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Differences in Health-Related Fitness Variables between Adult Athletes and Non-Athletes with Down Syndrome: A Descriptive Study

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Abstract: The main purpose of this study is to present objective data on the differences in anthropometrics and fitness variables between adult athletes and non-athletes with Down Syndrome (DS) members of the "Down Cordoba Association" (DCA), after adjusting for confounders. Twenty-seven adults, 7 athletes and 20 non-athletes with DS, participated in this study. Health-related fitness variables were measured with tests validated for this population. First, the characteristics of the subjects according to sex and sports practice are presented. Athletes present significantly higher values for height (p = 0.010) and waist-to-hip ratio (p = 0.005). Furthermore, male athletes compared to male non-athletes have lower values in % of body fat (p = 0.030), and in waist (p = 0.031) and hip (p = 0.041) circumferences. Furthermore, athletes have better values in tests of strength, cardiovascular endurance (66.60 $\pm$ 47.66 vs. 32.31 $\pm$ 24.49 (s); p = 0.037), and agility, but not in flexibility. Significant differences were only found in cardiovascular endurance. As a conclusion, the practice of sports among the users of the "Down Córdoba Association" in general leads to better health-related fitness values. Therefore, we encourage the guardians of people with DS in this association to motivate them to practice sports because this practice will more likely improve their overall health.

Keywords: Down syndrome; physical fitness; athletes

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1. Introduction

Down syndrome (DS) is a genetic disorder caused by the presence of an extra chromosome in the pair 21. It is the leading cause of congenital intellectual disability and the most common human genetic disorder. It occurs in all ethnic groups, in all countries, with an incidence of one for every 600–700 conceptions in the world [1].

Most people with DS have muscle hypotonicity, ligamentous laxity and congenital heart disease and are often overweight. Individuals with DS have lower aerobic capacity, lower peak heart rates, and lower levels of isokinetic muscular strength [2]. Various scholars recommend health maintenance through regular physical activity for adults with DS [3]. The positive relationship between physical fitness and health is well studied [4]. Therefore, individuals with DS should be encouraged to engage in physical activity and sports by family members, teachers, and other care givers [5]. More research is still needed, however, to assess the best training programs to improve the health of this population [6].

A non-invasive approach to determine health status is through the evaluation of health-related fitness variables (anthropometric and physical fitness). The relationship between anthropometric features and performance has been well established [7–10]. Furthermore, anthropometric parameters may be helpful for the selection, prediction, and improvement of physical performance, as well as for preventing injuries and conducting health risk assessments [10]. It is also important to evaluate not only anthropometric characteristics, but also physical fitness capacities. Reduced physical fitness presents a significant problem in people with DS, since low fitness and activity levels have been associated with reduced survival rates in this population [11].

Despite some concerns related to sports participation, the increased risks of medical complications due to a sedentary lifestyle make physical activity participation essential for individuals with DS [5]. However, a physically active lifestyle is not common in individuals with intellectual disabilities (ID), with or without DS. Furthermore, the sedentary lifestyle of this population is often associated with obesity and low levels of physical fitness. Although opportunities to participate and compete in sports are available through the Special Olympics and other organizations, for example, not everyone with ID participates in organized sports activities [3,12]. For these reasons, we believe that presenting objective data will encourage the guardians of this population to enroll people with DS to practice and participate in sports. DS associations are also encouraged to implement sports programs, since an overwhelming amount of evidence asserts that lifelong exercise is associated with a longer health span, delaying the onset of many chronic conditions/diseases in the general population [13], but more research is needed specifically in the DS population.

Finally, most studies on health-related fitness in the population with DS compare health-related fitness variables in people with and without Down Syndrome but not athletes with non-athletes. Further, there is a need to investigate other environmental factors, such as the practice of sport, "to understand how to optimize quality of life in this population" [14].

For these reasons, the primary aim of this research is to present objective data on the differences in anthropometrics and fitness variables between athlete and non-athlete adults with DS members of the "Down Cordoba Association" after adjusting for confounders. An additional objective is to present recommendations on testing to assess improvements in health-related fitness in people with DS enrolled in an exercise program or sport.

