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THE IMPACT OF AGE AND BODY COMPOSITION ON PHYSICAL FITNESS AND SOCCER SKILLS AMONG PRE-PUBERTAL PLAYERS IN "MIXED-AGE" TEAMS

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Abstract: Purpose*: The main objective of this research was to examine how age impacts physical fitness and soccer skills among players in mixed-age teams. Additionally, the study aimed to explore the connection between body fat percentage, BMI, and physical performance.* ***Methods****: The researchers selected 43 pre-pubertal children from an amateur soccer school and placed them in the "Under 10" or "Under 12" groups based on age. To evaluate the players, the researchers conducted tests such as the standing long jump, 20-meter sprint, shuttle dribble, and Yo-Yo Intermittent Recovery Test level 1 modified for Children (YYIR1C).* ***Results****: The results indicated that older and more experienced children performed better in physical and soccer-specific evaluations (p < 0.0001). Moreover, higher body fat levels harmed physical exertion and soccer-specific performance (p< 0.001).* ***Conclusion****: Therefore, mixed-age teams may not be the most effective solution for maximizing soccer school schedules, and nutritional guidance should be incorporated into soccer school programs.*

Key Words: Prepubertal Soccer– Different Years Of Age–Optimal Training – Soccer School – Lack Of Players.

INTRODUCTION

The "soccer school" usually refers to soccer activities for pre-pubertal children. It involves a wide range of players, ages four to twelve. According to Tanner's maturation[1], soccer school players go from stage I to stage III. Thus, anthropometrics, physical fitness, and motor performance abilities differ in the whole range of participants [2]–[4]. For this reason, soccer school players are usually grouped according to their chronological age to guarantee training homogeneity.

Nevertheless, chronological age not always corresponds to skeletal and biological maturation[5]–[7]. For example, Carrascosa and colleagues[8] identified five types of possible physical and skeletal growth that go from "very early" (hugely anticipated development concerning chronological age) to "very late" (significantly delayed development concerning chronological age). Therefore, different biological profiles might be located in the same age group, affecting training homogeneity[9]. Nowadays, several tools are available to assess skeletal and physical maturity. Wrist radiography[10], wrist ultrasounds scanning[11], and Dual-Energy X-ray Absorptiometry (DEXA) measurement[12] are direct methods to investigate skeletal and biological age in children. Alternatively, Mirwald and colleagues[13] developed a practical and non-invasive approach to predict physical and skeletal maturation from simple anthropometric measures. Finally, the simple computation of the Body Mass Index (BMI) is a valid method for understanding children's growth [14]. However, grouping players according to biological and skeletal development could be difficult for amateur or recreational clubs. It involves having many children to ensure an adequate number of squads. Thus, professional or well-organized academies might utilize these methods, but it could be harder for amateur or recreational soccer schools because of the restricted number of players or logistics. Besides, it is not rare that amateur clubs mix players in soccer school squads to guarantee the correct number of players to participate in local competitions.

Nevertheless, information about the effects of mixing children of different ages is deficient in pre-pubertal soccer. Figueira and colleagues[15] investigated how playing football with varying age groups affects tactical behaviour and physical performance. They found that the youngest trend generally increases their physical effort while the oldest reduces it. Tactically, the oldest showed better performances because of their more excellent football experience. Despite this, the study was conducted on adolescents (U15 and U17), so nothing is known about physical fitness and specific soccer ability changes in pre-pubertal players playing in mixed-age squads. This study aimed to investigate the effects of age on physical fitness and specific soccer abilities in a group of "Under 10" compared with an "Under 12" one playing in "mixed-age" teams. We hypothesized that "Under 12" might show better physical performances because they experienced two years more motor development than "Under 10". Secondly, we investigated the relationship between the percentage of body fat, BMI and physical tests to assess if we can observe in children the same trend in performance reduction in adults[16]

MATERIALS AND METHODS

According to their chronological age, forty-three healthy male children were recruited from an amateur soccer school and assigned to the Under 12 group or Under 10 groups. The testing sessions were performed in four training days between September and October 2021.

Only children with at least one year of experience in soccer training were considered eligible for the study. All testing procedures and any possible risks and discomfort were fully explained in detail to parents and trainers and the participants themselves before the start of the study. Furthermore, all the participants' parents signed a written consent form for participation in the study. The bioethical committee approved this study of the University of Turin (protocol number: 470603).

