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Biological and Technical Characterization of Judokas of the Sports Club of Universidad de Tarapacá

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KEYWORDS Aerobic. Anaerobic. Body Composition. Judo. Physical Development

ABSTRACT The objective of the present study was "to characterize, through morpho-functional and technical tests, judokas of the Sports Club of the University of Tarapacá". A non-experimental, cross-sectional and quantitative study was conducted, evaluating 18 judokas of the Club. For this, an analysis of the body composition, vertical jump tests, race test at distances of 1000 m for ladies and 1500 m for men were estimated estimating the maximum oxygen consumption, in addition, a projection test was applied in one minute. Observing among the main results that the evaluated judocas presented low maximum oxygen consumption, low power and jump speed and a high percentage of fat mass, the pedagogical test did not throw errors from the technical point of view. Concluding that the judokas of the University of Tarapacá require training focused on aerobic, anaerobic and morphological improvements, to contribute to a better future performance.

INTRODUCTION

The judo in its execution phase, demands a significant development of physical capacities, both in the achievement of a technique, as in the entirety of the combat (Sterkowicz et al. 2019). The combat in judo has its physiological support in the development of the explosive force, speed and power, being necessary to alternate the lactic and alactic anaerobic efforts conveniently (Agudelo et al. 2017).

In this sport, it is also required to develop aerobic capacity, to resist the work regime efficiently and advantageously during the minutes of combat. Aerobic resistance training increases the function of the cardiorespiratory system, the oxidative capacity, and the muscle glycogen reserves necessary for such a complex athletic performance (Chávez 2011).

According to Benítez et al. (2015), the maximum aerobic power is determined mainly by several factors, such as sex, age, body dimensions, inheritance, and training level.

Additionally, Bidaurrazaga et al. (2015) state that the maximum oxygen consumption (VO_2max) can be expressed in absolute values (l/min), or in relation to the total weight of the athlete (ml/kg/min) or lean weight (free weight of corporal fat) or active corporal mass (BMA), being necessary its evaluation during the development of the preparation of judoka.

Calvo et al. (2018), state that the morphological development of the athletes, as well as the changes that can be experienced as a result of the training process, constitute an essential pillar in the process of biological control of the training of all sports and even more when competing for weight divisions.

The evaluation of the athlete allows establishing a diagnosis of the state of health and the level of the skills of the athlete (Vera et al. 2015). Through its comprehensive evaluation, recommendations can be made to the training plan, taking into account the individual characteristics of the practitioner.

The commune of Arica has a large number of judo athletes, many of them have been part of

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the national team of this sport. However, its practitioners do not have comprehensive evaluations that include pedagogical variables along with morphological and physiological variables, so they lack indicators that favor an adequate orientation of sports training, this motivated the researchers to carry out the present study, the which had as objective:

General Objective

Determine, through bio-pedagogical tests, the morpho-functional and technical status of the members of the judo selection of the Club of Universidad de Tarapacá, at the beginning of the preparation.

Specific Objectives

1. Analyze the body composition of judokas at the beginning of a preparation macrocycle.
2. To examine the aerobic power of the judo athletes of the UTA Club, through a race test applying the Tokmakidis formula.
3. Evaluate the judokas of the Club of Universidad de Tarapacá anaerobically, using a jumping platform.
4. Pedagogically evaluate the judokas of the Club of Universidad de Tarapacá, through the Projection Test.

METHODOLOGY

A non-experimental, quantitative, transversal study was carried out at the beginning of the General Physical Preparation (IPFG). 18 athletes (both sexes) were considered, with an average age of 25 ± 4 and sporting age of 5 ± 2, members of the judo selection of the Club of Universidad de Tarapacá (UTA) (see Table 1).

The sample was selected intentionally, taking into account the approval of the athletes and coaches to participate in the research, as well as the Bioethics Committee of the Institution.