2. Materials and Methods

2.1. Design and Participants

This is a descriptive, quantitative, correlational non-experimental study. The sample consisted of 27 adults with DS belonging to the Down Córdoba Association (DCA). Seven participants were athletes (6 men who practiced soccer and 1 woman who practiced swimming) who have practiced sport for more than 9 months (every athlete in this association), and 20 participants were non-athletes that have not practiced sport at least in the past year. We would like to highlight that this non-homogeneous sample in terms of gender is taken into consideration in the statistics. Their ages were 31.29 ± 7.9 and 37.9 ± 9.2 years, respectively (no significant differences were found in age between groups).

All participants submitted a medical consent prior to their participation in the study. Both athletes and non-athletes participated in two regular sessions of "Physical Activity" at the CDC. These sessions consist of basic movement patterns which aim to resolve motor difficulties in participants' daily lives as well as improving basic physical fitness. Furthermore, various sports were practiced (basketball, football, etc.), which included the use of balls in games modified and adapted to the participants, etc.

Outside the CDC, athletes also took part in two 90-min training sessions per week under the supervision of a coach. This type of training is more demanding and focuses on motor skills and intensity rather than the routine sessions at the CDC.

All participants lived with their families, and prior to participating in the study, parents, legal guardians, and those responsible for the center were informed of the study details and the related protocols. In addition, informed consent was asked of all participants through consent forms which the participants' tutors were required to sign, prior to sampling. Furthermore, all participants had to give their verbal consent to participate in the study. The study followed the guidelines set out in the Declaration of Helsinki (2013) [15] and approved by the Institutional Review Board of DOWN CÓRDOBA, Asociación Síndrome de Down (number 127; 03/09/2020).

2.2. Measurements

Anthropometric measurements were implemented in the gym, and physical tests were performed in the sports court of the DCA center. The tests were performed at the same time of day, and the measurements were divided into different days of the same week, adapting the days to the availability of the research subjects. All of the tests were repeated two non-consecutive times. For the anthropometric measurements, a third measure was made if there was a difference greater than one centimeter in measurements. The average of the two measurements that were closest was calculated. For the physical tests, the average of the two tests was performed, except for the shuttle run test, where only one test was performed.

2.2.1. Anthropometric Study

These measurements were made before breakfast for all the subjects, who were bare foot and wore minimal clothing.

Height measurement was done with a professional height rod. Participants remained stretched out, standing, barefoot, with their heels together and their backs straight and in contact with the vertical ruler of the height rod. Once placed in the correct posture, the horizontal platform of the height rod was moved to make contact with the head, gently pressing on the hair and the corresponding measurement was taken.

The weight and body fat percentage were measured by The Tanita SC-240MA body composition analyzer. It is characterized by making the measurement by means of bio-electric impedance. Key features of this devise are a dual-frequency 4 electrode, accuracy grade: MDDclass ii-a, NAWI Class II. This model self-calibrates after each measurement. Measurements were collected using the standard setting (for both groups) after manually imputing the measured height, gender, and age of the subject. The subjects were instructed to stand still, with their feet touching all four metal plates. BF% was then estimated using the in-built Tanita equations.

The body mass index (BMI) was calculated taking the relationship between weight expressed in kilograms and height expressed in meters squared using the following formula: BMI = weight [kg]/height [m^2].

In order to know the intra-abdominal fat levels, the waist and hip circumferences were measured with a KaWe, Medizintechnick tape measure, seit 180 expressed in cm. The waist measurement was taken directly on the person's skin halfway between the last rib and the iliac crest to obtain more information about overweight and obesity, while the hip measurement was carried out with fine sportswear.

The waist-hip ratio (WHR) was obtained by the quotient between the waist circumference (WC) and the maximum hip circumference (HC) at the buttock level.

Waist-hip ratio = waist (cm)/hip (cm).

