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Sex-Related Differences in Ratings of Perceived Exertion and Estimated Time Limit

Abstract

The purpose of the present investigation was i) to study the effect of sex on ratings of perceived exertion (RPE) and estimation of time limit (ETL) during runs to exhaustion at both absolute and relative physical and physiological reference criteria, ii) to propose some recommendations for exercise intensity prescription from both RPE and ETL according to sex. Eight male and eight female middle-distance endurance-trained runners performed two exercises until exhaustion on an outdoor track. The first test was a graded exercise to determine maximal aerobic velocity ($v\dot{V}O_2max$), the velocity at the lactate threshold (vLT), and the velocity at delta 50 (vΔ50: the velocity halfway between $v\dot{V}O_2max$ and vLT). The second test was a constant all-out run at vΔ50 to determine the time to exhaustion at this intensity (tlim). The results of this study showed that the female runners perceived exercise as being harder, felt that they could endure less and had higher heart rate values than males for a given absolute velocity ($km \cdot h^{-1}$) whereas there were no difference between males and females for a given relative velocity (%$v\dot{V}O_2max$). Moreover, the female runners perceived exercise as lighter and felt that they could endure more than the males for a given absolute time period (in s) whereas there was no difference between males and females for a given relative time period (%tlim). This result may be explained by the fact that the same exercise intensity or duration corresponded to higher %$v\dot{V}O_2max$ and lower %tlim for the females compared to the males. Consequently, physical trainers can prescribe the same perceived ratings for a given percentage of $v\dot{V}O_2max$ or tlim both in male and female athletes.

Key words
Maximal aerobic velocity · exercise intensity · exercise duration · exercise prescription

Introduction

The determination of the optimal level of exercise intensity is an important point in the field of training for performance. For more than one decade, the use of a perceived exertion scale has been recommended by the A.C.S.M. [1] in order to monitor and individualise the prescription of training exercise intensity and duration. Most studies on perceived exertion in relation to physical work have been performed with the use of the Rating of Perceived Exertion scale (RPE, from 6–20), described by Borg [9–11,31]. A second perceived scale based on subjective estimation of exhaustion time (Estimation of Time Limit, ETL) has also been used in addition to RPE during exercise, to further understand how the subject is feeling [14,18]. The RPE scale is concerned with the current status of the subject (how hard he/she feels the exercise currently is) whereas the ETL scale deals with a subjective prediction of how long the current exercise level can be maintained. These two scales may be used as complementary

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tools for exercise-intensity prescription purposes (e.g. a combination of RPE and ETL criteria could increase the specificity of the ventilatory threshold detection which correspond to an exercise intensity currently prescribed during training programs) [18].

The influence of the type of sports training practised by the athlete [17], and the fitness level of the athletes [16,35] on these scales have been already studied. Similarly, many studies have already dealt with sex comparison on the rating of perceived exertion scale [25,27 – 29,33,36,37]. Most of these studies relate differences between males and females with regard to perceived exertion [25,27 – 29,37]. However, the results are subject to controversy, as some studies related higher RPE values for males [25,37], whereas for others, RPE was higher for females [27 – 29]. Moreover, the results were confused between studies carried out on different ergometers (cycle, treadmill, arm, simulated skiing), with physical (power output, velocity, distance, duration) or physiological (heart rate, oxygen uptake), absolute (heart rate, oxygen uptake, lactate or ventilatory threshold) or relative (percentage of maximal heart rate, percentage of maximal oxygen uptake) reference criteria. Few studies have focused on sex-related differences in RPE at both absolute and relative physiological values. Robertson et al. [30] and Sidney and Shephard [33] showed higher RPE for females for a given absolute oxygen uptake value whereas they concluded RPE was independent of sex when related to a given percentage of maximal oxygen uptake. Indeed, this usual difference for the same physical exercise disappeared when the exercise intensity was corrected according to working capacity, i.e. when relative measurements were compared [8]. Moreover, Robertson et al. [30] found no difference in RPE between males and female students both for a given absolute and relative heart rate value. Only Robertson et al. [30] were interested in sex comparison at absolute and relative physiological criteria within the same experimental paradigm for a given exercise mode (weight bearing, partial weight bearing, and nonweight bearing exercises). To our knowledge, no study has focused on the effect of sex on RPE and especially on ETL during incremental and constant runs to exhaustion at both absolute and relative, physical and physiological reference criteria. Taking into account previous research [14,16,17], like RPE, ETL is probably a multidimensional construct which results from an integration of many sensory inputs in conjunction with numerous physiological, psychological, and experimental factors. Therefore, as for RPE, there could be a possible gender effect on ETL.

