Journal of Exercise Physiologyonline

February 2020
Volume 23 Number 1

JEPonline

Official Research Journal of the American Society of Exercise Physiologists

ISSN 1097-9751

Maximum Oxygen Consumption: Validity of the Run Test of 20 Meters and Proposal of Equations for Prediction in Young People

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ABSTRACT

Mendez-Cornejo J, Gomez-Campos R, Andruske C, Sulla-Torres J, Urra-Albornoz C, Urzua-Alul L, Cossio-Bolanos M. Maximum Oxygen Consumption: Validity of the Run Test of 20 Meters and Proposal of Equations for Prediction in Young People**. JEPonline** 2020;23(1):24-37. The purpose of this study was: (a) to verify the validity of a 20 m round trip run test for young athletes; and (b) to propose regression equations for predicting VO_2 max in young athletes. The sample for this study consisted of 31 young university students. Age ranged from 18 to 24 yrs old. The absolute ($L \cdot min^{-1}$) and relative ($mL \cdot kg^{-1} \cdot min^{-1}$) VO_2 max values were measured with a test in the laboratory and in the field (20 m round trip run test). Weight, standing height, body fat percentage (BF%), fat mass (FM), lean mass (LM), and maximum expiratory flow (MEF) were also measured. No differences were found between the laboratory and the field run tests in absolute terms (criterion X = 49.3 ± 9.8 $L \cdot min^{-1}$, field X = 49.3 ± 9.8 $L \cdot min^{-1}$) and relative (criterion X = 3.3 ± 0.8 $mL \cdot kg^{-1} \cdot min^{-1}$ field X = 3.4 ± 0.8 $mL \cdot kg^{-1} \cdot min^{-1}$). The coefficient of concordance index (CCI) varied from 0.89 to 0.95. Three equations were created for the absolute VO_2 max: (R^2 = 90 to 94%), and three other equations for the relative

VO_2 max: (R^2 = 73 to 76%). The six equations demonstrated high values for Desirable Reproducibility Indexes (DRI) (precision 0.85 to 0.97) and (accuracy 0.94 to 0.99). The 20 m Back and Forth Run Test is valid for estimating absolute and relative VO_2 max in young athletes. Furthermore, the six equations developed for both sexes provide a reasonable alternative for evaluating aerobic fitness in the health and sport sciences context.

Key Words: Athletes, Prediction Equations, Youth, VO_2 max

INTRODUCTION

The maximum consumption of oxygen (VO_2 max) is defined as the maximum amount of oxygen consumed during a stress test (27). It is also known as cardio-respiratory aptitude marker and/or aerobic ability. Generally, it reflects the ability of the cardiovascular and respiratory systems to perform prolonged exercise (35).

This important health indicator may be affected by genetic and environmental factors that may determine the health status of different populations as well as the sports performance of athletes. The cardio-respiratory fitness tests can also help identify a target population for primary prevention in children as well as adults. Furthermore, these tests may be used to promote public health and in assessment of individuals and athletes in sports sciences, especially as a performance predictor for medium and long distance running (23). They are also used to monitor the control of training in various types of sports.

In general, testing for the maximum oxygen consumption occurs in the laboratory and in the field. For example, the VO_2 max reached during a maximum graduated exercise test conducted in a laboratory is considered as the criterion measure (i.e., the gold standard) for determining cardio-respiratory fitness (27).

Additionally, multiple alternative field tests have also been developed to indirectly measure VO_2 max (3,10,18,19). One test that has been used often during the last 30 yrs is the 20 m back and forth or round trip test. This test has been used in a number of national (1,31,34) and international (7.8.14) studies for different purposes. However, despite its great popularity among health and physical education researchers and professionals nationally, to date, no study has focused on verifying the validity of this test with young athletes in Chile.

As a result, this raises the following two hypotheses for this study: First, although the criteria for estimating cardio-respiratory capacity were valid in the original US 20 m Back and Forth Run Test, it may also be valid to use with young athletes in Chile. Second, taking into account that evidence exists that demonstrates VO_2 max is positively related to lean mass (LM) (12,22), age, sex, body weight (37), and maximum expiratory flow (MEF) (26), for this study, these variables may also act as potential predictors of VO_2 max in young athletes of both sexes.

