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Reliability and accuracy of Cooper's test in male long distance runners

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A B S T R A C T

Objective: Endurance capacity can be assessed by field test such as Cooper's test; however, reliability and accuracy are rarely reported in the literature. It was our aims to describe reliability and accuracy of Cooper's test in long distance runners.

Method: Fifteen male long distance runners performed twice all-out Cooper’s test in a 400 m track. Total distance covered, maximum heart rate (HR) and rate of perceived exertion were recorded. Bias correction factor (Bc) was used to describe accuracy and the main dimensions of reliability were calculated by an intraclass correlation coefficient (ICC), effect size (ES) and agreement analysis.

Results: Accuracy for total distance and HR were relatively high (Cb = 0.994 and 0.956). Reliability for covered distance was as small as 1.7% (52.2 m) and ICC was 0.99; additionally, neither proportional nor systematic bias was detected in the agreement analysis.

Conclusions: All together, our results may confirm a good accuracy and reliability of Cooper’s test in amateur long distance runners. Also, improvements or impairment lower than 52.2 m must not be associated with exercise training or retraining, since they are below the values of intra-subject reliability.

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Fiabilidad y precisión del test de Cooper en corredores varones de larga distancia

R E S U M E N

Objetivo: La capacidad de resistencia puede ser evaluada por una prueba de campo como el test de Cooper, sin embargo, la precisión y fiabilidad son raramente divulgados en la literatura. Es nuestro objetivo describir la fiabilidad y la exactitud del test de Cooper en corredores de larga distancia.

Método: Quince varones fondistas realizaron pruebas de Cooper dos veces en una pista de 400 metros. La distancia recorrida, la frecuencia cardíaca máxima (FC) y la percepción de esfuerzo fueron registradas. El factor de corrección de sesgo fue utilizado para describir la exactitud y las dimensiones de la fiabilidad y se calcularon los coeficientes de correlación intraclass (CCI), el tamaño del efecto y un análisis de concordancia.

Resultados: La precisión de distancia total recorrida y de la frecuencia cardíaca fueron relativamente altas (Cb = 0.994 y 0.956). La confiabilidad para el recorrido era tan pequeña como el 1.7% (52.2 metros) y el CCI de 0.99, además no se detectó ni sesgo proporcional ni sistemático mediante el análisis de concordancia.

Conclusiones: Nuestros resultados pueden confirmar una buena exactitud y fiabilidad del test de Cooper en corredores de larga distancia aficionados. También, las variaciones inferiores a 52.2 metros no deben ser asociados con el ejercicio de entrenamiento o desentrenamiento, puesto que están por debajo de la fiabilidad intra-sujeto.

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Introdução

O máximo consumo de oxigênio (VO₂max), limia de lactato e as condições que permitem ao atleta alcançar seu máximo consumo de oxigênio têm sido amplamente utilizados para avaliação do potencial aeróbico e testes de força muscular. No entanto, essas variáveis são, em geral, caras e demoradas para serem realizadas e, portanto, são raramente usadas no exame clínico. Além disso, a testagem de força muscular e VO₂max não são medidas fidedignas, uma vez que elas dependem de uma quantidade de fatores, como o grau de esforço, a fatiga e a confiabilidade das mensurações. 

O teste Cooper é um dispositivo de avaliação de condicionamento físico que pode ser realizado rapidamente e com baixo custo, e é amplamente utilizado no campo de estudo da saúde e desporto. O teste Cooper é realizado com os participantes correndo por um percurso de 1.500 metros, com o objetivo de determinar a distância mais longa que o participante pode correr em 15 minutos. O teste Cooper é um test de endurance e pode ser realizado por atletas de qualquer idade e nível de condicionamento físico. O teste Cooper é um teste de fiske e está descrito como um teste de validade, sendo que as distâncias corremadas em 15 minutos são usadas como uma medida de resistência cardiovascular.

Objetivos: A capacidade de resistência pode ser avaliada pelo teste de campo, tal como o teste de Cooper; no entanto, a fiabilidade e precisão são raramente relatados na literatura. O objetivo foi descrever a fiabilidade e precisão do teste de Cooper em corredores de longa distância.

