

A smartphone application tests your physical performance - How accurately does the 4-minute all out run measure your endurance performance?

Oeschger, Regina; Aubry, Luca; Albisser, Enrico; Alain Dössegger; Gilgen-Ammann, Rahel
Swiss Federal Institute of Sport Magglingen SFISM, Magglingen, Switzerland

Introduction

The Swiss Armed Forces have released a fitness app for personalised physical training that takes into account the current endurance performance. This is done by means of an integrated digital self-test of physical performance. The Cooper test (12-minute run), which is widely used in the military setting, is too long for the digital self-test. This study aims to investigate whether a self-paced 4-minute all out outdoor run (4Min_{max} run) is a valid method to assess endurance performance for personalised training planning in the app.

Methods

On the same day, the subjects completed a 4Min_{max} run on a flat 300 m circular track and a maximal exercise test ($\dot{V}O_{2max}$ -Test) using a graded protocol (figure 1). Average speed was calculated from the 4Min_{max} run (v_{4Min}), the relative maximum oxygen uptake ($\dot{V}O_{2max}$) and the maximum speed (v_{end}) from the $\dot{V}O_{2max}$ -Test. Maximum heart rate (HR_{max}) was measured during the 4Min_{max} run and the $\dot{V}O_{2max}$ -Test. Respiratory gases were analysed during the $\dot{V}O_{2max}$ -Test using a mixing chamber (Cosmed srl, Rome, Italy). Pearson correlations and linear regressions were used to test whether v_{4Min} predicted v_{end} and the relative $\dot{V}O_{2max}$. Two regression analyses were performed separately for women and men.

