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Association between body composition, physical activity level and Illinois agility test performance in young males and females

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Abstract

Background and Study Aim: Agility performance, which is a skill related to fast change of direction, explosiveness, and quickness, is a vital performance component for team sports. Illuminating factors that affect agility is substantial to understand the ability requirements and improve. This study aims to investigate correlations of the body analyze parameters and agility performance.

Material and Methods: One hundred twenty three young participants (93 male, 30 female) were included in this research. Height, weight, fat (%), fat (kg), fat-free mass (FFM), muscle mass, total body water (TBW, kg, and %), bone mass, basal metabolic rate (BMR), metabolic age, visceral rating, and body mass index (BMI) measured for all participants. Illinois Agility Test (IAT) was used to analyze agility performance. A questionnaire including questions about the physical activity level of participants was applied to all participants after IAT.

Results: Results showed that height was a dominant determinant of IAT performance. There were significant positive correlations between height (negative correlation in women), body weight, fat percentage, fat mass, and visceral rating level ($p < 0.05$). TBW (%) had a negative relation with IAT duration ($p < 0.001$). There was a statistically significant difference in terms of IAT between the participants who stated their physical activity levels as low, medium and high ($p = 0.025$*). Increased daily physical activity level and daily step count increased the agility performance ($p < 0.05$).

Conclusions: Coaches and athletes should be considered especially body weight, fat (%), hydration status, and daily physical activity level to improve agility performance.

Keywords: agility, performance, illinois agility test, body composition, physical activity

Introduction

Agility is an ability including fast change of direction, quickness, and explosiveness. For variable sports, especially in team sports, agility is one of the essential skills of must-have in athletes [1, 2, 3, 4]. Additionally, the agility skill is related to balance, coordination, power, and speed [5, 6, 7, 8, 9]. Some frequently used tests for agility measures in the literature were Change of Direction [10], Zig-zag drill [11], T-Test [12], Arrowhead Test [13], and Illinois Agility Test [5, 9]. Some new agility tests have also been developed and introduced to the literature, like Butterfly Agility Test [14] and Taekwondo-Specific Agility Test [15, 16].

Sekulic et al. revealed that the determinants of the agility skill could be variable in male and female athletes. Researchers indicated that the agility predictors of women were speed and power, but the balance for men [17]. Freitas et al. found the men performance is better than women in Change of Direction (COD) tests, but not in Zig-zag drill [18]. McFarland et al. tested the agility performance by COD and found strong correlations with peak anaerobic power and agility in female soccer players, but not found in the male [19]. Jukic et al. underlined that agility has a significant role in determining the fighting efficiency of young female karateka [20]. Sonessan et al. [21] and Pereira et al. [22] showed male agility performances were better than females; both young soccer players, and elite handball players, respectively. Kramer et al. applied Functional Movement Systems (FMSTM) tasks to male and female high school students, including the deep squat, hurdle-step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability test, and applied Y-Balance test (YBT). They found a negative correlation between agility and FMSTM in males and the left and composite YBT in females

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[23]. Stanish et al. showed agility time significantly correlated with Physical Ability Requirement Evaluation (PARE) time for both genders [24]. Kozinc and Šarabon found Illinois Agility Test had a significant correlation between the 505 test and figure of eight tests in males and had a significant correlation between T-test, the figure of eight, AFL run test, Edgren test, and shuttle run test in females [25].

A total result from the given literature demonstrated that agility performance differs in males and females in various aspects. However, the effect of body analysis parameters on agility performance in young males and females remains unclear. We hypothesized that the body analysis parameters would be correlated with agility performance and would be various in males and females. We aimed to identify the relation of age, height, weight, fat percentage, fat mass, fat-free mass, muscle mass, total body water (weight and %), bone mass, basal metabolic rate, metabolic age, visceral rating, and body mass index with agility performance of young male and female. A secondary objective of this study was investigating the relationship between daily physical activity habits of 18-21 age participants with agility performances. The last objective of this study was to analyze the agility performance differences of young males and females.

Materials and Methods

Participants

Male and female Physical Education and Sports candidate students participated in this study. Among the applied students to the special talent test of University in 2021-2022, one-hundred twenty tree (93 male, 30 female) volunteers participated in this study. Average age of male was 19.05 ± 1.33 and female 18.93 ± 1.31. The participants had medical reports about no health barrier to participating in the athletic performance test of University. The study was approved by the Ethics Committee, and conformed to the policy statement with respect to the Declaration of Helsinki and ethical guidelines. Written informed consent outlining the purpose, procedures, and protocol risks were obtained from all participants; the study procedures followed the principles outlined in the Declaration of Helsinki and were approved by University Ethics Committee.