Método: Quinze corredores de longa distância do sexo masculino realizaram teste de Cooper 2 vezes, numa faixa de 400 metros. Distância total percorrida, frequência cardíaca máxima (FC) e taxa de esforço percebido foram registadas. Fator de correção do viés (BC) foi usado para descrever a precisão e as principais dimensões de fiabilidade foram calculados por meio do coeficiente de correlação de intraclass (ICC), tamanho do efeito (ES) e análise de concordância.

Resultados: A precisão da distância total e frequência cardíaca eram relativamente altas (Cb > 0.994 e 0.956). Fiabilidade para o curso era tão pequena quanto 1.7% (52.2 metros) e ICC de 0.99, além disso, uma vez que nem viés proporcional, nem sistemático foram detetados através da análise de jogo. Conclusões: Os nossos resultados podem confirmar uma boa precisão e fiabilidade do teste de Cooper em corredores de longa distância amadores. A estrutura, melhorias ou prejuízo menor do que 52.2 metros não devem ser associados a treinamento físico ou destreinamento, uma vez que estão abaixo dos valores de fiabilidade intrassujeitos.
Table 1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>67.3 ± 10.7</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.0 ± 6.8</td>
</tr>
<tr>
<td>Age (years)</td>
<td>34.5 ± 1.9</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>22.9 ± 1.5</td>
</tr>
<tr>
<td>Training time (years)</td>
<td>3.7 ± 4.6</td>
</tr>
<tr>
<td>Km/week (km)</td>
<td>44.8 ± 9.8</td>
</tr>
</tbody>
</table>

($\sqrt{\frac{1}{N}(\text{test}_1 - \text{test}_2)^2}$), the standard error of the mean (SEM) and the effect size (ES) using the d coefficient of Cohen. For this study, an ICC<0.50 was considered fair; from 0.50 to 0.75 was considered good and >0.75 excellent. Also, Cohen’s d ES of 0.20 was considered small, 0.50 medium, and 0.80 large. The relative reliability was studied using the intraclass correlation coefficient (ICC) and relative CV (CV(mean 100)). An agreement analysis was conducted to confirm systematic and proportional bias by using Bland and Altman plots and Kendall’s Tau rank correlation coefficients.

Results

Statistical analysis of the anthropometric and training characteristics of the sample are reported in Table 1. In this sample, inter-subject variability for total distance covered was 10.9–11.8% for the distances of 1st and 2nd test respectively, which reflected the dispersion of the results around the mean of the population. The accuracy of Cooper’s test was relatively high for distance (Cb=0.994) and HR (Cb=0.956) but low for RPE (Cb=0.478).

No significant differences were found between test 1 and 2 either for total distance or HR. Additionally, our ICC results from test–retest data indicated that Cooper’s test had a very good reliability for covered distance and HR (Table 2). Regarding RPE, we observed a good ICC, although a significant difference was found between RPE in the first and second test (P<0.001, Table 2).

Agreement analysis from the Bland–Altman plots did not showed systematic error for both, distance (difference (−20.5 m, P>0.05) or minimal HR (difference (−1.1 bpm, P>0.05), neither proportional bias as confirmed by Kendall’s Tau rank correlation coefficient between differences and mean of measurements (Fig. 1).

Discussion

The aim of this study was to perform a preliminary reliability and accuracy of the Cooper’s test in amateur long-distance runners. Our data support a good reliability as suggested previously by other authors, who studied the reliability of Cooper’s test in non-athletic samples. Explained by the great heterogeneity of the athletic performance of the sample (range: 2350–3520 m trial 1 and 2275–3540 m trial 2), so the same absolute distance may represent similar percentages for high and low extremes in performance. In spite of the limitation, this may offer better generalization of our results since they included a larger range of performances and may highlight the bias of reliability data from a previous study where a more homogenous sample than ours was analyzed. Moreover, the ES of the differences was as low as 0.059 and the non-significant difference on covered distances between trials may indicate the good repeatability of this test.