Furthermore, in the recommendations of the A.C.S.M. [1], no precision is given for the exercise intensity prescription according to sex. If some parameter has an effect on RPE, a prescribed target RPE zone will thus be influenced by this parameter. Consequently, this parameter should be taken into consideration in the prescription and monitoring of exercise intensity. Similarly to the procedure employed for RPE, ratings on the ETL scale could be used as target zone in order to monitor and individualize the prescription of training exercise intensity and duration. Therefore, sex information could be particularly relevant when the aim is to prescribe an exercise intensity from RPE or ETL target values for male and female athletes.

Therefore, the purpose of the present study was first, to examine the effect of sex on ratings of perceived exertion and estimation of time limit during incremental and constant runs to exhaustion at both absolute and relative physical and physiological reference criteria, and secondly, to propose some recommendations for exercise intensity prescription from both RPE and ETL according to sex. These two types of exercises were used to examine a sex effect because these runs to exhaustion have become routine in the physiological testing of athletes at the beginning of the season. It was hypothesised that both RPE and ETL would be influenced by sex for an absolute reference but would not differ for the same relative reference criteria.

Methods

Subjects

Eight male (20.7 ± 3.1 years, 62.9 ± 3.0 kg, 175.5 ± 4.1 cm) and eight female (19.2 ± 1.7 years, 50.0 ± 3.6 kg, 165.7 ± 6.9 cm) middle-distance endurance-trained runners (from 800 to 10 000 m) participated in the study at the beginning of the athletic season (October – December). Both male and female athletes trained between three and five times per week, for approximately 45 min per session, and had practised their respective activity for at least 8 years. All these athletes were members of the regional middle distance running team. These subjects were medically examined before they signed an informed consent form about the purpose and procedures of the experiment. The approval of the consultative committee for the protection of persons in biomedical research of Lille (France) was obtained for the experimentations (CP 00/10).

Experimental design

In a first session, the subjects performed a graded exercise to exhaustion on an indoor synthetic track (200 m) to determine their maximal oxygen uptake ($\dot{V}O_2$max), the velocity associated with $\dot{V}O_2$max (v$\dot{V}O_2$max) and the velocity at the lactate concentration threshold (vLT). According to the performances of these athletes, the initial velocity was set at 14 km · h^{-1} and was increased by one km · h^{-1} every three minutes until 17 km · h^{-1} was attained [15]. Each stage was separated by a 30-s rest period. Then, the velocity was set at 18 km · h^{-1} and increased by one km · h^{-1} every two minutes until exhaustion, without resting time. Two days later, the athletes performed a constant run exercise up to exhaustion at velocity halfway between the velocity associated with $\dot{V}O_2$max and the velocity at the lactate concentration threshold (vΔ50), to determine the time to exhaustion at this velocity (tlim). For each test, each subject was verbally encouraged to give maximum effort. These two exercises were performed on the same running track and at the same time of day.