Thus, the purpose of the present study was to verify the validity of the 20 m Back and Forth Run Test for young athletes and propose regression equations to predict VO_2 max in young athletes of both sexes. The goal was to reduce costs, the need for sophisticated equipment, and constricting infrastructure. In general, these factors tend to limit evaluations in the sports and health sciences field.

METHODS

Subjects

A descriptive cross-sectional study was carried out with 31 young university physical education students (16 males and 15 females) between 18 and 24 yrs of age. The subjects were voluntarily recruited from a university in the city of Talca. By the time of the evaluation, the subjects had engaged in moderate to intense physical activity 3 to 4 times·wk^{-1}. In general, the students were amateurs participating in football (soccer), basketball, tennis, and other types of athletics (e.g., mid-field/track and field and javelin throw). The sample included students without any type of sports injury and those practicing a sport within the last 2 yrs. Students who were not within the required age range, those with less than 2 yrs of experience practicing a sport, and those who did not sign the informed consent form were excluded from the study. This study was carried out in accordance with the guidelines established by the Ethics Committee of the Universidad Autónoma de Chile. The protocol was approved by the Committee of the Universidad Autónoma de Chile. All subjects gave written informed consent in accordance with the Declaration of Helsinki.

Procedures

During the first day, the subjects' anthropometric variables were assessed between the hours of 9:00 to 12:00. Afterwards, following the laboratory test protocol, the subjects were informed about how to use the treadmill. During the second day of the study, maximum oxygen consumption (VO_2 max) was measured in the laboratory. Three days later, the 20 m Back and Forth Run Test was carried out with the subjects divided into 3 groups of 10 subjects each. They were evaluated on a basketball court inside a closed gymnasium.

The anthropometric values as well as weight, height, and skin folds (triceps and calf) were evaluated following the suggestions of the International Society for the Advancement of Cineantropometry [ISAK] (15). Body weight (kg) was measured with a scale (SECA, Hamburgo) with a precision of 0.1 kg. Height was measured, while the head was maintained on the Frankfurt plane, using a stadiometer (SECA, Hamburgo) with an accuracy of 0.1 cm. The skin folds (triceps and calf) were evaluated on the right side using Harpenden calibrator (British Indicators, Ltd., London).

The body fat percentage (BF%) was determined for both sexes by using equations proposed by Slaughter et al. (33). Age, triceps, and mid-calf skin folds were used. Lean body mass (LM) and fat mass (FM) were deduced from the BF%. The Body Mass Index (BMI) was calculated by using the formula: BMI = Weight (kg) / $height^2$ (m).

The validity of the 20 m round trip run test proposed by Leger and Lambert (18) was carried out with criterion validity. A laboratory test and the Back and Forth Run Test were used. The personal physiological variables from the students were measured directly for the maximum oxygen consumption (VO_2 max) with the students performing the test in the laboratory. The Wasserman et al. (37) test was used as the criterion. After a warm up and an adjustment period of 5 to 6 min, each student performed the test consisting of jogging on a treadmill with a constant 1% slope initially for 5 km·hr^{-1} that increased in speed of 1 km·hr^{-1} for each minute of jogging. The day prior to the VO_2 max evaluation, the subjects engaged in light training to avoid interfering with the stress test. The Medgraphics CPX Ultima System model and the Breeze Gas Suite 6.4.1 software were used to analyze the gases emitted by students during the test. The variables for oxygen consumption (VO_2), carbon dioxide (VCO_2) produced, ventilatory equivalent for oxygen (V_E/VO_2), and ventilatory equivalent for carbon dioxide (V_E/VCO_2) were determined as were the pressures at the end of each of the expirations of oxygen ($PETO_2$) and carbon dioxide ($PETCO_2$). Analysis of the gases was calibrated using the following gas standards: 15.35% O_2, 5.08% CO_2, and 100% N_2.

The field test was evaluated with the 20 m Back and Forth Run Test according to the description proposed by Leger et al (19). The test was given inside of a sports gymnasium commencing the back and forth run test at a speed of 0.5 $km \cdot hr^{-1}$, of which the speed was increased each minute. The test ended after two attempts where the subject could not reach the finish line before a whistle was blown. During the tests, all of the subjects were encouraged to keep running as the test progressed. The test used for speed velocity was [Y = -27.4 + 6.0*MAS] (8) where MAS: maximum aerobic speed, and Y: predicted VO_2 max in $mL \cdot kg^{-1} \cdot min^{-1}$.