Table 2

<table>
<thead>
<tr>
<th>Reliability</th>
<th>Distance 1 (m)</th>
<th>Distance 2 (m)</th>
<th>HR1 (bpm)</th>
<th>HR2 (bpm)</th>
<th>RPE1</th>
<th>RPE2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>3026 ± 330</td>
<td>3047 ± 359</td>
<td>182 ± 7.3</td>
<td>183 ± 5.7</td>
<td>8.7 ± 0.6</td>
<td>9.5 ± 0.5</td>
</tr>
<tr>
<td>Mean diff (95% CI)</td>
<td>20.46 (−20.22 to 61.15)</td>
<td>2.41 (−1.37 to 18.21)</td>
<td>1.13 (−0.06 to 2.93)</td>
<td>0.93 (0.80–0.98)</td>
<td>0.8 (0.48–1.11)</td>
<td>0.68 (0.05–0.89)</td>
</tr>
<tr>
<td>ICC (95% CI)</td>
<td>0.99 (0.96–0.99)</td>
<td>0.99 (0.96–0.99)</td>
<td>0.99 (0.96–0.99)</td>
<td>0.99 (0.96–0.99)</td>
<td>0.99 (0.96–0.99)</td>
<td>0.99 (0.96–0.99)</td>
</tr>
<tr>
<td>CV (CV %)</td>
<td>52.2 (1.7%)</td>
<td>52.2 (1.7%)</td>
<td>2.4 (1.3%)</td>
<td>2.4 (1.3%)</td>
<td>0.7 (7.5%)</td>
<td>0.7 (7.5%)</td>
</tr>
<tr>
<td>SEM</td>
<td>18.97</td>
<td>18.97</td>
<td>0.8387</td>
<td>0.8387</td>
<td>0.173</td>
<td>0.1447</td>
</tr>
<tr>
<td>Cohen’s d</td>
<td>0.059</td>
<td>0.059</td>
<td>1.405</td>
<td>1.405</td>
<td>1.13</td>
<td>1.13</td>
</tr>
</tbody>
</table>

Data in the table are from two repeated all-out Cooper’s test. 1 and 2 subscripts indicate first and second Cooper’s test respectively. HR, maximal heart rate during the last minute of the test; SD, standard deviation; Mean diff, mean difference between first and second test; ICC, interval of confidence; ICC, intraclass correlation coefficient; CV, coefficient of variation (CV (original units)) = $\sqrt{\frac{1}{N}(\text{test}_1 - \text{test}_2)^2}$; % CV = cv×mean×100; SEM, standard error of the mean; RPE, rate of perceived exertion (scale from 0 to 10).

$P<0.001$, for paired sample T-test.
Firstly, these results may be helpful for coaches and scientists when prescribing training load, reporting VO_{2\text{max}} changes or predicting performance in order to interpret the variability of their outcomes. On the other hand, researchers could use these data in order to calculate sample size. This study does not lack of limitations, and our results could be biased by the intensity of test, so it can be argued that the athletes did not exercise at maximum or same effort in both trials. By using HR, the intensity of aerobic exercise test may be easily confirmed. In this study, all participants reached theoretical maximal HR values as predicted from age, which may suggest that both trials were performed all-1 out. In relation with heart rate reliability, it was also observed a CV was also observed among 4 and 3.1%, a low effect size of the difference (0.17), as well as very low absolute reliability for the maximal HR (1.13 bpm); all together these results suggest that trials 1 and 2 were similar in intensity. Additionally, RPE is a recognized marker of intensity and homeostatic disturbance during exercise and it is usually monitored during exercise tests to complement other dimensions of intensity. Garcia analyzed the reliability of the HR and RPE in progressive and constant intensity exercises, concluding that these variables are reliable and replicable in these exercises. Nevertheless, our results did not confirm this latter evidence and RPE had a low reliability as confirmed by the very large ES found (1.4). A plausible reason for this disagreement may be related with the poor experience of athletes in using this variable.

In conclusion our results showed that the Cooper’s test is highly reliable when repeated after 48 h as confirmed by HR and distance data. This study provided support for the Cooper’s test as an accurate and reliable test to assess performance in a sample of amateur long-distance runners. Nonetheless, more studies are it must be necessary in order to validate performance-related constructs with Cooper’s test to confirm its utility as training tool in field settings.

**Conflict of interest**

The authors declare to have no conflict of interest.

**Acknowledgements**

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**References**