regular physical activity has a great impact on the body's capacity to carry blood in the coronary arteries, the distribution of the blood in the body, the blood glucose handling and the resting blood pressure. Although soccer develops the cardiovascular system (Bekris et al., 2011), it has been found that playing time is a variable that moderates its effects (Bekris, Gissis, Sambanis, Anagnostakos, & Sotiropoulos, 2012). It is also recognized as an important indicator of mental health (Miles 2007). Frequently parents view soccer as the vehicle for developing their children's life skills. They do not view soccer as a career for their children but they consider it as a method to improve their life skills. Life skills are considered as the transferable skills that everyday life requires, such as physical, cognitive and behavioral (Holt, Tink, Mandigo, & Fox 2008; Papacharisis, Goudas, Danish, & Theodorakis, 2005). Although soccer training programs aim to improve aerobic capacities, it has been found that they improve various aspects on the soccer performance (Hoff & Helgerud, 2004). Physical and physiological characteristics of young soccer players have been well examined by sport scientists (Carling, Le Gall, Reilly, & Williams, 2009; Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007; Gioldasis, Bekris, & Gissis, 2014; Gioldasis, Bekris, Komsis, Gissis & Alipasali, 2014). Although there is a great body of research on elite soccer players there is a gap concerning soccer beginners. Krustup and colleagues (2009) examined the effects of regular participation on recreational soccer in the health profile but they focused in cardio-vascular and musculo-skeletal adaptations. Whereas vast research has focused on physiological changes due to exercising in recreational sports such as walking, jogging, running, and cycling, there is a gap concerning entry level soccer players. In our knowledge no studies appear to examine the longitudinal effects of recreational soccer on the health profile of soccer players. The "big count" of the Federation Internationale de Football Association (FIFA) revealed that more than 265 million male and female registered players – or about 4% of the world's population – are actively involved in soccer (FIFA 2007). Despite this great percentage little is known about the longitudinal effects of regular soccer training. Therefore it would be of great interest to examine how regular soccer training affects the physiological characteristics related to the health profile of the players. Furthermore, the longitudinal structure of the current study will indicate how this player's profile is altered because of training. Thus according to FIFA's percentage of the world's population enacting

with soccer, the findings of this study may indicate the importance of soccer training as a classical health promoting activity

Materials and Methods

Participants

Seventeen soccer players aged from 10 to 15 years old (12.41 ± 1.734) participated in the study. All of them were members of a soccer team competing at the lowest level group for their age categories. They all had less than one year of soccer training experience which was the only limitation of the study. The university committee approved the research project. After informing the parents and the guardians of the participants about the ethics, the aims, the benefits and the risks of the study they provided written informed consent prior the first measurement of the season. The players participated in soccer training program twice per week for about 1 hour and 15 minutes. Each training session consisted of a 15-minute warming up, a 30-minute technical and tactical training, as well as a 30-minute simulated competition. During the study the players did not participate in any other organized training program or a specific strength and conditioning program either in or off season.

Measurements

Anthropometrical characteristics

The researchers used a calibrated precision weighing scale (BC1000, Tanita) to measure the body's weight (kg), the body's fat (%) as well as the body's mass index (BMI). In addition a cursor was placed on each participant's head to measure their height (cm).

Physiological characteristics

The participants had a 10-m sprint with a stationary start. Sprint times were recorded using infrared photoelectric cells interfaced to a timing system (Microgate, RACETIME 2) positioned 10-m from the starting line with a time resolution of 0.01 second and a measurement error of ± 0.01 second. They performed 3 trials, while a 3 minute recovery was allowed between each trial. The fastest 10-m sprint time was selected for analysis. Previous research has confirmed the reliability and the validity of the tests (Katis & Kellis, 2009; Wong, Chamari, Dellal, & Wisløff, 2009). The participants performed a vertical jump on the optical device called OptoJump System (Microgate, Bolzano, Italy) to measure their lower body explosive strength. OptoJump System consisted of two bars, the transmitter and the receiver, which contain photocells which are constantly communicating. This device detects any interruptions in communication between these bars and calculates their duration. The countermovement jump that the participants performed starts from a standing position allowing the countermovement with the intention of reaching knee flexion angles of about 90° just before the immediate vertical impulsion. Each player performed 3 trials interspersed with 1 minute recovery between each trial, and the highest jump was used for analysis. Previous findings confirmed the reliability and the validity of the tests (BenOunis et al., 2013). Agility was measured using the Illinois agility test which past research confirmed its reliability and validity (Katis & Kellis, 2009). For the assessment of agility two lines were drawn at a distance of 10 m from each other. The first line served as the starting and end-point line, while the other served as the touch line. The player started off by lying down with the hands next to the shoulders (start). After a verbal signal, the players got up and sprint until the touch line. They then run back to the starting line and immediately performed a zig zag around the