Research Design

In this comparative and correlational study, we investigated the relationship between Illinois Agility Test time and participants' age, height, weight, fat percentage, fat mass, fat-free mass (FFM), muscle mass, total body water (TBW, kg, and %), bone mass, basal metabolic rate (BMR), metabolic age, visceral rating, and body mass index (BMI). Firstly, the heights of the volunteers were measured. Then, participants' weights were measured, and body analyses were completed. After the measurements, the participants joined the Illinois agility test.

According to the second objective of this research, a questionnaire containing questions about physical activity levels was applied to the participants after the agility test. The questionnaire included the questions of participants daily step count (with answer choices: 2.500 – 5.000, 5.000 – 7.500, 7.500 -10.000, and 10.000+), average physical activity level (with answer choices: low, normal, high, and very high), licensed athlete or not (withs answer choices: "Yes" and "No") and participants rating of perceived exertion from Illinois Agility Test with answer choices between 1 (Very Easy) – 10 (Very Hard).

The participants' height was measured with standard protocol by Tanita HR-200 (Tokyo, Japan) stadiometer [26]. Body composition analysis of volunteers completed by calibrated Tanita Body Composition Analyzer SC-330 (Tanita Corp, Japan). Students participated in anthropometric measurements wearing light clothes, without wearing any all-metal items, and bare feet [27]. We recorded the weight, fat percentage, fat mass, FFM, muscle mass, TBW (kg), TBW (%), bone mass, BMR, metabolic age, visceral rating, and BMI measures from the body analyzer.

Illinois Agility Test is an agility skill measurement method that has been used in many studies [28, 29, 30] and has been tested for validity and reliability [5]. The test includes spins, slaloms, and sprint run around six cones similar to the "T" letter. The scheme of the Illinois Agility Test is shown in Figure 1. Participants started the test stepping one foot on the line one meter behind the left photocell to standardize the starting distance and avoid erroneous photocell recording. Before starting the test, participants were given 20 minutes to warm up. Each participant took the test twice, and the best times were recorded.

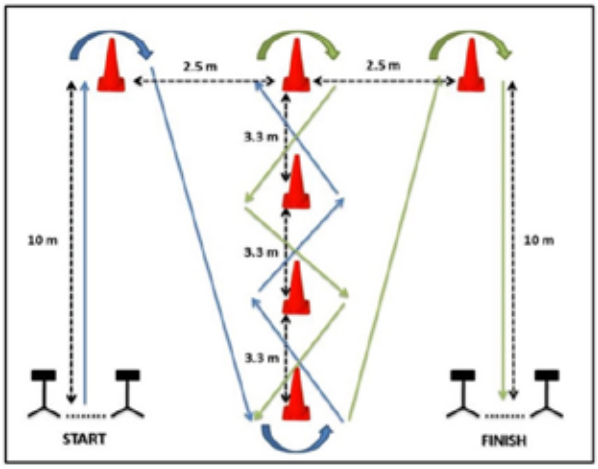

Figure 1. Illinois Agility Test [12]

The agility test was set in University Indoor Sports Hall. The test area was set up on a standard basketball court with parquet floors in the Hall.

Statistical Analysis

IBM SPSS Statistics 26 package program was used for statistical analysis of the research. Descriptive analysis was performed to determine the mean and standard deviation values for all measurements. According to the answers given to the physical activity level questionnaire, the participants were divided into four groups as low, normal, high, and very high, and the Illinois Test duration difference between the groups was tested with ANOVA. A similar grouping method was also made according to the answers given to the daily number of steps and licensed athletes' questions, and the ANOVA test was applied. The agility test times of male and female participants were recorded in separate tables, and Pearson Correlation analysis was applied to examine the relationship between the mean time values obtained for both groups and other measured demographic parameters. Independent Samples were analyzed by T-Test to analyze the difference between the mean agility test durations of male and female participants. The confidence interval was set as 95% for all statistical analyzes (*p < 0.05; **p < 0.01; ***p < 0.001).

Results

Height and body weight distribution analyzes of men and women in the participant group were performed and it was determined that they showed a normal distribution. As a result of the correlation analysis performed to examine the relationship between the IAT times and other measure results of male participants, it was determined that there was a significant positive correlation between height, body weight, fat percentage, fat mass, and visceral rating level (Table 1). As a result of the correlation analysis between IAT times and other measurements of female participants, negative correlations were found with height and TBW (%), but positively significant correlations with body weight, fat percentage, fat mass, BMR, metabolic age, visceral rating, and BMI values (Table 1). Correlations between other measurements and IAT times were insignificant.