The maximum expiratory flow MEF ($L \cdot min^{-1}$) was taken with a Mini Wright device (Clement Clarke International Ltd., Essex, England). The MEF consists of a maneuver commencing with a maximum inspiration (the same as in a spirometry) and concluding with a forced expiration. As described and suggested by Quanjer et al. (29), the evaluation took place while the subject was standing without bending the neck. The subjects performed three attempts. The best one was recorded.

Statistical Analyses

Descriptive statistical analysis was carried out for the arithmetic average, standard deviation, and range. The differences between the sexes were verified by the *t*-test for subjects of independent samples. Comparisons between criterion values and the field run test were carried out using the *t*-test for related samples. The relationship between the variables (criterion and the field test) was determined by using Pearson’s Correlation Coefficient (PCC) as well as the Coefficient of Concordance Index (CCI). To develop the equations, three regression models were created to predict VO_2 max. Multiple regression analysis was carried out in steps in order to search for the best combination between the predictor variables to estimate the VO_2 max. The equations were generated using the following criteria: R^2, Standard Error of Measurement (SEM), probability (P), and multi-collinearity. Within the collinearity, the variance inflation factor (VIF) was assessed.

In addition, Bland and Altman’s (6) Plot was used for the correlation/agreement between both measures. This allowed examination of the level of agreement and the tendencies of the differences in the averages between the criterion and the predictive values. To verify the precision and accuracy of the proposed equations, the Lin (20) desirable Reproducibility Index (DRI) was used. Calculations were performed with Excel sheets, SPSS 18.0, and MedCalc Statistical Software v.11.1.0. In all cases, statistical significance was set at an alpha level of $P<0.05$.

RESULTS

The anthropometric and physiological variables of the young athletes are illustrated in Table 1. Males showed greater body weight, standing height, sitting height, %BF, FM (fat mass), LM (lean mass), VO_2 max ($L \cdot min^{-1}$ and $mL \cdot kg^{-1} \cdot min^{-1}$), and MEF (maximum expiratory flow) in relation to the females (P<0.05). The females showed greater fat tissue in the triceps skin folds, and BMI in comparison to the males (P<0.05). No significant differences were observed in the triceps skin fold.

Table 1. Anthropometric and Physiological Characteristics of the Sample Studied.

Variables	Males (n=16)				Females (n=15)				Both (N=31)			
	X	±SD	Min	Max	X	±SD	Min	Max	X	±SD	Min	Max
Age (yrs)	19.8	1.6	17.8	23.4	19.6	1.6	17.8	23.5	19.7	1.6	17.8	23.5
Antropometry												
Weight (kg)	68.3*	8.2	52.5	80.0	61.5	10.2	44.5	83.0	64.9	9.7	44.5	83.0
Height (cm)	173.9*	6.1	159.0	184.0	160.7	6.6	151.0	176.0	167.3	9.2	151.0	184.0
BMI ($kg \cdot m^{-2}$)	22.6*	2.7	18.0	27.0	23.8	3.8	17.6	31.6	23.2	3.3	17.6	31.6
Triceps Fold (mm)	10.9*	2.4	8.0	18.0	16.7	3.6	9.0	23.0	13.8	4.2	8.0	23.0
Mid-calf Fold (mm)	12.6*	2.6	8.5	17.0	15.5	3.7	10.0	22.0	14.1	3.5	8.0	22.0
Body Composition												
Body Fat Percent (BF%)	16.3*	3.0	12.2	23.3	14.6	3.7	7.7	22.4	15.4	3.4	7.7	23.3
Fat Mass (kg)	11.2*	2.9	6.4	16.2	9.2	3.7	4.5	18.6	10.2	3.4	4.5	18.6
LM (kg)	57.0*	6.2	46.1	65.0	52.3	7.2	40.0	64.4	54.7	7.0	40.0	65.0
Maximum Consumption of Oxygen[1]												
VO_2 ($L \cdot min^{-1}$)	4.0*	0.4	3.3	4.6	2.5	0.4	2.0	3.4	3.3	0.8	2.0	4.6
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)	57.5*	4.3	48.0	63.0	41.1	6.1	29.0	53.0	49.3	9.8	29.0	63.0
Maximum Consumption of Oxygen[2]												
VO_2 ($L \cdot min^{-1}$)	4.0*	0.4	3.3	4.8	2.7	0.5	1.7	3.8	3.4	0.8	1.7	4.9
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)	59.4*	3.7	50.8	62.5	44.6	7.3	33.3	59.6	50.0	9.5	33.3	62.5
Spirometry												
MEF ($L \cdot min^{-1}$)	534.9*	71.4	396.7	663.3	407.4	55.4	316.7	523.3	473.3	90.4	316.7	663.3