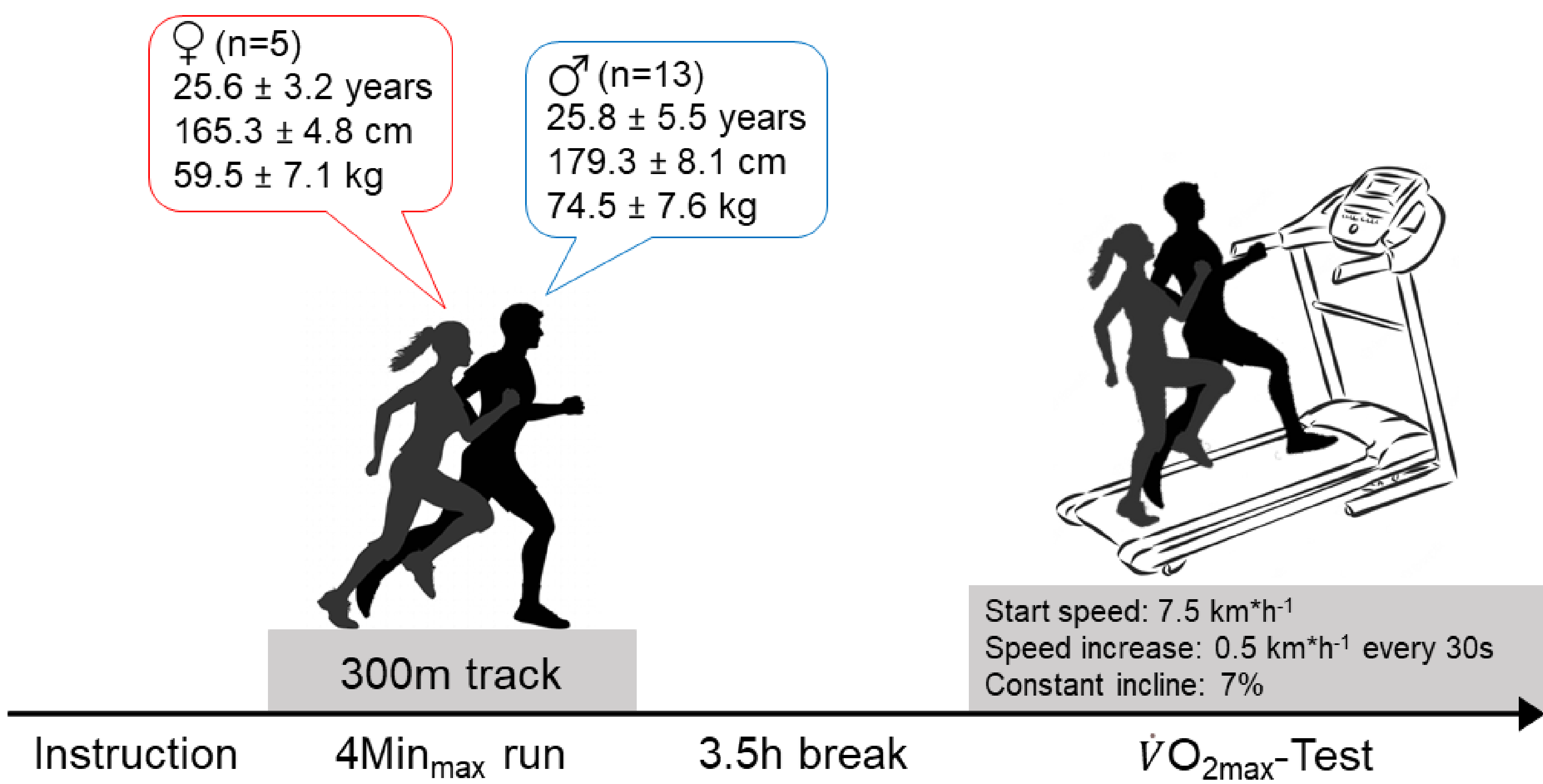


Figure 1. The methods of the study and the subjects' characteristics.

Results

Table 1 shows the descriptive statistics of the 4Min_{max} run and the $\dot{V}O_{2max}$ -Test of the 18 subjects.

Table 1.
Descriptive statistics of the 4Min_{max} run and the $\dot{V}O_{2max}$ -Test.

	Women	Men
v_{4Min} [km*h ⁻¹]	13.1 ± 1.8	16.7 ± 1.2
$\dot{V}O_{2max}$ [ml*min ⁻¹ *kg ⁻¹]	46.4 ± 11.6	57.2 ± 7.5
v_{end} [km*h ⁻¹]	11.6 ± 1.6	14.7 ± 1.7
HR_{max} @ 4Min _{max} run [bpm]	187.8 ± 6.6	189.0 ± 9.1
HR_{max} @ $\dot{V}O_{2max}$ -Test [bpm]	185.8 ± 4.6	194.1 ± 6.8
Borg @ 4Min _{max} run	17.8 ± 0.8	18.0 ± 0.9
Borg @ $\dot{V}O_{2max}$ -Test	18.6 ± 0.9	18.5 ± 1.0

Notes: All values are mean ± standard deviation. v_{4Min} : average speed during the 4-minute all out run; $\dot{V}O_{2max}$: relative maximum oxygen uptake; v_{end} : maximum speed at the end of the $\dot{V}O_{2max}$ -Test; HR: heart rate; $\dot{V}O_{2max}$ -Test: maximal exercise test.

In both men and women, v_{end} and v_{4Min} were strongly correlated ($r = 0.79$, $p = 0.001$, 95% CI: 0.424 - 0.934 and $r = 0.974$, $p = 0.005$, 95% CI: 0.647 - 0.998, respectively; figure 2). Also the $\dot{V}O_{2max}$ and the v_{4Min} were strongly correlated in men and in women ($r = 0.742$, $p = 0.004$, 95% CI: 0.324 - 0.918 and $r = 0.897$, $p = 0.039$, 95% CI: 0.073 - 0.993, respectively; figure 3). The linear regression model of the relative $\dot{V}O_{2max}$ explained by the v_{4Min} was statistically significant in women (adjusted $R^2 = 0.74$, $F(1,3) = 12.41$, $p = 0.039$) and in men (adjusted $R^2 = 0.51$, $F(1,11) = 13.504$, $p = 0.004$).

The regression equation for women was:

$$\dot{V}O_{2max}[\text{ml}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}] = -28.792 + 5.758 \cdot (v_{4Min} [\text{km}\cdot\text{h}^{-1}]).$$

The regression equation for men was:

$$\dot{V}O_{2max}[\text{ml}\cdot\text{min}^{-1}\cdot\text{kg}^{-1}] = -21.627 + 4.709 \cdot (v_{4Min} [\text{km}\cdot\text{h}^{-1}]).$$