The IAT durations showed a significant difference between the groups that expressed physical activity levels as low (n=1), normal (n=23), high (n=47), and very high (n=52) (p = 0.025*). It was observed that the test times shortened as the physical activity level increased (Figure 2).

The IAT performance of the group that marked the physical activity level as "very high" (mean = 16.16 ± 1.31 sec) was found to be better than the group that chose it as "normal" (mean=17.06 ± 1.39 sec; p = 0.036*). Participants were divided into groups according to their answers to the daily average number of steps, and the difference between IAT times was examined, but no significant difference was found. In the graph created according to the IAT duration averages of the groups, it was

Table 1. Pearson Correlation analysis of male and female Illinois Agility Test scores with age, height, weight, and anthropometric measures.

Variables	Men (n = 93)				Women (n = 30)			
	Mean	SD	r	p-Value	Mean	SD	r	p-Value
Age	19.05	1.33	0.06	0.574	18.93	1.31	0.01	0.965
Height (cm)	175.90	5.83	0.21	0.044*	162.00	4.39	-0.42	0.022*
Weight (kg)	69.73	9.87	0.25	0.014*	55.24	5.98	0.63	0.000***
Fat (%)	7.35	4.19	0.34	0.001**	16.05	5.41	0.71	0.000***
Fat Mass (kg)	5.43	3.88	0.34	0.001**	9.11	4.02	0.74	0.000***
FFM (kg)	64.29	7.05	0.17	0.108	46.13	3.20	0.25	0.176
Muscle Mass (kg)	61.10	6.73	0.17	0.108	43.79	3.04	0.26	0.174
TBW (kg)	45.46	4.70	0,11	0.282	33.32	2.46	0.30	0.113
TBW (%)	65.60	3.77	-0.39	0.000***	60.58	3.65	-0.69	0.000***
Bone Mass (kg)	3.20	0.33	0.17	0.109	2.34	0.16	0.23	0.232
BMR (kcal)	1902.48	213.77	0.19	0.076	1414.17	88.95	0.36	0.048*
Metabolic Age	12.49	2.58	0.19	0.062	12.80	2.64	0.56	0.001**
Visceral Rating	1.18	0.81	0.21	0.047*	1.07	0.25	0.68	0.000***
BMI	22.50	2.70	0.18	0,08	21.10	2.57	0.75	0.000***
Illinois-RPE	3.30	1.83	0.04	0.707	4.13	1.80	-0.03	0.897

SD = Standard Deviation; FFM = Fat-Free Mass; TBW = Total Body Water; BMR = Basal Metabolic Rate; BMI = Body Mass Index; Illinois-RPE = Illinois Test Rating of Perceived Exertion; *p < 0.05; **p < 0.01; ***p < 0.001

seen that the agility test times of the participants decreased as the daily number of steps approached 10.000 and above (Figure 3).

The IAT times of male and female participants were analyzed using the Independent Samples T-Test. Results showed that the agility test performances of male participants were significantly higher (Table 2).

Licensed athletes' agility performances (n=68; IAT mean = 16.14 ± 1.28 sec) were significantly better than non-licensed volunteers (n=55; IAT mean = 16.66 ± 1.18 sec; p = 0.022*).