Table 1: Distribution of the sample, according to weight and sex division

Division	*Men*	*No.*	*Ladies*	*No.*
Light	- 66 kg.	0	- 52 kg.	2
Semi-media	66-73 kg.	3	52 - 57 kg.	0
Medios	73-81 kg.	3	57 - 63 kg.	2
Semipesados	81-90 kg.	2	63 - 70 kg.	2
Pesados	+ 90 kg.	2	+ 70 kg.	2

Body Composition

For the analysis of body composition, the anthropometric measurement protocol of the International Society for the Advancement of Cineanthropometry was used. For the evaluations, they were subdivided according to the weight divisions in which they compete and the gender division.

It was taken into account that the measurements were made in a closed room, with adequate lighting, in the morning (before training). The evaluations were made by the same examiner, using calibrated equipment. Also, the athletes were oriented to wear appropriate clothing for the accomplishment of it.

For the calculation of the percentage of fat mass (% MG) the formulation proposed by Yuhasz (1962) recommended for the analysis of athletes was taken into account, which includes 6 folds: triceps, subscapular, suprailiac, abdominal, middle and calf thighs, using the following equation for men and women of any level of maturity:

% fat = 0. 1051 x Sum X + 2.585 (V)

% fat = 0. 1548 x Sum X + 3.580 (M)

Sum X = sum triceps, subscapular, suprailiac, abdominal, middle thigh, and calf.

For the calculation of the Body Mass Index (BMI), the following was assessed:

$BMI = \text{Body Weight (Kg)}/(\text{size})^2\ (m)$

Active Body Mass (BMA) was calculated employing the following equation:

BMA = Body Weight - KgGr

Where:

KgGr = body weight *% fat/100

The Active Substance Index. (AKS, for its acronym in German) was determined through the formula developed by Tittel and Wetscherk in 1972. This index estimates the amount of active body mass (a component of body weight) concerning height. The AKS is illustrative of the proportion of muscle mass.

AKS = MCA (gr) / (Size) 3 x100

Squat Test

The platform jump test was performed in the laboratory, and it allowed to evaluate the reac-

tion force concerning the floor and the mechanical power of a group or series of muscle groups. The test consisted of performing a vertical jump on the DMJUMP platform, which facilitated the evaluation of the height of the jump, taking into account the time traveled. For the determination of the height of the jumps, the methodology of the Bosco test (1994) was used.

It was considered the squat jump (SJ), which was executed from the mid-squat position with 2-3 of maintenance in that position, at the beginning an anterior knee flexion (90°) was oriented with the feet parallel, the hands placed in the pelvis to avoid the impulse, from there a jump was generated as high as possible.

Jump of opposite movement or against movement (CMJ), in this jump the initial position was made with the knees extended and the hands in the pelvis, then the knees were quickly flexed to 90°, and the jump was executed.

Jump of Abalakov, in this jump the athlete was allowed to use the arms in such a way that they took impulse through a semi-flexion of the legs (the legs had to be bent 90° in the knee joint), followed by the extension. The athlete placed the arms extended behind the trunk, which were carried forward, in a vigorous oscillation, coordinated and synchronized with the flexion and extension of the legs. During the flexion action, the trunk was as straight as possible to avoid any influence of the same on the result of the lower movements.

In the executions three attempts were made for the jumps SJ, CMJ, and Abalakov, obtaining the flight times (tv) of each jump and then selecting the best of each attempt for the calculation of the height and power.

With the weight (p) of the subject in kilograms, and the height reached (h) in meters, the power (P) in kgm/s was calculated. For this, the following formula was used:

P = (4.9) 0.5 * p * (h) 0.5 (Garrido and González 2004).

Elastic Contribution (CELA)

CELA = (CMJ-SJ) x100

Intermuscular Coordination

Neuromuscular Coordination= (Abalakov-CMJ) x100

Jump Speed of (m/seg)

Aerobic Power Test

To evaluate the aerobic power, a race distance test of 1000 m for the ladies and 1500 m for the males was carried out, estimating the maximum oxygen consumption (VO_2max) through the formula created by Leger, Mercier, and Bouchard, using the time developed as a variable at a certain distance. Tokmakidis (s.f.) referred by Pancorbo (2002).