Velocity was checked during the graded and the constant exercises by the experimenters. On the running track, the runners followed a pacing cyclist travelling at the required velocity. The cyclist received audio cues via a Walkman (Sony®); the cue rhythm determining the speed necessary to cover 25 m. Visual marks were set at 25-m intervals along the running track (inside the first lane) [6]. Moreover, the experimenters independently measured the time required to complete 25 m in order to check the pacer's and runners' velocity. For the graded and the constant run exercises, exhaustion was defined when the subject was unable to sustain the velocity (i.e. when the runner was continuously more than 5 m behind the cyclist for at least 100 m).

Cardio-respiratory measurements

During all the tests, heart rate (HR) and oxygen uptake (VO_2) were measured using a portable system (Cosmed® K4b², Italy). Before each test, the O_2 and CO_2 analysis systems were calibrated using ambient air and a gas of known O_2 and CO_2 concentrations. The calibration of the K4b² turbine flowmeter was performed using a 3-1 syringe (Quinton Instruments®, USA). This analyser has previously been validated over a wide range of exercise intensities [24]. Breath by breath VO_2 and HR data were averaged over a 15-s period.

The criterion used for $\dot{V}O_2max$ was a plateau where the increase in VO_2 was less than 150 $ml \cdot min^{-1}$ or 2.1 $ml \cdot min^{-1} \cdot kg^{-1}$, despite an increase in running speed equal to 1 $km \cdot h^{-1}$ [34]. Moreover, $\dot{V}O_2max$ had to be associated with a blood lactate concentration > 8 $mmol \cdot l^{-1}$, a respiratory exchange ratio > 1.1, and HR > 90% of the theoretical maximal HR (HRmax) in $beats \cdot min^{-1}$: 220-age (years) [2]. The velocity associated with $\dot{V}O_2max$ ($v\dot{V}O_2max$) was the lowest running velocity which elicited a VO_2 value equal to $\dot{V}O_2max$ in the graded test [5]. The velocity at the lactate concentration threshold (vLT) was determined from the relationship between blood lactate concentrations and velocity and was defined as the velocity for which an increase in lactate concentration higher than 1 $mmol \cdot l^{-1}$ occurred between 3 and 5 $mmol \cdot l^{-1}$ [3]. Velocity delta 50 was calculated as: $v\Delta50 = vLT + ([v\dot{V}O_2max - vLT]/2)$. This velocity is known to be sustainable for about 10 min and allows most subjects to elicit maximal oxygen uptake at the end of the run [6].

Lactate measurements

Blood lactate concentration was determined by a spectrophotometric method (Dr Lange®, LP20, Germany), which had previously been validated [21]. The accuracy of the analyser was checked before each test using standard solutions in lactate concentration. Fingertip blood samples were taken during each 30-s rest period for the graded exercise.

Perception measurements

Perception was expressed according to two scales: a French translation [32] of the Rating of Perceived Exertion scale (RPE) which is most commonly used [7], and a second scale based on subjective Estimation of Time Limit (ETL) [18]. The RPE scale consisted of 15 assessments between six and 20 (from "very very light" to "very very hard") whereas the ETL consisted of 20 assessments between one and 20 (from "more than 16 hours" to "2 minutes"). This scale was designed as a function of the logarithm of the estimated exhaustion time (tlim) (ETL = 21 minus 2 n, with $n = \log_2$ [tlim] where tlim was expressed in minutes). A base 2 logarithm was chosen in order to have enough assessments for exhaustion times ranging from less than 2 min (anaerobic exercise) to many hours. For example, ETL was 19 for tlim equal to two minutes and 15 for tlim equal to eight minutes. In order to facilitate the use of this scale, ETL equal to 13 and 11 corresponded to 15 and 30 min instead of 16 and 32 min, respectively. Similarly, the values of ETL equal to or lower than nine were expressed in multiples of one hour. The validity and the reliability of the ETL scale have previously been attested [16–19] (respectively).