X = Average, **SD** = Standard Deviation, **LM** = Lean Mass, **BMI** = Body Mass Index, **Max** = Máximum, **Min** = Minimum, **[1]** = Laboratory Test, **[2]** = Field Test, **MEF** = Maximum Expiratory Flow, *P<0.05

Table 2 illustrates the average values, ±SD (standard deviation), correlation coefficient, the CCI (coefficient of concordance index), and the significant differences in the VO_2 max between the laboratory and Back and Forth Run Test (18). No significant differences occurred when the absolute and relative VO_2 max were analyzed in males, in females, and in both sexes. In general, the correlation coefficient varied between r=0.76 and 0.94 (P<0.001), and the CCI ranged from 0.67 to 0.96 while accuracy reflected values greater from 0.84 to 0.96 in both sexes.

Table 2. Descriptive Values of the Absolute, Relative, and Distance and Speed of the VO_2 max of Young Athletes of Both Sexes.

Variables	X	±SD	R	CCI	*t*-test
MALES					
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)					
Criterion	4.0	0.4	0.8970; P<0.001; CI:0.7119 to 0.9656	0.885; CI=0.7044 to 0.9606; Accuracy = 0.9904	P>0.9999; t=0; CI = -0.2992 to 0.2992
Leger et al., 1988	4.0	0.4			
VO_2 ($L \cdot min^{-1}$)					
Criterion	58	4.3	0.7642; P=0.0009; CI:0.41419 to 0.9174	0.6781; CI=0.311 to 0.8635; Accuracy = 0.8873	P=0.2052; t=1.297; CI = -1.100 to 4.900
Leger et al., 1988	59	3.7			
FEMALES					
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)					
Criterion	2.5	0.4	0.8073; P=0.0003; CI: 0.5030 to 0.9335	0.6822; CI=0.3831 to 0.8518; Accuracy = 0.8451	P=0.2365; t=1.210; CI = -0.139 to 0.539
Leger et al., 1988	2.7	0.5			
VO_2 ($L \cdot min^{-1}$)					
Criterion	41	6.1	0.8145; P=0.0002; CI:0.45185 to 0.9361	0.6980; CI=0.3853 to 0.8670; Accuracy = 0.8571	P=0.1652; t=1.425; CI = -1.531 to 8.531
Leger et al., 1988	45	7.3			
BOTH					
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)					
Criterion	3.3	0.8	0.9472; P=0.001; CI: 0.8910 to 0.9748	0.9360; CI=0.8719 to 0.9686; Accuracy = 0.9882	P=0.6301; t=0.4841; CI = -0.314 to 0.514
Leger et al., 1988	3.4	0.8			
VO_2 ($L \cdot min^{-1}$)					
Criterion	49	9.8	0.9298; P=0.001; CI:0.8564 to 0.9664	0.8930; CI=0.7965 to 0.9452; Accuracy = 0.9605	P=0.2831; t=1.084; CI = -2.288 to 7.688
Leger et al., 1988	52.0	9.5			

X = Average, **SD** = Standard Deviation, **CCI** = Coefficient of Concordance Index, **IC** = Confidence Interval

The six regression equations developed to estimate the VO_2 max (absolute and relative) are illustrated in Table 3. The equations proposed for the relative VO_2 max reflected a power of explanation of R^2 = 80 to 90% while for the absolute VO_2 max, the values were less than 7 to 14% (R^2 = 73 to 86%). In both cases (absolute and relative), the values for the inflation factor (VIF) oscillated between 1.13 and 2.86, respectively. Furthermore, no collineality was observed in the six models. Even the SEM values were less than 5%, and they were highly significant (P<0.001).