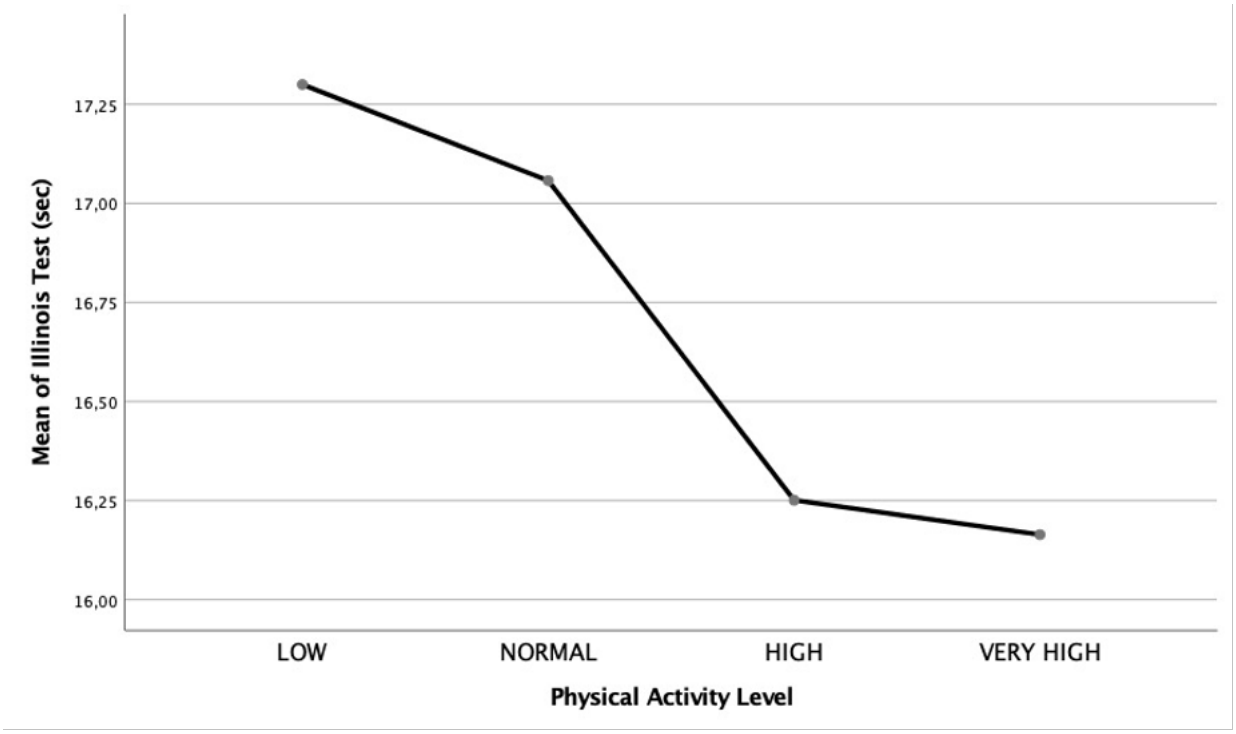

Figure 2. Average Illinois Agility Test (sec) according to the answers given by the participants to the physical activity question.

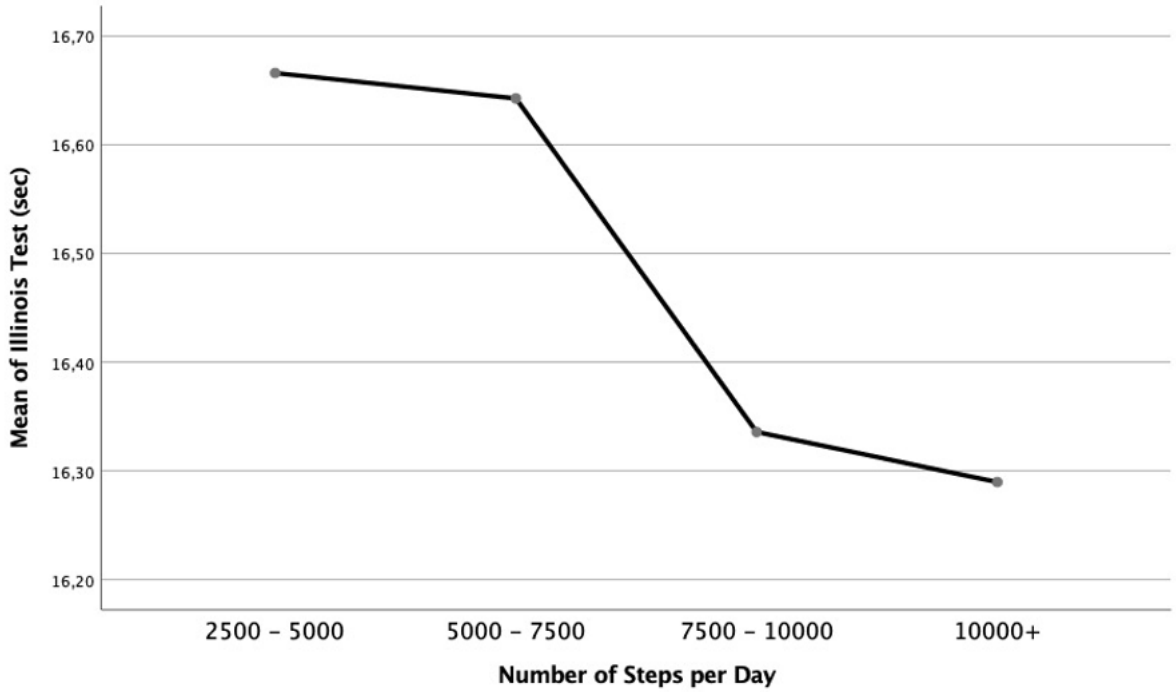

Figure 3. Average Illinois Agility Test (sec) according to the answers given by the participants to the number of steps per day.