Although subjects have been familiarized with both scales during previous training sessions, the scales were explained before each exercise as recommended by Noble et al. [26]. They were written on a board fixed on the back of the experimenter riding in front of the subject. The subjects were asked "How hard do you feel this exercise is?" and "How long would you be able to perform an exercise at this intensity to exhaustion". During both exercises, ratings were collected by a second experimenter who rode next to the runner. During the graded exercise, the ratings were collected at the end of each step. Up to 17 $km \cdot h^{-1}$, subjects had to point to a value corresponding to their sensations on the perception scales during the 30-s rest. Thereafter, as there was no rest period, subjects expressed the perception values with a fist (= 10 points) or their fingers (1 finger = one point) at the end of each step. The procedure was the same for the constant run exercise, but perception values were recorded every two minutes up to the end of exercise. The order of RPE and ETL was the same during the graded and the constant exercises for each subject, but was randomised among the subjects of each sex group. Instructions for the scales were given straight after each other.

Statistical analysis

Results are presented as mean (M) ± standard deviation (SD) values. The relationships between pairs of variables were analyzed by a Pearson product moment test. A covariance analysis was carried out for the relationships between parameters during incremental and constant runs to exhaustion [12,20,23]. The purpose of the covariance analysis was to estimate the effect of the subjects' sex on RPE, ETL, or HR, i.e. to study if, for the same given x value, the corresponding y value (RPE, ETL or HR) was significantly different between the males and the females. This analysis was performed for a given absolute physical reference criterion (velocity in $km \cdot h^{-1}$, time duration in s) and a physiological reference criterion (heart rate in bpm), and for a given relative physical reference criterion (relative velocity expressed in percentage of $v\dot{V}O_2max$: $\%v\dot{V}O_2max$, relative time period expressed in percentage of exhaustion time: %tlim) and a physiological reference criterion (relative heart rate expressed in percentage of HRmax: %HRmax). Thereafter, statistical differences between means were tested with a Student's *t*-test (with parametric data) or a Mann and Whitney test (with nonparametric data). Statistics in this paper were examined using Sigma Stat® (Jandel, Germany). Significance was set a priori at 0.05.

Results

Perceived exertion, estimated time limit, and HR were statistically significantly correlated with velocity (absolute and relative) ($p < 0.01$; Figs. **1 a, b** and **2 a, b**, respectively). The covariance analysis showed a statistical significant upward shift of the regressions between RPE, ETL, HR, and velocity ([$F(1,119) = 22.81$], [$F(1,119) = 12.70$], [$F(1,119) = 90.68$], $p < 0.01$, respectively). This means that for a given absolute velocity (in $km \cdot h^{-1}$), the females perceived exercise as harder, felt that they could endure less, and had higher HR values than the males. However, the relationships between RPE, ETL, HR, and $\%v\dot{V}O_2max$ were not significantly dif-

