Original article

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

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ABSTRACT

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 detraining, 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

RESUMEN

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 esfuerzo 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 teste de Cooper é amplamente utilizado para a mensuração da aptidão cardiovascular e do estado de forma física em atletas e outras populações. No entanto, alguns estudos questionam a validade e a reprodutibilidade do teste.

O presente estudo teve como objetivo avaliar a fiabilidade e a precisão do teste de Cooper em corredores de distância longa do sexo masculino.

Método

O teste de Cooper tem como objetivo medir a resistência cardíaca máxima de um corredor, utilizando o tempo gasto para percorrer uma distância específica.

Resultados

Os resultados mostraram uma alta consistência e fiabilidade do teste de Cooper, com coeficientes de correlação intraclass e de concordância de 0.949 e 0.956, respectivamente.

Conclusões

O teste de Cooper é uma ferramenta confiável e precisa para avaliar a aptidão cardiovascular de corredores de longa distância.


Palavras-chave:
Atletas amadores
Teste de campo resistência
Fator de correção de viés
Erro técnico de medição
Análise de concordância
Coeficiente de correlação intraclass
Tamanho do efeito

Fiabilidade e precisão do teste de Cooper em corredores de longas distâncias do sexo masculino

R E S U M O

Objetivo: O teste de Cooper é amplamente utilizado para avaliar a resistência cardíaca máxima de um corredor, mas sua fiabilidade e precisão são questionados. O presente estudo teve como objetivo avaliar a fiabilidade e precisão do teste de Cooper em corredores de longa distância.

Método: Um grupo de corredores de longa distância (50) participou do teste de Cooper, realizado duas vezes, com intervalo de um mês entre as medições.

Resultados: Os resultados mostraram uma alta consistência e fiabilidade do teste de Cooper, com coeficientes de correlação intraclass e de concordância de 0.949 e 0.956, respectivamente.

Conclusões: O teste de Cooper é uma ferramenta confiável e precisa para avaliar a aptidão cardiovascular de corredores de longa distância.

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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>

\(\sqrt{\left(\sum_{i=1}^{n}(x_i - \bar{x})^2/n\right)}\), 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, 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 (\(\text{Cb}=0.994\)) and HR (\(\text{Cb}=0.956\)) but low for RPE (\(\text{Cb}=0.478\)).

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 (\(P<0.001, \text{Table 2}\)).

Agreement analysis from the Bland–Altman plots did not show systematic error for both, distance (difference = -20.5 m, \(P>0.05\)) or maximal 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</td>
<td>9.5</td>
</tr>
<tr>
<td>Mean diff (95% CI)</td>
<td>20.46 (-20.22 to 61.15)</td>
<td>0.93 (0.80–0.98)</td>
<td>1.13 (-0.66 to 2.93)</td>
<td>0.8 (0.48–1.11)</td>
<td>0.68 (0.05–0.89)</td>
<td>0.7 (7.5%)</td>
</tr>
<tr>
<td>ICC (95% CI)</td>
<td>0.99 (0.96–0.99)</td>
<td>2.4 (1.3%)</td>
<td>0.8387</td>
<td>0.173</td>
<td>0.059</td>
<td>0.095</td>
</tr>
<tr>
<td>CV (CV %)</td>
<td>52.2 (1.7%)</td>
<td>0.059</td>
<td>0.059</td>
<td>0.095</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td>18.97</td>
<td>0.059</td>
<td>0.059</td>
<td>0.095</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cohen’s d</td>
<td>1.405</td>
<td>0.059</td>
<td>0.059</td>
<td>0.095</td>
<td></td>
<td></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, intraclass correlation coefficient; CV, coefficient of variation (CV [original units]) = \(\sqrt{\left(\sum_{i=1}^{n}(x_i - \bar{x})^2/n\right)}\); % cv = cv/mean \times 100; SEM, standard error of the mean; RPE, rate of perceived exertion (scale from 0 to 10).

\(P<0.001, \text{for paired sample T-test.}\)
Firstly, these results may be helpful for coaches and scientists when prescribing training load, reporting VO_{2max} 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. García 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.

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References