Table 3. Regression Equations for Estimating the VO_2 max (L·min^{-1}) **for Young University Students of Both Sexes.**

N°	Equations	Collinearity Variables	Tolerance	VIF	r	R^2	SEM	P
	VO_2 (mL·kg^{-1}·min^{-1})							
1	VO_2 max = 4.264 + 0.002*MEF – 1.249* Sex	MEF	0.49	2.06	0.90	0.80	0.39	0.001
		Sex	0.49	2.06				
2	VO_2 max = 2.929 + 0.041*LM – 1.261* Sex	LM	0.88	1.13	0.94	0.88	0.30	0.001
		Sex	0.88	1.13				
3	VO_2 max = 3.185 – 0.001*MEF + 0.043* LM – 1.334* Sex	MEF	0.35	2.85	0.95	0.90	0.31	0.001
		LM	0.63	1.60				
		Sex	0.48	2.09				
	VO_2 (L·min^{-1})							
1	VO_2 max = 78.829 – 0.007*MEF – 17.381* Sex	MEF	0.59	2.04	0.85	0.73	5.32	0.001
		Sex	0.59	2.04				
		LM	0.85	1.13				
2	VO_2 max = 82.485 – 0.137*LM – 17.114*Sex	Sex	0.85	1.13	0.86	0.73	5.26	0.001
3	VO_2 max = 82.252 – 0.141*LM + 0.001 * MEF – 17.046*Sex	MEF	0.35	2.86				
		LM	0.63	1.59				
		Sex	0.48	2.86	0.87	0.76	5.36	0.001

MEF = Maximum Expiratory Flow, **LM** = Lean Mass, **VIF** = Variance Inflation Factor, **SEM** = Standard Error of Measurement, **Sex** = (1 = Males and 2 = Females)

The concordance analysis using Bland and Altman's Plot is illustrated in Figure 1. The six equations demonstrated a wide range of agreement associated with the criterion method (VO_2 max) in absolute and relative terms. In the regression equations for (mL·kg^{-1}·min^{-1}), the values fluctuated between -0.37 and 0.76 while for L·min^{-1}, the values varied from -10.2 to 9.9.