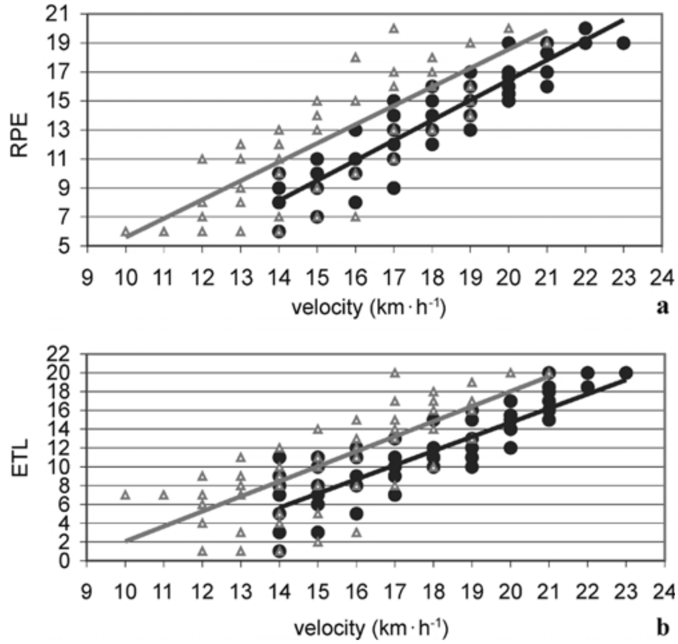

Fig. 1 **a** and **b** **a** Relationships between velocity (expressed in $km \cdot h^{-1}$) and perceived exertion (RPE) during the incremental exhausting exercise for the males (black dots and thick regression line, r = 0.92, n = 65) and the females (empty triangles and dashed regression line, r = 0.79, n = 63). **b** The same relationships with the estimation of time limit (ETL) (r = 0.86, n = 65 and r = 0.76, n = 63, for the male and female subjects, respectively).

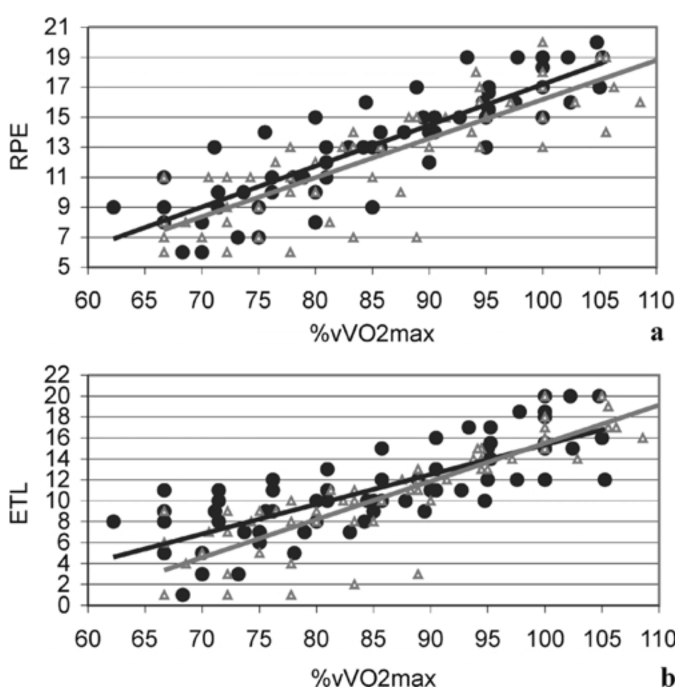

Fig. 2 **a** and **b** **a** Relationships between velocity expressed in percentage of maximal aerobic velocity (%v$\dot{V}O_2$max) and perceived exertion (RPE) during the incremental exhausting exercise for the males (black dots and thick regression line, r = 0.87, n = 65) and the females (empty triangles and dashed regression line, r = 0.83, n = 63). **b** The same relationships with the estimation of time limit (ETL) (r = 0.78, n = 65 and r = 0.87, n = 63, for the male and female subjects, respectively).

ferent between the male runners and the females ([F(1,119 = 4.89], [F(1,119) = 3.84], [F(1,119) = 6.27], $p > 0.01$, respectively). Perceived exertion, estimated time limit, and HR values remained the same between the males and females for a given relative velocity. Moreover, the relationships between ETL and RPE was not significantly different between the males and females ([F(1,119) = 0.07], $p > 0.01$, Fig. **3**). Estimated time limit values remained the same between men and women for a given perceived exertion value.

During the incremental exercise, RPE and ETL were statistically significantly correlated with HR (expressed in bpm or in percentage of HRmax) ($p < 0.01$). The covariance analysis showed no statistical significant upward shift for the regressions between RPE or ETL and HR ([F(1,119) = 5.21], [F(1,119) = 4.53], $p < 0.05$, respectively). The same results were found for a given percentage of HRmax ([F(1,119) = 4.39], [F(1,119) = 3.42], $p > 0.01$, respectively). Perceived exertion and estimated time limit values remained the same between the males and females for a given HR or percentage of HRmax.