The test consisted of covering a distance (in the shortest time possible) previously determined by the evaluator, then, using regression equations, it was possible to estimate the maximum oxygen consumption, according to the time spent in the race, then the speed in kilometers per hour (km / h), replacing this data in the equations according to the corresponding distance:

Tokmakidis Formula

1000 m MET: 1.2730 + 0.8325 * (Vkm/h)

1500m MET: 2.4318 + 0.8343 * (Vkm/h)

For the analysis, it was taken into account that:

The result of the equation is the estimation of the metabolic equivalent (MET)

The VO_2 max. is expressed in milliliters/kilograms/minute and is obtained by multiplying the MET by 3.5 (1 MET corresponding to 3.5 ml/kg/min).

To determine the speed (V) the following formula was applied:

V = Distance (km) / Hour (h)

Projection Test

A pedagogical test (projection) was applied, which consisted of the performance of projection techniques (the largest amount in one minute). The coach previously determined the techniques. In this evaluation, the total of techniques applied, the quality of the execution and the percentage of effectiveness were considered, at the same time, biological variables such as heart rate and blood pressure were taken into account.

For the fulfillment of the test, a 15-minute warm-up was carried out for all the subjects under assessment before beginning the test, also establishing the use of suitable clothes.

Evaluation Instruments

- Digital balance with fitness analyzer. Omron HBF-514 C.
- ADE portable height meter. Germany MZ 10042
- Tape measure: ADE. Germany
- Adipose panicle meter (Plycometer): Lange type.

- Holtain Harpender Anthropometer (Game).
- The king's foot. The mitutoyo brand.
- Bioimpedance mBCA SECA 514
- Jumping platform, DMJUMP brand.
- Tensiometer, ADE brand.
- Pulse oximeter, ADE brand.

Statistical Treatment

A computerized analysis of all the data through the statistic program of IBM SPSS 21 was carried out. Statistical processing was applied to the variables evaluated, including Absolute (n) and relative (%), Mean (X), and Deviation Standard (DS), depending on the type of data processed.

RESULTS

Judo demands high physical demand from its participants; in both systematic practice and competitive events, in the same manner, the judoka must make a great effort in the maintenance of body weight, having to choose the weight category recommended to compete appropriately. For this, it was necessary to study the body composition of judokas, finding as main results that in both sexes, although athletes were with weights close to the category in which they would compete, they showed high levels of fat mass percentage with an average in the women of 26.2 percent and men of 15.35 percent (see Tables 2 and 3).

The neuromuscular test applied in a jumping platform allowed to evaluate the power of the jumps with and without the help of the arms, the jumping power from the squat position, the elastic contribution, the neuromuscular coordination, and the jump speed. Checking a power (average) of jump with the help of the arms (Abalakov) of 57.3 kgm/s in the women, while in men this variable behaved at 100.8 kgm/s. The speed of the jump, presented an average in women of 0.15 (m/s), while in males it was established at 0.21 (m/s). Additionally, neuromuscular coordination behaved indistinctly in all weight categories, in both sexes (see Tables 4 and 5).

The race test allowed indirectly to determine the maximum oxygen consumption, finding 40.46 ml/kg/min in women, while male representatives had 47.49 ml/kg/min. Developing a running speed (1000 m for women, 1500 m for men) of 10.87 km/h and 13.34 km/h, respectively (see Tables 6 and 7).

Moreover, the resting heart rate showed an average for women of 77.5 beats/min. Consequently, at the end of the test, an average of 165

Table 2: Anthropometric evaluation. Ladies, Judo Club of Universidad de Tarapacá

Division	*Weight (Kg)*	*Size (m)*	*Sum of folds*	*Fat mass percentage %*	*Fatty weight (Kg)*	*Active body mass (Kg)*	*Active body substance index (gr/cm³)*	*BMI (Kg/m²)*
Light	51.9	1.51	115.2	21.0	10.9	40.9	1.2	22.7
Medium	63.0	1.58	120.3	23.0	15.4	45.7	1.3	25.3
Semi-heavy	67.4	1.64	130.0	23.1	15.6	51.8	1.2	25.0
Heavy	73.8	1.55	232.0	37.7	27.8	45.9	1.2	30.7

