ORIGINAL ARTICLE

Validity of the VO_{2peak} prediction model to Brazilian youth with spina bifida

Validação de um modelo preditivo do VO_{2pico} em jovens brasileiros com espinha bífida

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ABSTRACT

Objective: To validate a peak oxygen uptake (VO_{2peak}) prediction model in Brazilian youth with spina bifida. **Methods:** Twenty participants with spina bifida performed a graded arm crank test to measure VO_{2peak}. The VO_{2peak} values predicted by the equation "VO_{2peak} (mL/min) = 194 + 18 × peak workload – 110 × sex" were compared to the VO_{2peak} values measured. **Results:** The predicted VO_{2peak} was not different from the measured VO_{2peak}. A high correlation was found between both VO_{2peak} values, and the Bland-Altman analysis did not show a significant difference, demonstrating agreement between the values. **Conclusions:** The VO_{2peak} prediction model in Brazilian youth with spina bifida was validated, being an advantageous alternative to assess and follow physical fitness and prescribe exercise training intensity.

Keywords: Exercise Test, Oxygen Level, Spinal Dysraphism

RESUMO

Objetivo: Validar uma equação preditiva do consumo pico de oxigênio (VO_{2pico}) em jovens brasileiros com espinha bífida. **Métodos:** Vinte participantes com espinha bífida realizaram um teste ergoespirométrico de membros superiores para medir o $VO2_{pico}$. Os valores de $VO2_{pico}$ preditos pela equação "VO_{2pico} (mL/min) = 194 + 18 × carga pico – 110 × sexo" foram comparados com o VO_{2pico} medido. **Resultados:** O VO_{2pico} predito pela equação não foi diferente do VO_{2pico} medido. Foi encontrada alta correlação entre os valores de VO_{2pico} e, a análise Bland Altman não mostrou diferença significativa, demonstrando concordância entre os valores. **Conclusão:** A equação preditiva do VO_{2pico} é válida para jovens brasileiros com espinha bífida e é uma alternativa vantajosa para obter e acompanhar o condicionamento físico e prescrever a intensidade de treinamento nesses indivíduos.

Palavras-chaves: Teste de Esforço, Nível de Oxigênio, Disrafismo Espinal

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INTRODUCTION

The highest value of oxygen uptake (VO_{2max} or VO_{2peak} for children) represents aerobic capacity and provides important diagnostic and prognostic information in various clinical situations.[1] Especially for the population with spina bifida (SB), which has complications associated with reduced physical activity and sedentary behaviour,[2,3] the improvement of aerobic capacity is essential to prevent metabolic and cardiovascular diseases later in life.[4] The World Health Organization and the American College of Sports Medicine have recommended 60 min of moderate to vigorous physical activity daily, and individuals with disabilities can adapt it to their personal condition.[4] The intensity (moderate to vigorous) of exercise prescription should be designed considering the individual's level of VO_{2peak}, which can be assessed by cardiopulmonary exercise testing (CPET).

CPET is the gold standard to assess VO_{2peak}, but the cost, personal requirements, and time associated with this laboratory technique have become a disadvantage. Consequently, prediction models have been developed to estimate VO_{2peak}. A recent study reported the first prediction model of VO_{2peak} for children with SB using a graded arm crank test. However, the validity and accuracy of the predicted model was not tested in Brazilian subjects.[5] A measurement instrument only can be stated as valid when its scores are tested in a specific situation and population.[6] To validate evaluative and diagnostic instruments (as the developed prediction model), it is necessary to understand the degree that the score of the model adequately reflects the gold standard score.[6] Therefore, the validity of the prediction model is essential to provide safe exercise prescription in therapeutic intervention.

OBJECTIVE

The purpose of this study was validate the prediction model of VO_{2peak} in Brazilian youth with SB.

METHODS

In this study, we analysed data from 30 participants diagnosed with SB recruited from the Infant Neurological Walking at Clinical Hospital in Ribeirão Preto, USP from August 2019 to March 2020. For statistical analysis, 10 participants had to be excluded, because they did not meet the criteria for maximal effort (n= 8) or had missing values (n= 2). The final study was composed of 20 participants between 8 and 16 years of age with medical permission to perform a maximal exercise test and able to understand simple instructions. Exclusion criteria were bone fractures in the upper limbs within 1 year prior to the test. The study protocol was approved by the Human Research Ethics Committee of the Clinical Hospital (CAAE: 60154216.7.1001.5440) followed the Helsinki Declaration (2000). The legal guardians of the participants provided informed consent.

All participants were evaluated according to their anthropometric measurements, level of physical activity,[7] level of lesion,[8] functional ambulation[9] and performed the CPET following the same methodology described in the previous study that developed the predicted model.[5]

The Shapiro-Wilk test checked data normality, and according to the result, the paired-sample t test assessed the significant difference between the measured and predicted VO_{2peak}. The reliability between both VO_{2peak} values was evaluated by the intraclass correlation coefficient (ICC) model 2.1.A, considering ICC= 0.7 to 0.8 an acceptable correlation, ICC= 0.8 to 0.9 a high correlation, and ICC > 0.9 an excellent correlation.[6] The Bland-Altman analysis tested the average limits of agreement (LOA) of the measured and predicted VO_{2peak}, and linear regression assessed the proportion bias in the Bland-Altman plot. The significance level was fixed at 5%, and SPSS (IBM version 22) software was used for all statistical analysis.

RESULTS

Data of the 20 participants were used to validated prediction model for VO_{2peak}. The characteristics of the participants and their test results are given in Table 1.