cones go and return. After zig zag they run back to the touch line before returning to the finish line. The participants run as fast as possible without falling and knocking down the cones. If a cone was knocked down or the participant did not follow the prescribed path, the trial was cancelled. Time was measured by gates using photocells (Microgate, RACETIME 2) positioned at the starting and the finishing line. Each player performed 2 trials interspersed with 1 minute recovery between each trial, and the best trial was used for analysis. The shark skill test is a reliable and valid method to assess the dynamic balance of the players (Gatz, 2009). A box that consisted of 9 squares 30cm each of these was drawn by the researchers. The participants stood on the center square on one foot, and hopped inside the other squares in a row. Before each advancing they had to return to the center square. Two stopwatches were activated by the researchers at the starting signal and were stopped when the participant finished the last jump. The average of these two values was used in the analysis. Furthermore, a penalty time of 0.10 s was added for each time the participants were touching the lines of each square, not returning to the starting square and touching the ground with the non-hopping foot. Each player performed 2 trials for each foot with 1 minute recovery, and the best trial was used for analysis. Sit and reach test was used to assess the flexibility of the lower back and hamstrings (Bertolla, Baroni, Junior, Pinto, & Oltramari, 2007; Wells & Dillon 1952). It involves removing shoes and socks, sitting on a mat with legs stretched out straight ahead. Participants place the soles of the feet flat against the testing box. Then with the palms facing downwards, and the hands on top of each other, they were reaching forward along the measuring line as far as they could. Researchers recorded the distance that was reached by the hands. Each player performed three trials. The highest value was used in the analysis. The optical device OptoJump System (Microgate, Bolzano, Italy) was used to assess the reaction time to visual stimulus which was assessed by the mean flight time when the participant reacts to an optical stimulus by raising his foot after three stimuli in a row for each foot. Specifically, the player must 'react' to a stimulus from the PC screen that a red circle becomes green after a random period of time. Each participant had three trials for each foot. Past research has also used this method to assess the reaction time of athletes (Yi-feng, 2012). The aerobic condition (VO_{2max}) of the players was assessed with the 20 m shuttle run test. Past research has confirmed its reliability and validity (Léger, Mercier, Gadoury, & Lambert, 1988). This test took place on the pitch between two parallel lines of 20 m distance that the players had to run back and forth and touch the 20 m line at the same time that a sound signal was emitted from a pre-recorded tape. The frequency of the sound signals was increasing in such a way that running speed was increased by 0.5 km h^{-1} each minute from a starting speed of 8.5 km h^{-1} . The test stopped when a player was unable to reach the line before the sound signal for two times in row. The last announced stage number was then considered as the VO_{2max} value which was used in the analysis.

Procedure

The researchers informed the training staff of the team about the aims of the research project and they agreed to participate in the study. They arranged three dates throughout the season, the first before the first training during September, the second in the half of the season during January and the third at the end of the season after the last training session during June. The participants were familiarized to all test procedures before the assessment of their physical and physiological characteristics. Similar environmental conditions were used for the indoor tests while the outdoor tests were performed under a difference of about 10° of calcium between the second and the other measurements.

Statistical analysis

All the values of physical and physiological characteristics are expressed as means and standard deviations. Principally, Kolmogorov-Smirnov and Levene's tests were used to examine the homogeneity and the normality in distribution of the variables. The researchers then run Friedman test instead of one-way ANOVA with repeated measures because of the violated assumptions. Finally paired-sample t tests were conducted to examine the differences among the groups.

Results

The following table shows the descriptive statistics (means and standard deviations) for all the measurements of the variables (Table I). It also presents the Friedman analyses and the comparisons between the measurements.

Table 1. Descriptive statistics, Friedman tests and paired wise comparisons of the variables