2.2.2. Physical Fitness Tests

Warming up: Before exposing the participants to the tests themselves, they performed a warm-up exercise which consisted of 3 min of running or walking according to the subjects' capacities. This exercise was intended to increase the heart rate and body temperature and to familiarize the subjects with the lines of the "shuttle run" test. Thereafter, participants performed joint mobility exercises.

Afterwards, participants were divided into groups to perform tests in the form of a circuit. Each test was explained to them until they understood it, and they were able to try the test before the evaluation. If they did not perform the test correctly, it was explained to them again and they would have two more opportunities. The "shuttle run" test was performed as the last test for all subjects divided into groups of 4–5 people.

The Alpha battery tests were used to evaluate the physical fitness of the subjects. The protocol, validated by Tejero-Gonzalez et al. [16] for people with DS in the Spanish population, was used.

Test to assess flexibility: To evaluate flexibility, the "Sit and Reach" test was performed with a self-made box following standard measurements.

Test 4 × 10 m to evaluate speed-agility: The necessary material to carry out this test is a stopwatch, three sponges of different colors and a smooth, non-slip surface. Before starting, two parallel lines were drawn 10 m apart. Sponge B was placed on the starting line, and sponges A and C were placed on the opposite line. When the start was indicated, the evaluated person (without the sponge in hand) ran as fast as they could towards the opposite line to catch sponge A and return to the starting line, where they had to leave this sponge to catch B, and run again toward the opposite line, leave sponge B, and catch C, returning to the starting line as quickly as possible.

Tests to evaluate strength: Handgrip strength: This test evaluates the force of the upper body and was carried out with a Takei tkk 5401 digital dynamometer, with a handle adjustable to the size of each individual hand. (These tests were performed the same day as the anthropometrics measures).

Long jump: This test is to evaluate the strength/power of the lower body. The participant prepares behind the starting line, having to jump forward as far as possible, touching the ground simultaneously with both feet and with the body vertically. The distance was measured from the starting line to the point where the heel lands. It was considered null if the subject landed first with one foot and then with the other.

Shuttle run test: This test assesses cardiovascular endurance. Participants have to run between two lines that are 20 m apart, maintaining the rhythm established by audio signals. The test ends when the participant does not reach one of the lines, according to the audio signals, on two consecutive occasions. The rhythm was initially led by a researcher until the subjects were able to follow it individually, as a modification suggested by Tejero-Gonzalez et al. [16].

2.3. Statistical Analyses

Data analyses were performed using SPSS 25.0 (IBM), for all variables analyzed, and the level of significance was set at 0.05. Descriptive statistics of all the variables were reported with means and standard deviations. MANCOVA tests were conducted to determine whether athletes and non-athletes produced mean differences after adjusting for relevant covariates. Analyses were conducted in two sets: (1) anthropometric variables controlling for sex and (2) fitness test variables controlling for sex and anthropometric variables. To evaluate the differences between groups in the fitness test, two different models were created. MANCOVA was used to reduce the type I error rate compared with a series of ANCOVA tests [17,18]. To perform the MANCOVA test, it was found that there were homogeneous variances. When homogeneous variances could not be verified, the Student's *t* test was performed to compare athletes and non-athletes separated by sex.

3. Results

Table 1 shows the descriptive statistics of the demographic information and the anthropometric characteristics of the study subjects, separated by sex and by sports practice. It is interesting to observe that in people with intellectual disabilities, there is no separation between genders in sports such as soccer or basketball, while there is a separation in sports such as gymnastics or swimming. Since most of our athletes are footballers, and we only have one woman who practices swimming, we have presented the data together, although the analysis is controlled by sex.

Table 1. Demographic and anthropometric information.