During the constant run exercise, RPE, ETL, and HR were statistically significantly correlated with exercise duration (expressed in s or in percentage of exhaustion time) ($p < 0.05$). The covariance analysis showed a statistical significant upward shift of the regressions between RPE or ETL and time period ([F(1,50) = 9.49], [F(1,50) = 8.89], $p < 0.05$, respectively). For a given absolute time period (in s), the males perceived exercise as harder and felt that they could endure less than the females. The relationships between HR and time period not being significantly different between the males and females in this test ([F(1,50) = 0.02], $p > 0.01$), HR remained the same between both for a given absolute time period value. Moreover, the upward shifts of the %tlim-RPE, %tlim-ETL and %tlim-HR regressions with sex were not significant ([F(1,50) = 2.98], [F(1,50) = 2.97], [F(1,50) = 6.21], $p > 0.01$, respectively), i.e. perceived exertion, estimated time limit, and heat rate values remained the same between the males and females for a given relative time period (%tlim). As in the in-

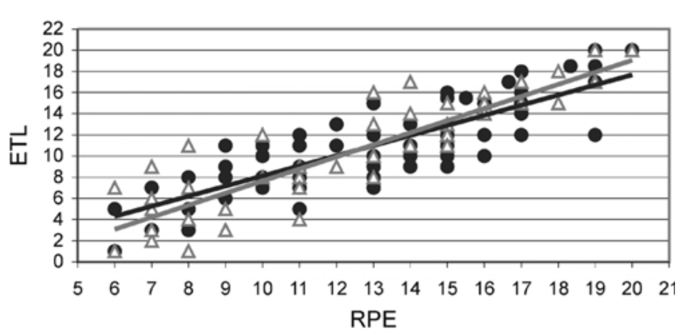

Fig. 3 Relationships between the estimated time limit (ETL) and perceived exertion (RPE) during the incremental exhausting exercise for the males (black dots and thick regression line, r = 0.82, n = 65) and the females (empty triangles and dashed regression line, r = 0.89, n = 63).

Table **1** Means (M) and standard deviations (SD) of main results of field tests for men (n = 8) and women (n = 8)

		$\dot{V}O_2max$ ($ml \cdot min^{-1} \cdot kg^{-1}$)	*HRmax (bpm)*	*$v\dot{V}O_2max$ ($km \cdot h^{-1}$)*	*vΔ50 ($km \cdot h^{-1}$)*	*vΔ50 (%$v\dot{V}O_2max$)*	*vLT ($km \cdot h^{-1}$)*	*vLT (%$v\dot{V}O_2max$)*	*tlim (s)*
Men	M	66.2*	192	20.6*	19.6*	94.6	18.2*	88.2	325*
	SD	3.8	7	1.0	1.0	1.7	1.2	3.4	103
Women	M	58.2	193	17.8	16.4	92.1	15.1	86.5	477
	SD	3.0	7	1.0	1.1	3.1	1.2	5.3	143

$\dot{V}O_2max$: maximal oxygen uptake, HRmax: maximal heart rate, $v\dot{V}O_2max$: velocity associated with $\dot{V}O_2max$, vΔ50: velocity halfway between $v\dot{V}O_2max$ and velocity at lactate threshold, %$v\dot{V}O_2max$: percentage of $v\dot{V}O_2max$, vLT: velocity at lactate threshold, tlim: time to exhaustion at vΔ50. * statistically significantly different, $p < 0.05$

cremental test, estimated time limit remained the same between the males and females for a given perceived exertion value ($[F(1,50) = 0.46]$, $p > 0.01$).

Maximal oxygen uptake, $v\dot{V}O_2max$, vΔ50, and vLT were significantly lower whereas tlim was significantly higher for the female runners compared to the males (Table **1**). No significant difference was observed between the males and females for HRmax and the percentage of $v\dot{V}O_2max$ corresponding to vLT (or vΔ50) (Table **1**).