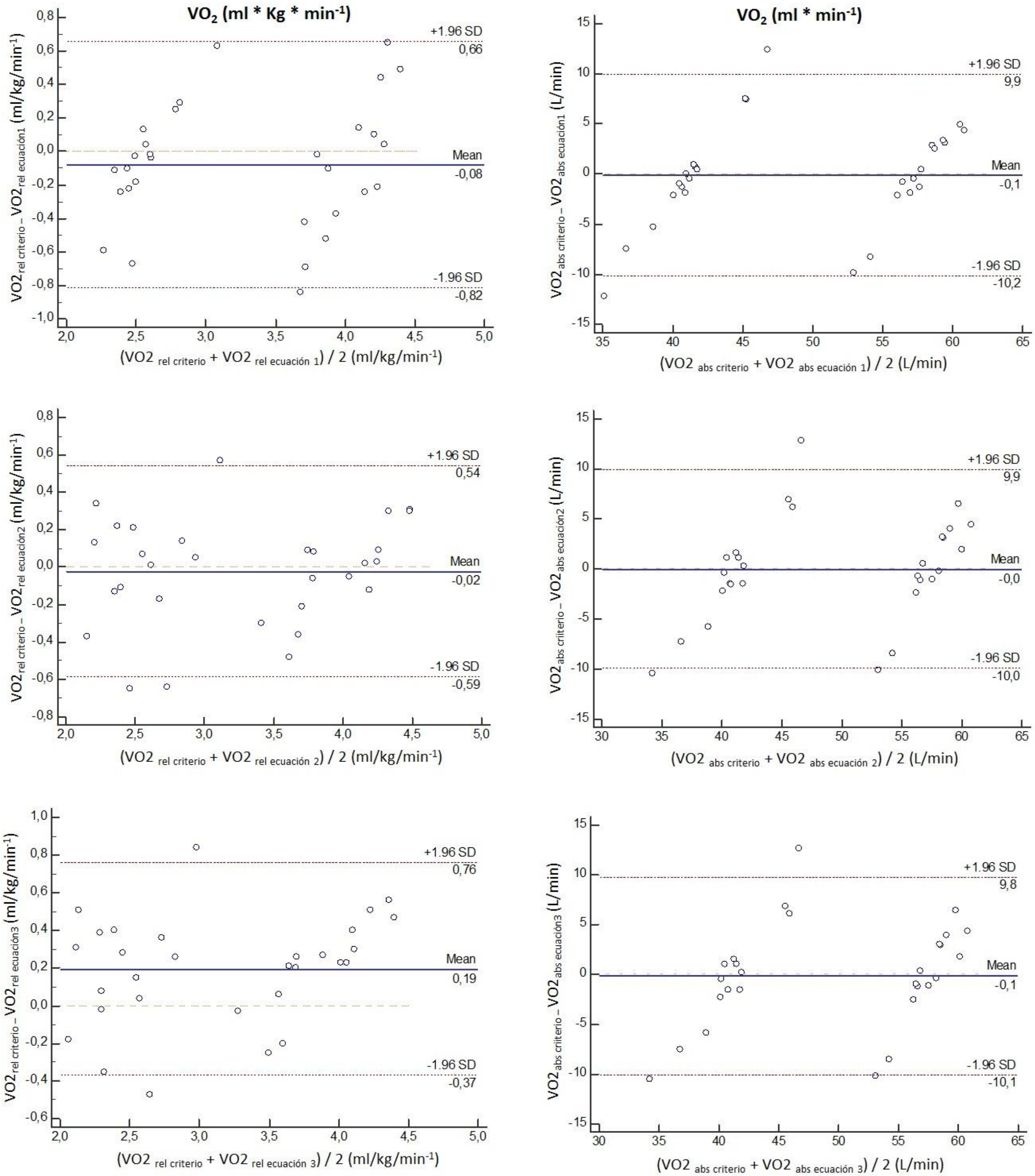

Figure 1. Analysis of Bland and Altman's Plots Concordance between the VO_2 max (Criterion) Values and the Regression Equations.

The significant differences between the criterion method and the regression equations that estimated the VO_2 max in absolute and relative terms are illustrated in Table 4. No significant differences occurred between the criterion and the six equations, both for the absolute and relative VO_2 max ($P>0.01$). In addition, the correlations are highly significant for the six equations ($P<0.001$). The values of the DRI expressed in precision and accuracy for relative

VO_2 max were slightly higher (P = 0.89 to 0.97 and E = 0.94 to 0.99) in relation to the absolute VO_2 max (P = 0.85 to 0.86).

Table 4. Descriptive Values of the VO_2 max ($mL \cdot kg^{-1} \cdot min^{-1}$ and $L \cdot min^{-1}$) **and the Desirable Reproducibility Index** (DRI) **and between the Criterion Method and the Proposed Equations.**

Equations	X	±SD	r	*t*	DRI		
					CCI	P	E
VO_2 ($mL \cdot kg^{-1} \cdot min^{-1}$)							
VO_2 max Criterion	3.26	0.84					
Equation 1: VO_2 max = 4.264+0.002*MEF-			0.894*	-1.155	0.88	0.89	0.99
1.249*Sex	3.34	0.77					
VO_2 max Criterion	3.26	0.84					
Equation 2: VO_2 max = 2.929+0.041*LM-			0.939*	-0.437	0.94	0.94	0.99
1.261*Sex	3.28	0.79					
VO_2 max Criterion	3.26	0.84					
Equation 3: VO_2 max = 3.185-			0.939*	0.554	0.91	0.97	0.94
0.001*MEF+0.043*LM-1.334*Sex	3.16	0.76					
VO_2 ($L \cdot min^{-1}$)							
VO_2 max Criterion	49.30	9.83					
Equation 1: VO_2 max = 78.829-0.007*MEF-			0.853*	-0.161	0.84	0.85	0.98
17.381*Sex	49.45	8.41					
VO_2 max Criterion	49.30	9.83					
Equation 2: VO_2 max = 82.485-0.137*LM-			0.857*	-0.026	0.71	0.86	0.98
17.114*Sex	49.32	8.42					
VO_2 max Criterion	49.30	9.83					
Equation 3: VO_2 max = 82.252-			0.857*	-0.158	0.85	0.86	0.99
0.141*LM+0.001*MEF-17.046*Sex	49.45	8.44					

MEF = Maximum Expiratory Flow, **LM** = Lean Mas, **X** = Average, **SD** = Standard Deviation, **Sex** = (1 = Males and 2 = Females), **DRI** = Desirable Reproducibility Index, **CCI** = coefficient of concordance index, *P<0.001

DISCUSSION

Within the requirements for validity (crossed, concurrent, and criterion), the first objective for this study was to validate the 20 m Back and Forth Run Test (8). This research was based on criterion validity where Wasserman et al. (37) laboratory test was used to evaluate the absolute and relative VO_2 max.