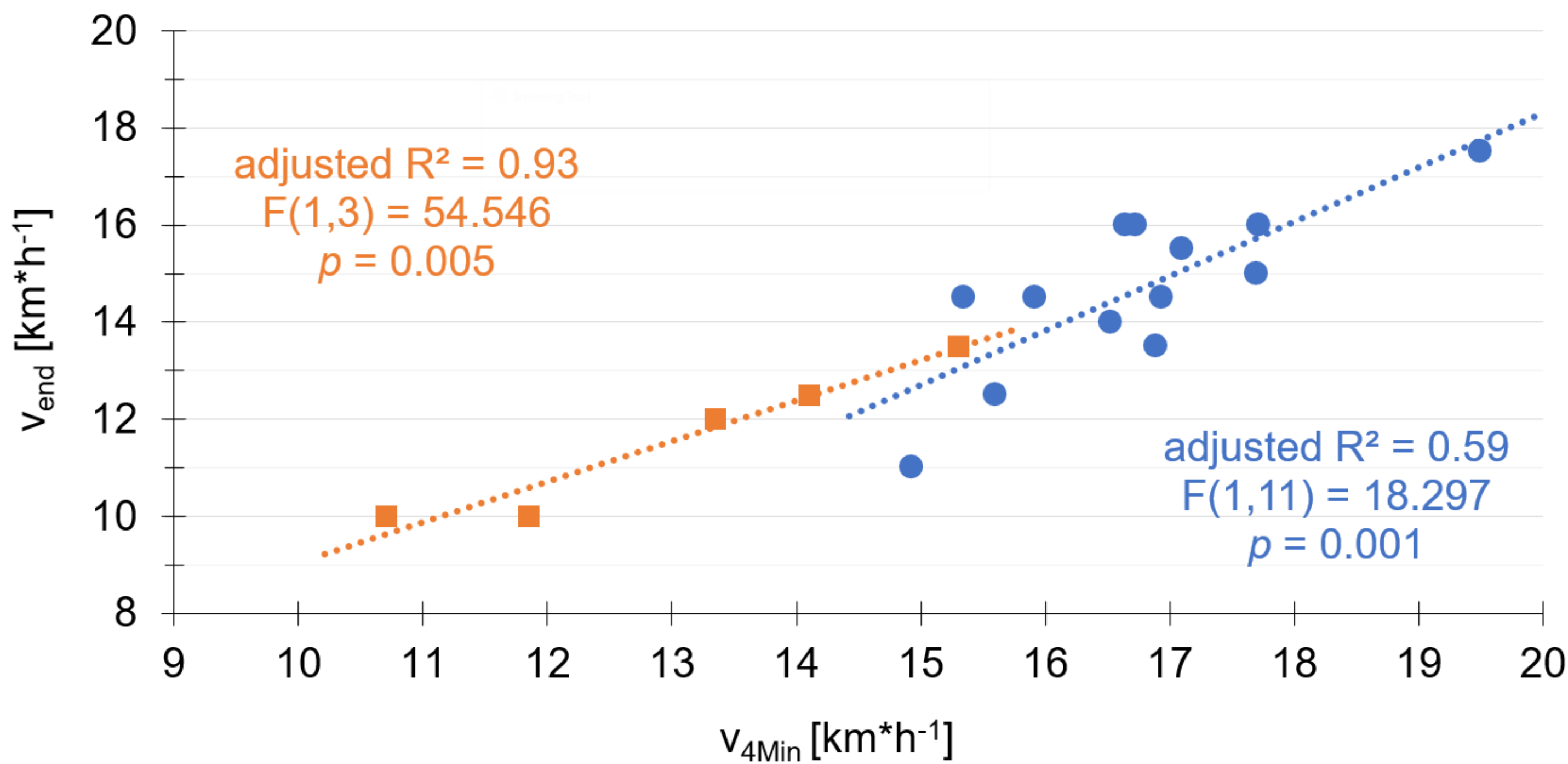


Figure 2. Scatterplot with regression line of the average speed of the 4-minute all out run (v_{4Min}) and the maximal speed of the $\dot{V}O_{2max}$ -Test (v_{end}) divided by sex. The red squares are the female participants, the blue dots are the male participants.