Table 3: Anthropometric evaluation. Men, Judo Club of Universidad de Tarapacá

Division	*Weight (Kg)*	*Size (m)*	*Sum of folds*	*Fat mass percentage %*	*Fatty weight (Kg)*	*Active body mass (Kg)*	*Active body substance index (gr/cm³)*	*BMI (Kg/m²)*
Semi-media	70.7	1.76	109.0	14.2	10.0	61.0	1.10	22.8
Medium	76.9	1.78	135.0	16.7	12.8	64.0	1.12	24.2
Semi-heavy	89.2	1.76	103.0	13.6	11.1	77.0	1.39	28.8
Heavy	112.0	1.81	137.0	16.9	18.9	93.0	1.57	34.1

Table 4: Neuromuscular evaluation in jumping platform. Ladies, Judo Club of Universidad de Tarapacá

Division	*Power Abalakov (Kgm/s)*	*Power CMJ (Kgm/s)*	*Power SJ (Kgm/s)*	*(CELAS) (cm)*	*Coordi-nation neuro-muscular (cm)*	*Jump speed (m/s)*	*SJ (cm)*	*CMJ (cm)*	*Abala-kov (cm)*
Light	57.7	41.8	40.8	1.0	4.2	0.13	6.3	7.0	10.9
Medium	49.98	39.75	39.75	0	4.3	0.15	7.4	7.4	11.7
Semi-heavy	60.80	43.76	32.35	3.9	8	0.18	4.7	8.6	16.6
Heavy	61.02	50.35	43.30	2.5	4.5	0.17	7.1	9.6	14.1

Table 5: Neuromuscular evaluation in jumping platform. Men, Judo Club of Universidad de Tarapacá

Division	*Power Abalakov (Kgm/s)*	*Power CMJ (Kgm/s)*	*Power SJ (Kgm/s)*	*(CELAS) (cm)*	*Coordi-nation neuro-muscular (cm)*	*Jump speed (m/s)*	*SJ (cm)*	*CMJ (cm)*	*Abala-kov (cm)*
Semi-media	83.46	87.33	65.43	8.6	-1.7	0.19	11	19.6	17.9
Medium	84.46	88.33	70.43	9.6	2.7	0.20	12	20	18.9
Semi-heavy	97.93	84.52	75.81	3.6	6.3	0.22	14.8	18.4	24.7
Heavy	137.39	136.27	138.06	-0.8	0.5	0.25	31	30.2	30.7

Table 6: Career test applying the Tokmakidis formula. Ladies, Judo Club of Universidad de Tarapacá

Division	*Cardiac frequency Rest(beats / min.*	*Final heart rate (beats / min)*	*Tension arterial rest(mm Hg)*	*Tension final arterial (mmHg)*	*Time (seg.)*	*Speed (Km/h)*	*MET. (mlO_2/ Kg/min.) 1000 metros*	*VO_2 Max.*
Light	85	172	110/60	120/80	318	11.32	11.88	41.59
Medium	85	176	115/65	125/85	311	11.58	12.10	42.34
Semi-heavy	75	186	110/60	120/75	323	11.15	11.74	41.08
Heavy	65	126	120/80	130/85	381	9.45	10.32	36.13

Table 7: Career test applying the Tokmakidis formula. Men, Judo Club of Universidad de Tarapacá

Division	*Cardiac frequency Rest(beats / min.*	*Final heart rate (beats / min)*	*Tension arterial rest(mm Hg)*	*Tension final arterial (mmHg)*	*Time (seg.)*	*Speed (Km/h)*	*MET. (mlO_2/ Kg/min.) 1000 metros*	*VO_2 Max.*
Semi-media	75	160	120/80	130/85	390	13.85	13.99	48.97
Medium	55	145	116/69	125/75	441	12.24	12.65	44.29
Semi-heavy	78	165	140/85	160/90	390	13.85	13.99	48.97
Heavy	75	167	158/90	170/95	402	13.43	13.65	47.76

beats/min was observed. The male representatives revealed resting heart rate values of 70.75 beats/min. Furthermore, at the end of the test, they increased to 159.25 beats/min.