Table 1. Characteristics and test results

	n= 20 (55% female)
	Mean (SD)
Age, y	10.5 (0.6)
Body mass, kg	35.3 (2.6)
Arm span length, cm	137.7 (3.9)
Body mass index, kg/m2	18.8 (1.2)
Physical activity level	Frequencies (percentages)
Extremely sedentary	7 (35%)
Sedentary	9 (45%)
Moderate active	4 (20%)
Level of lesion	
Thoracic	6 (30%)
High lumbar	5 (25%)
Low lumbar	5 (25%)
Sacral	4 (20%)
Hoffer classification	
Normal	...
Community	3 (15%)
Household	4 (20%)
Therapeutic	1 (5%)
Nonambulatory	12 (60%)
	Mean (SD)
HR_{peak}, bpm	162.9 (4.7)
RER_{peak}	1.1 (0.02)
Test duration, min	7.0 (0.4)
Distance m	459.1 (84.3)
Peak workload ,W	30.9 (2.9)
VO_{2peak}, L/min	0.72 (0.6)
VO_{2peak}, L/min/kg	21.0 (1.9)

Abbreviations: Hrpeak: peak heart rate; RER: respiratory exchange ratio; VO_2: oxygen uptake

The predicted VO_{2peak} (mean= 695.3 mL/min, SD= 235.0) of the participants was not different from the measured VO_{2peak} (mean= 719.3 mL/min, SD= 266.4) of the participants (p= 0.54).

The ICC between the VO_{2peak} values was 0.867 ($p < 0.001$), showing a high correlation. Bland-Altman analysis showed a mean difference of the measured and predicted VO_{2peak} of 24.0 mL/min (95%CI: 57.4–05.4) and did not show a significant difference ($t= 0.61$, $p= 0.54$), demonstrating agreement between the values (Figure 1). Furthermore, the linear regression analysis did not show a proportion bias between the measures ($p= 0.56$ and $p= .41$, respectively).

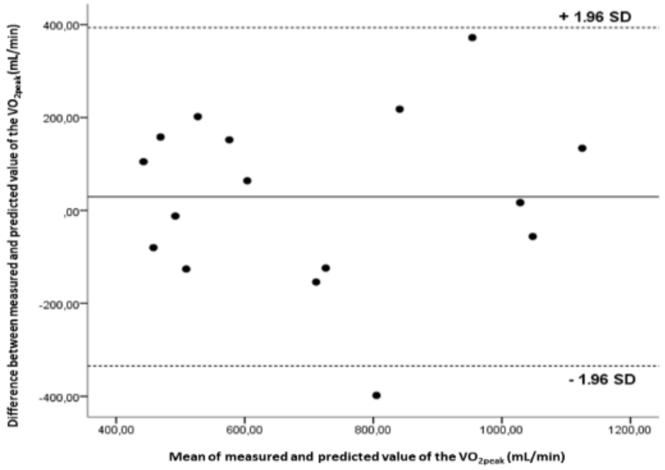

Figure 1. Bland-Altman plot of the limits of agreement between the measured VO_{2peak} and the predicted VO_{2peak} values

DISCUSSION

This study aimed to validate the prediction model of VO2peak in Brazilian youth with SB. Our findings showed that the prediction equation "VO_{2peak} (mL/min)= 194 + 18 × peak workload − 110 × sex (0 for boys, 1 for girls)" is valid for estimating the VO_{2peak} in these subjects. The Bland-Altman analysis showed that the values are distributed in an equal proportion above and below 0. It indicate that the VO_{2peak} measured using this prediction model will not underestimate or overestimate the aerobic capacity of patients with SB.

In order to use a predictive model in clinical practice, we must be attentive when analysing the results. Although the predicted VO_{2peak} was shown to have statistically significant agreement with the measured VO_{2peak}, it is important to interpret the clinical significance. While statistical significance indicates the validity of the study results, clinical significance reflects its impact on clinical practice.[10] Thus, the smaller the difference between the values are, the more reliable it is to implement in practice rehabilitation. An example of how a poor interpretation of statistical significance may have adverse effects in clinical practice is to use the most common prediction equation for maximal heart rate (HRmax= 220 − age) to prescribe exercise intensity. It is known that the percent of maximal HR and VO_2 have a linear relationship, even for cycle arm exercise.[11] However, what few people don't know is that this HR equation has a high standard deviation (7–11 beats per minute), which can overestimate the exercise intensity and cause risk to the patient during training, mainly those with reduced aerobic capacity.[12]

Thus, when we use a predictive equation without considering its confidence interval or the absolute value error range, adverse events can occur during exercise, or still, it may not reach the intensity level to achieve health benefits (around 80%).[2,13] Additionally, it is fundamental to consider the population whose equation was devised and keep its use following the original proposal. In both studies, the one that developed and validated the oxygen uptake equation, the sample was only composed of children and adolescents with SB.

Therefore, it is strongly recommended to apply this predictive model only in this group. Advantageously, this model does not require a gas analysis system and specialized professionals reducing the time and cost to obtain VO_{2peak}, which benefits the clinical trial follow-up. Complementing this, the absence of masks makes the test more tolerable and acceptable for patients, eliminating the usually self-reported sensation of suffocation. Nevertheless, this model still requires an ergometer that shows the peak workload, restricting its use in specialized laboratories or training centres. Future studies should be developed to test a predictive model based on HRpeak to promote its use in clinical practice.

CONCLUSION

In conclusion, the VO_{2peak} prediction model in Brazilian children and adolescents with SB is valid. It is an advantageous alternative to assess and follow the physical fitness of patients with SB and prescribe exercise training intensity in training centres and clinical research.

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