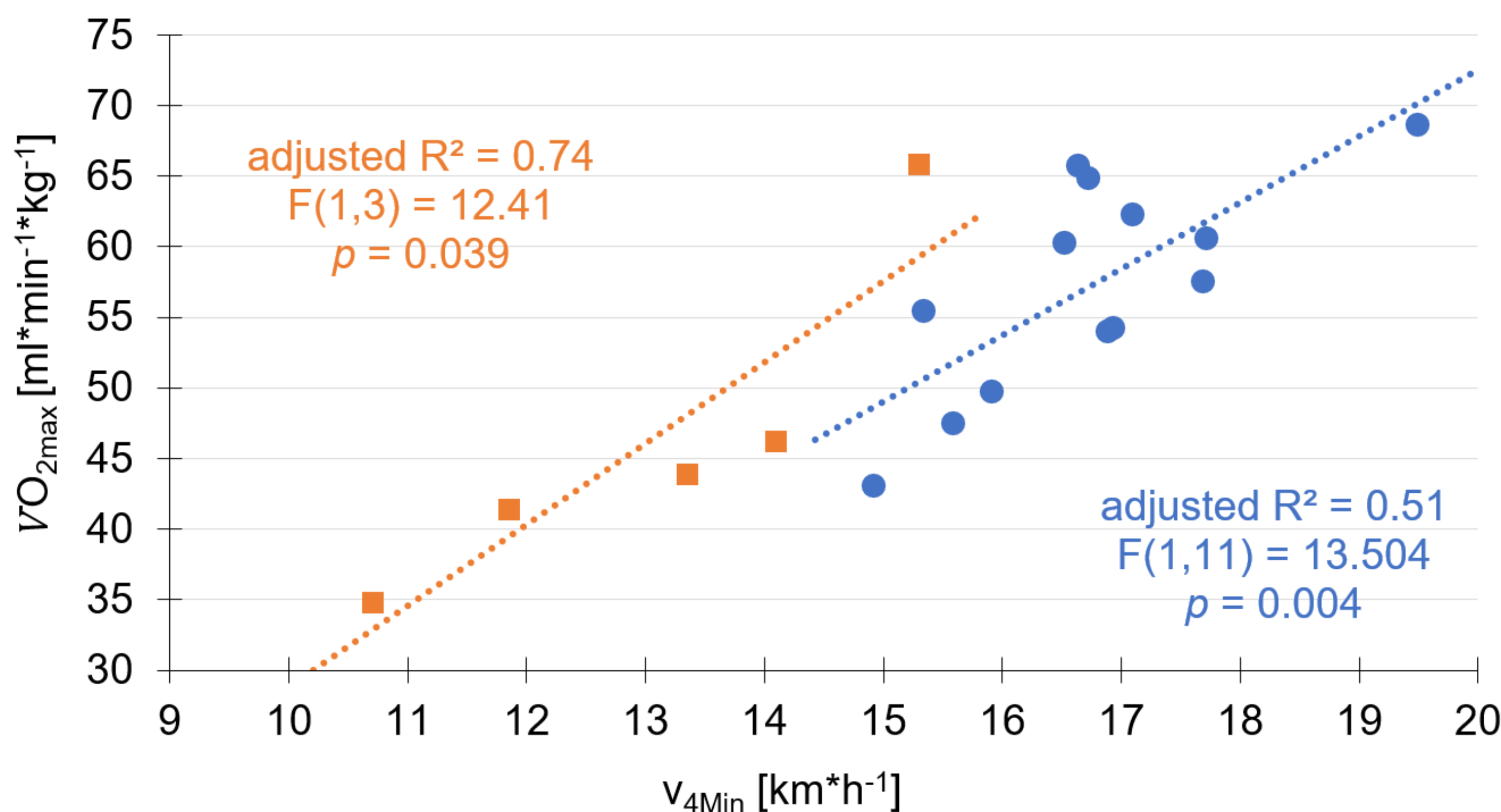


Figure 3. Scatterplot with regression line of the average speed of the 4-minute all out run (v_{4Min}) and the relative maximum oxygen uptake ($\dot{V}O_{2max}$) divided by sex. The red squares are the female participants, the blue dots are the male participants.

Conclusion

The performance in the 4Min_{max} run can accurately estimate both $\dot{V}O_{2max}$ and v_{end} with a slightly higher adjusted R^2 between v_{4Min} and v_{end} than between v_{4Min} and $\dot{V}O_{2max}$. As the $\dot{V}O_{2max}$ is comparable to reference values, it is recommended to calculate the estimated $\dot{V}O_{2max}$ from the 4Min_{max} run to assess the endurance performance in the digital self-test. The regression equation for women should be further investigated with a larger number of subjects and should therefore be used with caution.

Military Impact

The Swiss Armed Forces offer their recruits and soldiers a digital solution for physical training before and between military service. The digital performance test implemented in this application, which can be carried out independently, regardless of time and place, and without any special equipment, enables the generation of a personalised physical training. The 4Min_{max} run is a promising solution to assess the endurance performance and is an alternative to conventional laboratory and field tests.

Contact

regina.oeschger@baspo.admin.ch



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office of Sport FOSPO