Procedures

Measurements were conducted on four separate days simultaneously and at the beginning of the training session to avoid that fatigue might affect the outcomes. Besides, tests were conducted on the usual training field and sunny days to reduce bias due to the changing playing surface and weather conditions. Anthropometrics were registered first, while neuro-muscular and aerobic fitness were performed considering energy expenditure and fatigue; less demanded first, more expensive last. Neuro-muscular mechanisms (lower limbs power and speed) were evaluated with the standing long jump and 20 meters sprint. Aerobic fitness was assessed using the Yo-Yo Intermittent Recovery Level 1 test (YYIR1C), modified for children[17]. Finally, the shuttle dribble test[18] was used to evaluate the ability to lead the ball at maximum speed on different distances with a change of direction (technical and coordinative evaluation). The Standing long jump, 20 meters sprint and shuttle dribble test were performed twice, taking the best score, while Yo-Yo Intermittent Recovery Level 1 was modified for children just one. Three minutes of rest were guaranteed between trials to ensure a complete recovery.

Testing Schedule

Tests were performed at the beginning of the training session. When the designed evaluation was accomplished, players practised regular soccer training. The test schedule was organized as follows: 1) Anthropometrics; 2) Standing long Jump and 20 meters sprint; 3) shuttle dribble test; 4) YYIR1C (Table I). Under ten were evaluated on Tuesday and Thursday, while Under 12 on Monday and Wednesday. Therefore, logistical interaction among the group during the testing schedule has been avoided.

Anthropometrics

Body mass (kg) and % of body fat were measured with the bio-impedance analyzer Tanita[19] (InnerScan 50 BC-313, Tokyo). Body mass was measured to the nearest 0.1 kg, with the participants wearing underwear only. Standing height was measured to the nearest 0.01 meter with a centimetre applied to the wall. BMI was calculated using a Microsoft Excel sheet where the BMI formula was previously inserted (BMI= Bodyweight/ (height x height)).

Standing long jump test

Participants stood behind the white back line of the court with feet shoulder-apart and performed a two-foot take-off, swinging the arms and bending the knees to provide forward drive. The subjects were instructed to jump as far as possible, landing on both feet without falling backwards. Two attempts were performed, and the best score was considered for analysis.

20 meters Sprint

This test involves running a single maximum sprint over 20 meters, with the time recorded. Two pairs of photocells (Microgate Witty, Bolzano, Italy) are placed one meter apart at the start and finish line. The player starts stationary, with one foot in front of the other. The front foot must be slightly behind the starting line to not activate time counting before running. The tester should provide a signal to start running, hints to maximizing speed and encouragement to continue running hard past the finish line. Two attempts were performed, and the best score was considered for analysis.

Shuttle dribble test

The shuttle dribble test requires the players to perform 30 m shuttle sprints at different distances carrying the ball. This test was born to evaluate field hockey performance but was also validated among soccer players[18]. One pair of photocells (Microgate Witty, Bolzano, Italy) are placed one meter apart at the start/finish line. The 180°-) direction changes are performed at 5, 6, 10 meters and 9 meters, returning to the photocells line after each change of direction. All distances must be completed at maximum speed while carrying the ball. All these shuttles must be performed in a 2-meters passageway. The test was repeated twice, and the best score was recorded for evaluations.

Yo-Yo Intermittent Recovery Test level 1 modified for Children

This version modified for children is very close to the "original" defined by Bansgbo and colleagues[20]. The main changes are in the shuttle length and distance for recovery. In this modified version, shuttles are 16 meters long instead of 20, and the recovery distance is four meters instead of five. However, the numbers of shuttles at each level, beep frequency, and running speed are the same as the traditional Yo-Yo Intermittent recovery level 1.

Players have to run out and back on a 16-meter course, with a 10-second active break (walking out and about on a four-meter path) after each 32m, with speed increasing at set intervals until they cannot continue. The test is completed when the player cannot continue and ask to stop or when the course is completed missing the "beep" two times consecutively.

Statistical Analysis

Data are presented as means ± standard deviations (SD). Data normality was verified with the Kolmogorov-Smirnoff test; therefore, a non-parametric test was not necessary.

A mixed model ANOVA (groups x trials) with Bonferroni post hoc test was used to determine the effect of age on trials. Furthermore, an unpaired T-Test was utilized to identify differences if a crossover interaction between groups and practices would be placed. Finally, Pearson r was calculated to investigate the relationship between BMI and body fat percentage with physical fitness.

The level of significance was set at $p < 0.05$. Data were analyzed using SPSS, version 19.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

Five players assigned to Under 10 and four from Under 12 did not complete all test sessions and were excluded from the analysis. Consequently, data were analyzed from 19 and 15 players in the Under ten and Under 12 groups, respectively. The anthropometric characteristics of the participants are presented in Table II. Under 12 were significantly taller ($p<0.001$) and heavier ($p< 0.05$), while no significant difference was noted in BMI ($p= 0.604$) and % of body fat ($p=0.179$).