After the analysis was carried out for both sexes, the results indicated that no significant differences occurred between the criterion test and the field test (absolute and relative VO_2 max.). Furthermore, the correlations were high and significant. Also, the CCI showed exact values when analyzed separately in both sexes. This demonstrated that the 20 m Back and Forth Run Test is valid for young university students practicing sports.

The results obtained in this research are consistent with those from various other studies carried out with other age groups and populations around the world (9,13,16,34). The 20 m Back and Forth Run Test has been shown to be valid not only for children, adolescents, and adults but also for youth with similar characteristics to the ones in the current study.

In fact, despite Leger et al. (19) rest reflecting criterion validity for youth, other research has shown that the field test underestimates VO_2 max in relation to the laboratory test (11,13). Presumably, what could affect the prediction of energy demands might possibly be greater effort and motivation required during the execution of the Back and Forth Run Test.

In general, various international studies have highlighted that the Back and Forth Run Test is valid and trustworthy (4,28). The test is considered to be a useful tool to evaluate cardio-respiratory fitness of different populations around the world. Without question, the test presents advantages related to reduced costs and ease of administering to a large number of subjects in a short amount of time. However, the actual validity of Leger and colleagues (19) test has created an important milestone in the excessive use of this test after 30 yrs without validating the use of the test with diverse populations in Chile (8). Although the findings in the present study suggest using Leger and Lambert (18) test as an alternative for estimating cardio-respiratory fitness in young students practicing different types of sports, it is necessary to carry out more research studies to verify the test's validity and reliability in samples of adolescents and adults different from the sample actually studied.

This study has a second objective where regression equations were proposed to predict the absolute and relative VO_2 max in young athletes of both sexes. The results from this study indicated that the equations developed reflected high percentages of agreement (R^2 = 73 to 90%). In addition, the limits of agreement at 95% are narrow, and the correlation coefficients are highly significant ($P<0.001$). In fact, the findings from this research are similar to other studies that have developed equations to estimate the VO_2 max in diverse populations independent of the type of test administered. However, the majority of these studies only report R^2, SEM, and probability. Also, it is necessary to point out that the equations once proposed need to demonstrate a high level of reproducibility. In this sense, the six equations proposed according to Lin (20) and Lanza (17) DRI showed precision and exactness. These findings reflect the strength of the models proposed unlike studies only based on traditional statistical strategies (24,36).

Consequently, given the precision and accuracy of the proposed equations, they could be used to help detect changes in cardio-respiratory fitness in intervention programs, in prospective studies, and in monitoring athletes before and after training. In addition, the predictor variables used in the equations generally are easy to measure (LM and MEF), and they are within the reach of health and sports science professionals. These variables do not require specific and sophisticated equipment to collect data, nor do they require much time. Therefore, the models proposed here are considered a reliable and consistent alternative within the numerous equations that exist internationally for estimating the VO_2 max in young athletes. The equations proposed in the present study can be used in Chile as an alternative in the health sciences and in sports.

Limitations in this Study

Based on the results from the current study, it is necessary to point out some limitations related to the selection of the sample. Since a non-probabilistic sample was used, the results are not generalizable to other areas, and they need to be analyzed with caution. Moreover, it is necessary that future research verify the reliability of the 20 m back and forth run test. Additionally, it is necessary to point out that despite being the first research study carried out in Chile that validated the Leger and Lambert test (18), the equations developed depict precision and accuracy. Furthermore, the variables used to predict the VO_2 max can be used daily and are easy to use.

CONCLUSIONS

The 20 m Back and Forth Run Test is valid for estimating the absolute and relative VO_2 max in young athletes. Moreover, the equations developed for both sexes are a reasonable alternative for evaluating aerobic fitness and should contribute to the health sciences and sports. In fact, it may help in decision making with regard to evaluating, diagnosing, and monitoring individuals in physical activity programs and in overseeing sports training. The equations may be accessed using the following link: http://www.reidebihu.net/vo2_ maxoxicon.php

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