The projection test in one minute was the specific test that applied in the judokas of the Club of Universidad de Tarapacá, it demanded a submaximal effort and, through it, could be evaluated quantitatively and qualitatively the quality of the execution of the technical element. This analysis allowed to determine the percentage of effectiveness, showing in the women a total of

31 techniques performed, of them 28.7 good and 9.0 bad, for the effectiveness of 92.7 percent. For their part, the male representatives performed 31 techniques, of which 28.5 were good, and 10 were poorly executed, with an effectiveness percentage of 91.9 percent (see Tables 8 and 9).

In this evaluation, biological variables were also considered, verifying a resting heart rate of 66.2 beats per minute (women), being at the end of the test 172.7 beats per minute. In men, the results were 65.5 and 168.5 beats per minute, respectively.

The resting blood pressure variable behaved at lower values than the one shown at the end of the test, both in systolic and diastolic blood pressure, this behavior is similar in both sexes and all weight categories.

DISCUSSION

In the analysis of body composition, the percentage of fat mass was found high in both sexes, being higher in women than in men, which coincided with the study conducted by Spanias et al. (2019) those that emphasized, that the elite of female judokas present approximately 10 percent of the fat mass higher than the male judokas.

In the present study, women showed an average percentage of fat mass of 27.8, while men exhibited 15.3 percent. This behavior was higher than that reported by Franchini et al. (2011), these authors evaluated elite judokas from Canada, Japan, Brazil, and North America, who presented percentage values of fat mass of 12.3 percent, 16.2 percent, 13.7 percent, and 8.3 percent, respectively, all of them below those evidenced in the present study.

Futhermore, Umeda et al. (2008) stated that university judokas between 19 and 20 years old had a percentage of fat mass of 19.3 percent, not coinciding with the results shown in the present study. Also, Franchini et al. in 2007, presented the behavior of fat mass percentage in older athletes (22 years), remarking that in women this value behaved in 19.9 percent, while in men it was 8 percent, there is no similarity with the study done to the judokas of the Club of Universidad de Tarapacá.

Regarding the BMI, the judokas evaluated in the present study showed high levels of BMI, with values of 25.9 Kg/m^2. Meanwhile, the males presented 27.4 Kg/m^2. This indicator showed some similarity with that reported by Rodríguez et al. (2014), who analyzed the athletes of the High-Performance Center of Chile, highlighting

Table 8: Projection Test. Ladies, Judo Club of Universidad de Tarapacá

Division	*Cardiac frequency Rest(beats / min.*	*Final heart rate (beats / min)*	*Tension arterial rest (mm Hg)*	*Tension final arterial (mmHg)*	*Techni-ques good*	*Techni-ques bad*	*Total*	*% effec-tiveness*
Light	65	155	110/70	120/80	31	3	34	90.32
Medium	78	188	119/79	125/85	35	1	36	97.14
Semi-heavy	57	168	113/76	126/85	22	2	24	90.91
Heavy	65	180	119/69	127/81	27	3	30	88.89

Table 9: Projection Test. Men, Judo Club of Universidad de Tarapacá

Division	*Cardiac frequency Rest(beats / min.*	*Final heart rate (beats / min)*	*Tension arterial rest (mm Hg)*	*Tension final arterial (mmHg)*	*Techni-ques good*	*Techni-ques bad*	*Total*	*% effec-tiveness*
Semi-media	58	160	120/80	130/90	31	3	34	90.32
Medium	54	168	116/69	123/85	27	3	30	88.89
Semi-heavy	70	172	120/80	140/90	31	3	34	90.32
Heavy	80	174	125/84	170/95	25	1	26	96.00

that the judo practitioners had a BMI of 25.1 kg/m^2 and 26 kg/m^2 men.

The World Health Organization considers this variable for the classification of obesity and overweight; however, according to Canda (2017), to diagnose obesity in athletes, body fat should be taken into account.

Concerning active body mass, the athletes evaluated showed superior results in the major divisions, which coincides with the study conducted by Callister et al. (1991), referred by Torrez et al. (2016), who affirmed that judokas in higher weight categories had greater muscle mass.