	Non-Athlete/Athlete	Age (years)	Height (m)	Weight (Kg)	% Body Fat	BMI	Waist Circumference (cm)	Hip Circumference (cm)	Waist/Hip Ratio
Male	Non-Ath. N = 8	35.63 (10.29)	1.55 (0.05)	71.55 (9.54)	23.90 (5.70)	29.54 (3.85)	93.09 (9.21)	106.75 (9.83)	0.87 (0.05)
	Ath. N = 6	28.50 (3.21)	1.60 (0.08)	62.15 (8.01)	17.27 (3.75)	24.28 (3.26)	82.83 (5.16)	96.42 (5.74)	0.86 (0.05)
	Total = 14	32.57 (8.62)	1.58 (0.07)	67.52 (9.85)	21.06 (5.88)	27.29 (4.40)	88.70 (9.15)	102.32 (9.64)	0.87 (0.05)
Female	Non-Ath. N = 12	39.42 (8.68)	1.49 (0.08)	68.92 (14.90)	33.28 (8.62)	31.63 (8.41)	88.85 (13.16)	112.15 (14.99)	0.79 (0.06)
	Ath. N = 1	48.00	1.47	54.00	17.30	24.99	84.50	103.50	0.82
	Total = 13	40.08 (8.64)	1.49 (0.08)	67.77 (14.68)	32.05 (9.37)	31.12 (8.26)	88.52 (12.66)	111.48 (14.55)	0.79 (0.06)
Total	Non-Ath. N = 20	37.90 (9.29)	1.51 (0.08)	69.97 (12.80)	29.53 (8.79)	30.80 (6.89)	90.55 (11.67)	109.99 (13.16)	0.82 (0.07)
	Ath. N = 7	31.29 (7.93)	1.58 (0.09)	60.99 (7.94)	17.27 (3.42)	24.38 (3.00)	83.07 (4.76)	97.42 (5.88)	0.85 (0.05)
	Total = 27	36.19 (9.29)	1.53 (0.09)	67.64 (12.26)	26.35 (9.44)	29.14 (6.71)	88.61 (10.76)	106.73 (12.88)	0.83 (0.06)

Notes: Mean (Standard Deviation). Ath: Athlete m: meters; Kg: Kilograms; cm: centimeters; s: seconds.

The MANCOVA test was performed to see if there were significant differences between the anthropometric variables of the groups, controlling for sex, since there was only one woman within the group of athletes. Homogeneous variances were only found for the variables of height, weight, BMI and WHR, and therefore only the results of these variables corrected for sex are presented. In the corrected model, significant differences were found between athletes and non-athletes in height (p = 0.01) and in the WHR (p = 0.005), not finding significant differences either in weight or in BMI, as seen in the Table 2. For the variables that could not be analyzed using the MANCOVA test, a Student's t-test was performed, separating by sex and comparing athletes and non-athletes. In women, the tests could not be executed, as there was only one woman in one of the groups. For men, significant differences were found in both, % body fat (p = 0.030), waist circumference (p = 0.031), and hip circumference (p = 0.041), as seen in Table 2. To facilitate the understanding of the results of the anthropometric variables, Table 2 is presented as a summary. In this table we can see a summary of the anthropometric variables, with the results presenting only means and standard deviations, of athletes and non-athletes, and the subjects and statistic test used.

Table 2. Summary of the anthropometrics' results. (Vertical orientation).

Variables	Athletes	Non-Athletes	p (Test Used)
Height (m) (all subjects)	1.58 ± 0.08	1.51 ± 0.08	p = 0.01 (M)
Weight (Kg) (all subjects)	60.99 ± 7.94	69.97 ± 12.80	p > 0.05 (M)
% Body Fat (only men)	17.27 ± 3.75	23.90 ± 5.70	p = 0.030 (t)
BMI (all subjects)	24.38 ± 3.00	30.79 ± 6.89	p > 0.05 (M)
Waist circumference (only men)	82.83 ± 5.16	93.09 ± 9.21	p = 0.031 (t)
Hip Circumference (only men)	96.41 ± 5.73	106.75 ± 9.83	p = 0.041 (t)
Waist/Hip Ratio (all subjects)	0.85 ± 0.04	0.82 ± 0.07	p = 0.005 (M)

Notes: M: MANCOVA controlling for sex. t: t-Student.

Table 3 presents the descriptive statistics of the results of the tests to evaluate the physical fitness of our subjects separated by sex and athletes and non-athletes.

Table 3. Descriptive statistics of fitness tests.