Under 12 showed better performances in the standing long jump by 18% ($p < 0.0001$), in the 20 meters sprint by 7% ($p<0.0001$), in the shuttle dribble test by 14% ($p < 0,0001$) and in the YYIR1C by 76% ($p<0.0001$) (Table III). Furthermore, the percentage of body fat was negatively associated with the standing long jump ($r=-0.545$; $p< 0.001$) and YYIR1C ($r= -0.620$; $p< 0.0001$). In addition, the percentage of body fat was positively associated with the Shuttle dribble test ($r= 0.472$; $p<0.001$) and 20 meters sprint ($r=0.600$; $p< 0.0001$), while BMI was negatively associated with YYIR1 ($r= -0.484$; $p< 0.001$) (Table IV and V)

DISCUSSION

The primary aim of this study was to determine if chronological age could affect physical fitness and soccer-specific performance abilities. Anthropometrics analysis revealed that the Under 12 were taller and more substantial than Under 10, but BMI did not differ between groups. The intrinsic properties of this index might explain this fact. First, BMI is a value derived from the weight and height of the person[21]. Thus, considering mathematical rules, increasing the numerator and denominator did not affect the outcome. Secondly, BMI trends are higher in healthy shorter adults than taller ones[22], and this propensity seems to be confirmed in childhood by our findings. Finally, neuro-muscular mechanisms and physical fitness reveal that players from the Under 12 group are the strongest, fastest, and more resistant than those from Under 10 group. In pre-pubertal age, lower limb power and speed, measured using the standing long jump and 20-meter sprint, are strictly associated with coordination and multilateral motor experiences [23]–[25]. Motor learning refers to the processes associated with practice or experience that lead to the acquisition/reacquisition of relatively permanent movement capability[26]. Thus, being two years older offered more effective motor practice and expertise to Under 12 players, which might produce better outcomes in lower limb strength and speed.

Under 12 showed more significant levels of aerobic fitness. The YYIR1C test was utilized to assess this parameter. This trial involves running abilities, and running economy is related to motor performance abilities and practice[27]. Therefore, two more years of motor practice and experience paid again in favour of Under 12 manifesting better aerobic fitness results. Thirdly, soccer-specific performance abilities evaluated with the shuttle dribble test[18] highlighted better outcomes in those from the Under 12 group than the Under 10 group. Handling the ball is complex and requires high coordination levels and specific motor experience[28]. Again, in pre-pubertal children, older means having more motor experience and specific practice that help express better performances during evaluations. Finally, the Under 12 group performed better in neuro-muscular mechanisms, physical fitness, and soccer-specific performance abilities. These findings confirm our hypothesis that older children could be more experienced in motor performance abilities and, consequently, showed better outcomes during the physical evaluation. According to our findings, mixed-age rosters in soccer schools are not advantageous for younger players. They are disadvantaged in anthropometrics, neuro-muscular mechanisms, aerobic fitness, and soccer-specific tasks. Therefore, alternative strategies are needed. One possible solution is represented by futsal. The high similarity with soccer combined with the smaller number of players represents a possible strategy to overcome the lack of players of the same year of age. Also, futsal has been proved to be very functional in improving soccer-specific skills and promoting motor performance ability transfer[29]. Future studies should investigate the benefits of futsal insertion on the process of specific-soccer performance abilities development in pre-pubertal age.

Secondly, we investigated the relationship between the percentage of body fat, BMI, and physical tests. The highest level of body fat (in percentage) was correlated with the worst outcomes in evaluating neuro-muscular mechanisms, aerobic fitness, and soccer-specific performance abilities. On the opposite, higher scores of BMI were only related to lower scores in YYIR1C. BMI is considerably limited even if it is a helpful tool for investigating children's skeletal and biological maturation and health[14]. BMI can effectively neutralize the influence of height on body weight, but it provides no distinction between Fat Mass (FM) and body Free Fat Mass (FFM)[30]. Therefore, the body fat percentage analysis is more accurate in measuring the negative effect on the performance of high values of body fat. Our findings reveal that elevated body fat values adversely affect the neuromuscular mechanism, aerobic fitness, and soccer-specific performance abilities in prepubertal children, confirming the trend identified in adults[16].

In conclusion, possible limitations of this study are represented by the limited number of players and the inability to measure skeletal and biological maturation precisely. We enrolled children from an amateur soccer school to investigate the "mixed-age teams" and their effects on physical and soccer-specific performance abilities. However, the small number of players and the lack of organization and financial support typical of an amateur club might influence results. Future studies should improve this research by investigating the problem of "mixed-age" teams for an entire season to provide more information about training effects on younger and less experienced children.

CONCLUSIONS

In conclusion, the older and more experienced children showed better neuro-muscular mechanisms, aerobic fitness, and soccer-specific performance abilities. Therefore, mixed-age teams are not the best solution to maximize soccer school schedules. We suggest adopting different strategies to overcome the problem of squad formation due to a lack of players. Secondly, higher fat mass values negatively affect physical effort and soccer-specific performance abilities. Thus, nutritional advice should be included in soccer school development programs to maximize soccer development plans' benefits.

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