Table 2. T-Test results of IAT mean' difference of men and women.

Gender	n	Mean (sec)	Best Time (sec)	p-Value
Male	93	15.982 ± 1.046	14.41	0.000***
Female	30	17.587 ± 1.092	15.95	

***p < 0.001

Discussion

Our research showed that physical activity and daily steps were associated with agility performance. It was observed that the Illinois agility test time decreased as the physical activity level increased from "low" to "very high" (Figure 2), and the average daily step count moved from "2,500" to "10,000+" (Figure 3). Pohl et al. worked with children with epilepsy on a similar topic and noted that children with epilepsy did not differ in their daily step counts compared to healthy children, but their agility performance was low [31]. Venckunas et al. showed a significant positive relation between agility and aerobic performance [6]. In addition, Rotman et al. revealed a relation between daily steps and aerobic ratio [7]. Considering these results, it can be concluded that the agility ability is related to physical activity and daily steps.

Our findings showed that as the height of male participants increased, Illinois agility test durations also increased. However, there was a negative relationship between height and test durations in female participants. Dhapola and Verma analyzed the relationship between height and agility in forty-five male participants and no found a significant relation [32]. The average height of participants in Dhapola and Verma's study was 167.82 ± 5.77 (n=45) cm but was 175.90 ± 5.83 cm (n=93) in our research. Different findings of both studies may be depended on the height averages of participants. Similarly, Thakur et al. found a significant positive relationship between height and thirty male participants who had 160.40 ± 2.62 cm height average [33]. In our study, female participants had 162.00 ± 4.39 cm average height, and female agility duration was negatively correlated with height (the opposite of the result in men). In conclusion, the agility and height relationship may variable depending on the participants' height average and gender.

Body weight and IAT duration relation showed a positive correlation in male and female. In other words, increased bodyweight harmed agility performance. Parallelly, Mayhew et al. and Dhapola and Verma showed a positive relationship between body weight and agility test duration [32, 34]. Similarly, fat percentage and fat mass negatively affected the agility performance of both males and females. Naylor and Greig found similar result between agility T-test and fat percentage in nineteen male participants [35]. Chaouachi et al. showed the same result between fat percentage and agility test duration in basketball players and found a significant correlation between agility T-test duration and body mass [36].

There was no significant correlation between TBW mass and agility test duration. However, a significant negative correlation between TBW percentage and agility test score was observed. Increased TBW percentage improved agility performance for both males and females. Serra- Prat et al. showed that the TBW (%) (used ICW as TBW in the article) had a significant impact on the functional performance of individuals with similar muscle mass and underlined the improved TBW related to improved performance. In addition, their study showed a significant relation between TBW (%) and gait speed, what often termed walking speed [37, 38]. In parallel, our study found participants who had increased TBW (%) had better agility performance.

Although metabolic age did not show a significant correlation with agility performance in males, it has a close value to be significant (r = 0.194; p = 0.062). In women, metabolic age showed a negative correlation with agility performance. In addition, our findings showed increased visceral rating positively related to increased agility test durations and therefore decreased performance. In men, BMI and agility performance no-showed significant difference (p = 0,08) but, a significant negative correlation was found in women. Increased BMI decreased the agility performance of women.

Men showed better performance than women in IAT. Moreover, the participants who have sportsmen licenses showed better agility performance than others (p = 0.022*).

Conclusions

Improved agility performance is an influential compound of many sports. Therefore, illuminating the factors affecting agility performance will benefit many sports branches. Our results enlighted some outcomes about agility performance as:

- Daily physical activity level and daily step count may affect agility performance.
- Height affects agility performance variously depending on gender, and research results differ by height average of participants.
- Increased body weight harmed the agility performance.
- Hydration may be a critical factor affecting agility performance. Increased TBW (%) increased agility performance.
- Higher metabolic age decreased the agility performance in women.
- Increased visceral rating decreased the agility performance.
- Increased BMI decreased the agility performance

in women.

Further research will clarify why height affected agility performance differently in males and females. These results will contribute to coaches and athletes improving agility performance.

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Conflict of interest

The authors declare no conflict of interest.

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