	Non-Athlete/Athlete	Right Handgrip (Kg)	Left Handgrip (Kg)	Total Handgrip (Kg)	Flexibility (cm)	Right Leg Jump (cm)	Left Leg Jump (cm)	Long Jump (cm)	Agility (s)	Shuttle Run (s)	Coord. Number of Bounces
Male	Non-Ath. *N* = 8	10.34 (3.19)	9.71 (2.10)	20.06 (4.75)	17.32 (7.47)	4.71 (6.11)	3.43 (5.09)	23.93 (9.43)	26.45 (6.77)	40.57 (27.80)	16.93 (5.53)
	Ath. *N* = 6	10.26 (3.10)	8.45 (4.29)	18.71 (5.48)	17.00 (14.40)	27.96 (36.90)	9.30 (8.06)	60.21 (38.66)	22.61 (8.85)	76.37 (43.86)	20.83 (8.54)
	Total = 14	10.31 (3.03)	9.17 (3.14)	19.48 (4.92)	17.17 (10.69)	15.44 (27.04)	5.88 (6.05)	40.67 (31.96)	24.68 (7.71)	57.09 (39.15)	18.73 (7.06)
Female	Non-Ath. *N* = 12	8.70 (2.22)	7.58 (2.77)	16.29 (4.53)	21.42 (9.61)	3.33 (5.19)	4.94 (6.15)	19.06 (18.12)	27.63 (7.06)	25.89 (20.96)	13.61 (9.27)
	Ath. *N* = 1	12.30	11.75	24.05	27.75	0.00	0	49.00	27.72	8.00	21.00
	Total = 13	8.98 (2.35)	7.90 (2.89)	16.88 (4.84)	22.05 (9.28)	3.00 (5.00)	4.45 (6.00)	22.05 (19.5)	27.64 (6.66)	24.10 (20.56)	14.35 (9.05)
Total	Non-Ath. *N* = 20	9.36 (2.70)	8.44 (2.69)	17.80 (4.88)	19.63 (8.72)	3.94 (5.46)	4.28 (5.58)	21.19 (14.73)	27.12 (6.73)	32.31 (24.49)	15.06 (7.81)
	Ath. *N* = 7	10.55 (2.93)	8.92 (4.11)	19.47 (5.39)	18.54 (13.76)	23.96 (35.30)	7.75 (6.71)	58.61 (35.54)	23.34 (8.31)	66.60 (47.66)	20.86 (7.80)
	Total = 27	9.67 (2.75)	8.56 (3.03)	18.23 (4.96)	19.29 (10.18)	10.03 (21.19)	5.23 (5.92)	32.58 (28.32)	25.97 (7.27)	42.75 (35.90)	16.83 (8.10)

Note: Kg: Kilograms; cm: centimeters; s: seconds.

The MANCOVA test was performed using two different models to see if there were significant differences between the groups of athletes and non-athletes in the fitness variables. Model 1 controlled for the variables of sex, height, BMI, and WHC and their interaction. In model 2 the variables of: age, sex, and all anthropometric variables and their interaction were controlled. In this second model, the variables of flexibility and jumping with both legs could not be studied, as they did not present homogeneous variances once the Levene test was performed. In model 1, no significant differences were found with any of the variables studied, the greatest differences being found in the shuttle run test, with $p = 0.055$. However, in model 2, significant differences were found between athletes and non-athletes in the shuttle run test ($p = 0.037$), but in none of the other variables studied.

For the variables that could not be analyzed using the MANCOVA test in model 2 (flexibility and jumping with both legs), a Student's *t*-test was performed, separating by sex and comparing athletes and non-athletes. In women, the tests could not be executed, as there was only one woman in one of the groups. In men, no significant differences were found between athletes and non-athletes for these variables.

To facilitate the understanding of the results of the physical fitness variables, Table 4 is presented, with the values of the fitness tests in a summarized form. It shows only means and standard deviations, of athletes and non-athletes, and whether there are significant differences between them and the statistical test used.

Table 4. Summary of the physical fitness tests' results.