Measurements	1 st	2 nd	3 rd	Friedman	Paired wise
	M (SD)	M (SD)	M (SD)	χ^2	
Height	150.77 (15.17)	152.82 (15.47)	155.21 (15.16)	34.000***	1<2; 2<3; 1<3
Weight	44.19 (14.54)	45.05 (14.49)	46.55 (14.23)	19.882***	1<2; 2<3; 1<3
Body Fat	15.77 (4.90)	16.95 (5.41)	14.72 (4.82)	13.059***	1<2; 2>3; 1>3
BMI	18.91 (2.63)	18.77 (2.64)	18.89 (2.46)	1.531	
Left leg balance	10.27 (2.63)	8.15 (1.79)	7.74 (1.68)	15.176***	1>2; 1>3
Right leg balance	9.69 (2.35)	7.53 (1.68)	7.45 (1.64)	17.821***	1>2; 1>3
Left leg reaction time	.54 (.05)	.52 (.04)	.54 (.06)	.400	
Right leg reaction time	.54 (.04)	.53 (.04)	.50 (.04)	8.585**	1>2; 2>3; 1>3
10m sprint	2.15 (.16)	2.09 (.22)	2.15 (.20)	8.212**	1>2; 2<3
Agility	18.22 (1.54)	17.49 (1.55)	17.67 (1.52)	10.776**	1>2; 2<3; 1>3
Vertical Jump	22.44 (5.84)	22.41 (6.20)	24.84 (6.36)	8.818**	2<3; 1<3
Flexibility	16.82 (4.77)	17.41 (7.27)	18.59 (7.26)	3.492	
VO2max	46.55 (4.61)	48.51 (4.07)	44.14 (7.81)	2.716	

* p<.05 ** p<.01 *** p<.001

Friedman test

Comparison of the repeated measures was performed using Friedman's test because one-way ANOVA with repeated measures violated the necessary assumptions. The test showed a statistically significant change of height ($\chi^2 = 34.000, p < .001$), weight ($\chi^2 = 19.882, p < .001$), body fat ($\chi^2 = 13.059, p < .001$), left leg balance ($\chi^2 = 15.176, p < .001$), right leg balance ($\chi^2 = 17.821, p < .001$), right leg reaction time ($\chi^2 = 8.585, p < .01$), 10m sprint ($\chi^2 = 8.212, p < .01$), vertical jump ($\chi^2 = 8.818, p < .01$), and agility ($\chi^2 = 10.776, p < .01$). A non-statistically significant change was found for the BMI ($\chi^2 = 1.531, p = ns$), left leg reaction time ($\chi^2 = .400, p = ns$), flexibility ($\chi^2 = 3.492, p = ns$), VO2max ($\chi^2 = 2.716, p = ns$).

Paired-sample T tests

Paired-sample T tests were conducted to examine the differences among the groups resulting in a significant increase between the measurements of height $1^{st} < 2^{nd}$ ($t = -8.250, p = .000$), $2^{nd} < 3^{rd}$ ($t = -8.653, p = .000$) and $1^{st} < 3^{rd}$ ($t = -10.038, p = .000$). Regarding weight a significant increase was observed among the measurements $1^{st} < 2^{nd}$ ($t = -3.059, p = .007$), $2^{nd} < 3^{rd}$ ($t = -4.552, p = .000$) and $1^{st} < 3^{rd}$ ($t = -4.851, p = .000$). Concerning body fat a significant increase was found between the measurement $1^{st} < 2^{nd}$ ($t = -2.286, p = .036$), while a reduction was found between the measurements $2^{nd} > 3^{rd}$ ($t = 4.051, p = .001$) and $1^{st} > 3^{rd}$ ($t = 1.803, p = .090$). The left leg balance presented the following improvement among the measurements $1^{st} > 2^{nd}$ ($t = 3.404, p = .004$), $2^{nd} > 3^{rd}$ ($t = 1.287, p = ns$) and $1^{st} > 3^{rd}$ ($t = 4.335, p = .001$), as well as the right leg balance $1^{st} > 2^{nd}$ ($t = 3.777, p = .002$), $2^{nd} > 3^{rd}$ ($t = .173, p = ns$) and $1^{st} > 3^{rd}$ ($t = 4.546, p = .000$). Similarly right leg reaction time decreased among the measurements $1^{st} > 2^{nd}$ ($t = 1.707, p = .107$), $2^{nd} > 3^{rd}$ ($t = 2.311, p = .034$) and $1^{st} > 3^{rd}$ ($t = 3.394, p = .004$). The 10m sprint revealed a significant improve between the measurement $1^{st} > 2^{nd}$ ($t = 2.226, p = .041$), but the players reduced their performance between the measurement $2^{nd} < 3^{rd}$ ($t = -3.343, p = .004$). As far as the vertical jump a significant increase was found between the measurements $2^{nd} < 3^{rd}$ ($t = -4.806, p = .000$) and $1^{st} < 3^{rd}$ ($t = -3.006, p = .008$), as well as the agility was improved between the measurements $1^{st} > 2^{nd}$ ($t = 5.367, p = .000$) and $1^{st} > 3^{rd}$ ($t = 3.176, p = .006$). However the agility performance was reduced between the measurement $2^{nd} < 3^{rd}$ ($t = -2.030, p = .059$).