Štefanovský et al. in 2017 considered it necessary to relate the morphological variables with the functional status of the athlete, concluding that the elite athletes had a greater circumference of the forearm and wrist compared to a group of non-elite athletes, an aspect that to evaluate in future studies.

In the jumping test, it should be mentioned that the results were lower than those reported by Bahamondes et al. (2018), these researchers evaluated 31 male athletes of the National Program of Sports Projection of the National Sports Institute of the Region of Aysén, with ages of 15.5 ± 1.7 years. These authors showed mean values of Squat Jump 30.9 ± 7.0 cm. Moreover, for the jump against movement 32.2 ± 7.2 cm., This being greater than that observed in the judokas of the Club of Universidad de Tarapacá.

The jump from the squatting position was lower than that evidenced in the study of (Garrido and González 2004) which found an average of 34.49 ± 5.13 for men and 26.31 ± 4.47 for women, not coinciding with the present study.

Regarding the countermovement jump, it was observed that there were no coincidences with the study conducted by Garrido and González (2004), these authors observed average values of 36.58 ± 8.55, being higher in the male group 39.23 ± 5.58 than in the feminine 29.47 ± 10.86, the behavior by gender presented similarity with the results of our investigation.

Likewise, in Abalakov jump, the mean for the study by Garrido and González (2004), in the group of men was 47.20 ± 10.23 and in the group of women was 33.49 ± 5.30, is also superior to that presented in the investigation that concerns us.

In the hop test, the age and morphological status of the athlete should be taken into account, since according to what was proposed by Moran et al. (2017) in a meta-analysis that aimed to verify the adaptive response caused by plyometric training in young athletes. Concerning to the maturation of the athlete; concludes that the power performance, evaluated by the countermovement Jump, may be mediated by biological maturation.

Another study that considered the squatting position jump was one made by Almeida et al. (2018), with which there was no coincidence since the athletes of the UTA showed lower values than those exposed by the mentioned authors. These analyzed the influence of the global active stretching in the improvement of the physical performance in the male judo competitors of the Sergipe Judo Federation, this variable behaved above 44.36 ± 6.12 in the groups mentioned. The countermovement jump behaved in the same way, being observed in the judokas of the Judo Federation of Sergipe values above 44.78.

A través de la prueba de carrera, se pudo estimar el VO_2 max observando en los resultados valores inferiores a los expuestos por Torrez et al. (2016), quienes destacan que los judocas masculinos de Europa presentaron valores de 56.0 ml/Kg/min y los brasileños 52.2 ± 7.9 ml/Kg/min.

Through the race test, VO_2 max could be estimated observing in the results lower values than those exposed by Torrez et al. (2016), who highlight that male judoka from Europe presented values of 56.0 ml/kg/min and Brazilians 52.2 ± 7.9 ml/kg/min.

During the projection test, it was possible to verify an adequate percentage of effectiveness in both sexes, predominantly in men. However, the physiological variables showed increases in heart rate and blood pressure at the end of the test, which response to immediate adaptive changes as a result of the effort made. This coincides with the results shown by Hernández et al. (2009), who in turn emphasize that the assessment of resting heart rate, submaximal tests, and maximal intensity assessments, contribute to capacity monitoring aerobic and exercise intensity.

In the resting heart rate variable, similarity was found with the results presented by Degoutte et al. (2003), who evaluated the energy

demands and their recovery during a judo match, highlighting that resting heart rate values for the men were at 54 beats/min and in ladies, 65 beats / min.

CONCLUSION

The judokas of the UTA Club require improvements in the variables of body composition and power in the vertical jump, so that this can have a favorable impact on their sports performance; since high percentages of fat mass, low muscle mass and on the other hand, low height, speed and power in the vertical jump were evidenced in the present study, however relatively high percentages of effectiveness in the projection test were shown in a minute.

RECOMMENDATIONS

It is recommended to carry out similar studies at other stages of the preparation, in addition to incorporating the analysis of other functional tests such as spirometry, dynamometry, goniometry, among others.

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