Variables	Athletes	Non-Athletes	*p* (Test Used)
Right Handgrip (kg)	10.55 ± 2.93	9.36 ± 2.69	$p > 0.05$ (M 1,2)
Left Handgrip (kg)	8.92 ± 4.10	8.43 ± 2.68	$p > 0.05$ (M 1,2)
Total Handgrip (kg)	19.47 ± 5.39	17.79 ± 4.86	$p > 0.05$ (M 1,2)
Flexibility (cm) (only men)	17.00 ± 14.39	17.32 ± 7.47	$p > 0.05$ (t)
Long Jump (2 legs) (cm) (only men)	60.20 ± 38.65	23.92 ± 9.42	$p > 0.05$ (t)
Agility (4 × 10) (s)	23.34 ± 8.31	27.12 ± 6.73	$p > 0.05$ (M)
Shuttle run (s)	66.60 ± 47.66	32.31 ± 24.49	$p > 0.05$ (M 1) $p = 0.037$ (M 2)

Notes: M 1 = MANCOVA models 1; M 2 = MANCOVA models 2; M 1,2 = MANCOVA models 1 and 2; t = t-Student; kg: Kilograms; cm: centimeters; s = seconds.

4. Discussion

The main aim of this study is to present objective data on the differences in anthropometrics and fitness variables between adult athletes and non-athletes with DS members of the DCA after adjusting for confounders. To the best of our knowledge, this is the first study comparing health-related fitness variables in adult athletes and non-athletes with DS in recreational sports. We have reviewed the English, French, and Spanish literature. Balic et al. [12] compared Olympic athletes with DS with non-athletes. In the doctoral thesis of Zorrilla [19], only anthropometric variables but not physical fitness variables were compared in athletes and non-athletes with DS.

In a very general and summarized way, we see that athletes presented healthier results both in most anthropometric variables and in most physical fitness tests. Although this is a descriptive study, many experimental studies in adults with DS have shown that this population can improve their health-related fitness through exercise (please read the systematic reviews by Palomba et al. [6] and Li et al. [20] for more information). For example, in the study by Tsimaras et al. [21], after 12 weeks of training, aerobic capacity was improved. Moreover, Rimmer et al. [22] also found that after 12 weeks of training all outcome measures for cardiovascular fitness, strength, and body composition were improved, whereas the control group in both studies showed almost no change. Moreover, recently, Farías-Valenzuela et al. [23] found that 10 months of a concurrent motor games program twice a week improved anthropometric variables in adults with DS. Therefore, although more studies are needed with experimental designs in the adult athlete population with DS, we believe that these results may encourage parents and guardians of individuals with DS to enroll them in some type of sport.

Below, both anthropometric and physical fitness variables are discussed in more detail.

4.1. Anthropometric Variables

In the model corrected for sex, we found significant differences between athletes and non-athletes in height, which revealed that the participants who were athletes were taller. Balic et al. [12] and Zorrilla [19] also found values which indicated a taller height in athletes than in non-athletes, but they did not find significant differences. Obviously, playing sports does not make you taller, but it may well be that taller people have a higher propensity to participate in sports activities. For example, one study in the general population also found that athletes were taller than the control group of non-athletes, which may have been attributed to the type of sports chosen, namely team sports [24].

Regarding the % of body fat, in the group of male athletes, they presented a significantly lower % of body fat than the male non-athletes, as expected. Although in the study by Balic et al. [12] significant differences were not found, they did find lower values in the % of body fat in athletes. Unfortunately, in the study by Zorrilla [19] the % of body fat of the participants was not evaluated. Significant differences have been found in the % of body fat between athletes and non-athletes in the general population [25] and in soccer players, for example, compared with the sedentary population [26]. Due to the descriptive nature of this study, we do not know if participants who have a lower percentage of fat practice sports or if they have a have a lower percentage of fat because they practice sports. In any case, studies have been carried out on the effect of training in people with DS [2,6,20,22,23,27,28]. For example, it has been seen that in adolescents with DS there was a reduction in the % of body fat after different 12-week training programs [22,27]. In the same way, an improvement in the lipid profile of adolescents with DS who performed physical activity has been found [27,28].