Discussion

The findings of the current study confirm the impact of soccer training on the health profile of beginner players. Furthermore, it is of great importance how these characteristics change throughout a competitive season. Height and weight of the players were normally increased because of the maturation of the youngsters. Concerning body fat although an increase took place in the first half of the season it was finally reduced in the end of the season. Literature review showed that organized physical activity (LeMura & Maziekas, 2002; LeMura et al., 2000) as well as professional soccer training (Ostojic, 2003) reduces body fat. In congruence with past research soccer players reached the lowest levels of body fat at the end of the season (Ostojic, 2003). This fact was probably due to the intensive training, the competition schedules, the dietary habits as well as some psychological effects. This finding was also supported by the fact that even high leveled players tend to have high depots of body fat than the optimal (Manna, Khanna, & Dhara, 2010; Ostojic, 2003). In contrast to previews findings (Ostojic, 2003) BMI did not change significantly. Changes of height and weight probably

affected this index. Furthermore, BMI ranged in normal level which indicates that soccer would prevent youngsters from diseases. It also reduces cardiovascular, obesity, diabetes, pressure and cancer risks. As for the dynamic balance the results revealed a significant improvement in all the measurements. Past research indicates that athletes perform higher balance than non-athletes as well as that balance is related to the experience of the players (Davlin, 2004; Hahn, Foldspang, Vestergaard, & Ingermann-Hansen, 1999). Therefore balance was probably improved because of the experience and the frequent one-leg movements and positions such as dribbling, passing and kicking (Bekris, Gioldasis, & Gissis, 2014; Bressel, Yonker, Kras, & Heath, 2007). Concerning the reaction time to visual stimulus the results showed an improvement but only for the right leg. Literature review supports our finding since soccer players tend to perform better on visual stimulus than non-athletes (Soichiando & Oda, 2001). As for the changes only on the right leg a possible explanation is that for the majority of the participants the dominant foot was the right which they practiced more during the training sessions. Regarding 10m sprint and agility players improved their performance in the middle of the season finding that the literature review supports (Huijgen, Elferink-Gemser, Lemmink, & Visscher, 2012; Ostojic, 2003). However, both the sprint ability and the agility reduced at the end of the season that was probably due to environmental changes such as the weather. In addition the training program was not specified for improving the sprinting ability and agility of the players. Probably soccer training as well as regular participation in soccer games improves the acceleration and the agility during the competitive period. It seems that competitive period heightens the leg strength, the coordination of the muscles and the development of fast-twitch muscle fibers. Regarding the lower body explosive strength of the players it was increased after the middle of the season. Literature review supports the finding about changes on vertical jump of the players (Wisløff, Castagna, Helgerud, Jones, & Hoff, 2004; Schmidtbleicher, 1992). However, a possible explanation for not altering the vertical jump in the beginning of the season was the entry level of the players as well as that the training program was not specified enough for improving the lower body explosive strength. Literature review confirmed that vertical jump does not change without a specific training program aiming to develop the lower body explosive strength (Mohr, Krustup, & Bangsbo, 2003). Concerning flexibility it was found that soccer training improves this skill but not significantly enough. Previous findings concluded the benefits of stretching on flexibility (Zakas, 2005). Finally a tendency was found that soccer training improves the aerobic condition of the players but only in the middle of the season. Literature review supports the changes of VO₂max because of training (Rowland & Boyajian, 1995) which is also related to better cardiovascular system (Bekris et al., 2012). However it was notable that VO₂max was reduced at the end of the season. This finding is probably explained by the environmental changes as well as the fact that before and after the season, many soccer players reduce aerobic activity and change their nutritional and behavioral habits (Ostojic, 2003). In addition, Rowland and Boyajian (1995) suggested that aerobic condition can be improved with endurance training during the childhood years, but the degree of aerobic trainability is limited in healthy, active children. Thus, it is obvious that beginner players improve their aerobic condition rapidly and then they present a reduction. However the VO₂max changes of the current study were not significant.

Conclusions

In conclusion, soccer training positively affects anthropometric characteristics such as the body mass index and the body fat in developmental ages. Thus soccer is an activity that improves players' health profile. Furthermore it improves physical as well as physiological characteristics such as balance, reaction time to visual stimulus, speed, vertical jump, agility, flexibility and VO₂max. Finally, the study showed that peak performance of variables such as speed, agility and VO₂max is achieved in the middle of the season. Therefore it is of great importance for youngsters to participate to a soccer team with regular training sessions and games.

Conflict of Interest

The authors have not declared any conflicts of interest.

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