Regarding weight, in the model corrected for sex, we did not find significant differences between groups. No differences were found in other studies in athletes with DS either [12] or between athletes and non-athletes in the general population [25]. Therefore, it may simply be that weight is not a good variable to compare athletes and non-athletes either in people with DS. In fact, the BMI that relates weight to height was introduced in the 19th century by Eknoyan [29], who recognized that it is necessary to correct for differences in body size when comparing adiposity among patients.

It is interesting to note how significant differences were not found in BMI, neither in our study, athletes vs non-athletes, nor in that of Balic et al. [12]. Although in our study athletes had lower BMI, the SD for the non-athletes was very high. Other authors also did not find differences in BMI in men, although they did found a lower BMI in the group of non-athletes than in the rest of the groups in the general population [25] and in the Down population [21]. It has been seen that in young athletes [25,30] this index is not as reliable as in the general population, since there is a larger muscle mass among the male and female athletes. BMI incorrectly classifies athletes with normal fat levels as overweight [30,31]. According to our study, this could also occur in people with DS. We found differences in the % of body fat and not in BMI. However, both in our study and in that of Balic et al. [12], the BMI was lower in athletes than in non-athletes, so more research is needed regarding athletes with DS and BMI.

WC and HC could only be studied in the male population, as explained previously. In men, we found that non-athletes had significantly lower values in both WC and HC. In the model corrected for sex, the WHR was significantly higher in athletes compared with non-athletes with a level of significance. Unfortunately, the other two studies comparing adult athletes with DS with non-athletes [12,19] did not evaluate these perimeters in their participants. It has been difficult to find studies that measure waist and hip perimeters and their index between athletes and non-athletes, although the doctoral thesis of Blazquez [32] is an example of one. She compares 122 athletes with 20 non-athletes and did not find significant differences in the WHR. The failure to find data on these variables in athletes may be due to the fact that these variables (WC, HC, WHR) are normally used to assess the risk of obesity and metabolic diseases in the general population [33]. For example, in the population with DS it has been seen that in adolescents the WHR presents a higher correlation than the rest of the anthropometric variables with the total cholesterol/HDL cholesterol ratio, this ratio being one of the best predictors of coronary heart disease [34].

4.2. Physical Fitness Variables

Regarding the grip strength test, although the athletes presented higher values with both the right hand and the left hand and the sum of the two, no significant differences were found with respect to the non-athletes for any of the two models studied. The grip strength of the hand was not important for any of the sports in which the athletes in our study participated. We might have seen different results if the athletes had been gymnasts or rowers, for example, who would need this grip for their competition. In the study by Balic et al. [12], they also did not find differences in these variables between athletes and non-athletes, although they did have other athletes such as gymnasts or ping-pong players for whom this variable could be more important.

In the flexibility test we were only able to compare the men, as we could not perform the MANCOVA test, as explained previously. Male non-athletes presented slightly higher values than athletes. In athletes we see a very high SD, almost twice that of non-athletes;

that is, we have athletes who present very high values of flexibility, but we also have athletes with very low values. Unfortunately, we have not found articles that compare the flexibility between athletes and non-athletes with DS. It is also the case that flexibility can be very different depending on the sport performed [35]. In this study, men only participated in soccer. In an article in which they compared adolescents, sedentary people, and soccer players, they also did not find significant differences between groups, although, in contrast to the current study, higher values were found in soccer players [36]. Nevertheless, since individuals with DS have deficits of hypermobility and joint laxity, attention should be paid to improve and evaluate other components of their physical fitness instead of flexibility [20].

In the long jump test, only men could be studied. Although the average of the distance jumped by athletes is about three times higher than in non-athletes, no significant differences were found between the groups. The SD was also very high in athletes, and it is important to mention at this time that in our group of male athletes there were players from both the Córdoba first football team and the Córdoba School of Football. It would be interesting for future research to determine if there are differences between these two groups. Due to an insufficient sample and scope of this study, the investigation into these differences was not pursued. With respect to other athletes with DS, Balic et al. [12], did not find significant differences between the squat jump and the counter movement jump in these groups, although they also found higher values in athletes. As mentioned earlier, they had a mix of athletes, not only footballers. Although these jumps are vertical and the long jump is horizontal, they all evaluate lower body strength/power.

In the agility test (4×10) the athletes also presented better values than the non-athletes, taking less time to perform the test, although no significant differences were found between groups in either of the two models studied. No other authors have been found that compare the agility of athletes and non-athletes, neither in the general population nor in the population with DS. The comparison was made only between adolescent soccer players and sedentary adolescents [36]. These authors, although performing another type of test, found that soccer players had significantly better values than non-athletes. In the current study, when comparing only male soccer players, significant differences between groups were not found, although faster values were found in soccer players. It may be that a larger sample is needed to achieve this significant difference, since the male-only sample comprised 13 people.

In the test to evaluate the cardiovascular endurance (shuttle run), we found more positive values in athletes being able to maintain the race pace for more seconds. In model 2, which controlled for age, sex, and all anthropometric variables and their interaction, significant differences were found. This result was to be expected, since athletes present higher values in the cardiovascular endurance tests. Balic et al. [12] also found significantly higher values in oxygen consumption, which is a variable to evaluate cardiovascular endurance, in athletes than in non-athletes. It has been proved that adults with DS can improve their cardiovascular endurance with only 12 weeks of training [22]. Furthermore, there are numerous studies that have shown that having higher values of cardiovascular endurance is beneficial. For more information, please read [13].

4.3. Limitations and Strengths of the Study

The main limitation of this study is that we recruited men and women, in an unbalanced proportion, due to the possibilities and availability of our research material. Only one woman among the participants practiced sports, which made the sample of athletes much smaller and less representative for women. We have tried to solve this limitation by using MANCOVA models corrected for sex, although in some variables we have not been able to use them because there was no homogeneity in the variances. Therefore, in these variables we had to compare only men. Another limitation to this study is that only the members of one association have been evaluated, so more associations should be evaluated in other to make a more general conclusion.

As a strength of this study, this is the first study, to our knowledge, that compares health-related fitness variables between people with Down syndrome who are recreational athletes and non-athletes. This research provides information to parents, guardians, institutions, and caregivers, with concrete values. Furthermore, it is important to mention that studies with physical activity intervention run for about 12 weeks, and longer interventions are needed in order to provide more information about exercise in this population [20]. The athletes in this study practiced sport for more than 9 months, so this study provides information about the effect of exercise over a longer period of time. This has only been presented by Balic et al. [12]. However, they did not look at recreational athletes but at Olympic athletes, that may have special characteristics, not applicable to the general DS population.

5. Conclusions

Adult athletes with Down Syndrome (DS) from the "Down Córdoba Association" presented significantly higher values for height and a higher waist-to-hip ratio than the non-athletes from the association. No significant differences were found in weight or in body mass index between groups. Furthermore, male athletes compared to male non-athletes have lower values in % of body fat, and in waist and hip circumferences, female athletes could not be compared in these variables. With regard to physical fitness, athletes have better values in the tests of strength, cardiovascular endurance, and agility, although significant differences were only found in one of the models for the cardiovascular endurance test. Conversely, comparing only men, non-athletes presented slightly better values in the flexibility test, without significant differences.

It should be noted that from the tests carried out on our participants, the practice of sports among the users of the "Down Córdoba Association" in general leads to better health-related fitness values. Therefore, we encourage the guardians of people with DS in this association to motivate them to practice sports, because this practice will more likely improve their overall health. Furthermore, we encourage other researchers to evaluate the subjects of other associations so we can extrapolate this conclusion to the whole DS population.

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Informed Consent Statement: All participants had medical consent to participate in sports activities. Before participating in the study, parents, legal guardians and those responsible for the center received information and protocols about it. In addition, they were given informed consents to be signed by their tutors that had to be returned before sampling. Furthermore, all participants had to give their verbal consent to participate in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to data protection.

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