Discussion

The main result of this study was that there was an effect of sex on RPE and ETL for an absolute physical reference criterion (i.e. for a given velocity and time period) whereas there was no effect for a relative one (i.e. for a given %vVO2max and %tlim). Moreover, there was no effect of sex on RPE and ETL for both absolute and relative physiological reference criteria (i.e. for a given heart rate and %HRmax). Finally, the relationships between RPE and ETL were not significantly different between the males and females for both the incremental and constant run tests.

According to Gunnar Borg, the RPE-scale is based on the "range-principle", i.e. all individuals will experience a variation between a minimum value equal to 6 and an absolute maximum value equal to 20 in the same way [8]. That is, the range in perceived exertion from 6 to 20 should be approximately equal between individuals. However, the work load (velocity in our study) will differ between individuals (between men and women in our case). Although our subjects were all at a regional level, differences are present in regard to working capacity (x-axis) between the average man and the average woman. Similar differences were obtained at an international level between male and female athletes [22]. Since $v\dot{V}O_2max$ was significantly higher for the male subjects compared to females, consequently the metabolic demand was at a higher %$v\dot{V}O_2max$ for the female subjects compared to the males. For example, 17 $km \cdot h^{-1}$ corresponded to approximately 92% of the female runners' aerobic capacities whereas to only 82% of the males. The same argument may be used for the comparison made at a given time period. Exhaustion time (tlim) was significantly higher for the female subjects compared to males, and consequently for a given time period, the percentage of exhaustion time was higher for the males compared to the females. For example, a time of 5 min corresponded to 80% of the mean male exhaustion times compared to only 60% for the female subjects. The same trend was found by Billat et al. [4] in 14 female and 15 male sub-elite long distance runners, with longer exhaustion times performed at the velocity associated with $\dot{V}O_2max$ for the females compared to males (367 ± 118 s vs. 421 ± 129 s, respectively). However, these exhaustion times were not statistically significantly different in Billat's study [4]. Consequently, this working capacity difference ($v\dot{V}O_2max$ or tlim) may explain the plausible difference in the perception variation between men and women for the comparisons made at given absolute reference criteria. The perception (y-axis) will show the same variation while the velocity or time duration will differ widely according to the physical working capacity of the athlete (x-axis).

Some studies which were performed for a given absolute reference criterion indeed found some influence of sex on RPE or HR [27,29,30,33,36]. However, as in the studies by Robertson et al. [30], Sidney and Shephard [33], and Winborn et al. [37], our results showed there was no effect of sex on RPE, ETL, and HR if we took the precaution to relativize the physical reference criteria, i.e. if RPE, ETL, and HR were examined for a given relative velocity or time period. This result was not surprising since, as shown in the second paragraph of the discussion, the same RPE value is related to a higher velocity for the male subjects compared to females, which corresponds to a similar percentage of $\dot{V}O_2max$. For example, RPE = 15 corresponded to approximately 18.8 $km \cdot h^{-1}$ for the male runners whereas to only 16.5 $km \cdot h^{-1}$ for the females; velocities which corresponded to approximately 91% $v\dot{V}O_2max$ for both sexes. The same argument may be used for the comparison made at a given relative time period. Similarly to Robertson et al. [30] and Ueda and Kurokawa [36], RPE and ETL values remained the same between the males and females for a given HR or percentage of HRmax. This result may be due to the fact that HRmax values were not statistically significantly different between the males and females.

It is very interesting to observe that although there was some difference in the method of calculation used between our study and the study by Robertson et al. [30], the same results were found. Indeed, in the present study the use of a covariance analysis may keep the whole of the recorded points of the relationships between the parameters studied, whereas Robertson et al. [30] made a comparison of RPE values calculated for each subject

Table **2** Relationships between the percentage of the velocity associated with the maximal oxygen uptake (%v$\dot{V}O_2$max) and RPE or ETL in prescription exercise intensity purpose for moderate or high level endurance men and women runners aged between 18 and 25 years

	High-level		*Moderate-level*		*High-level*		*Moderate-level*	
%v$\dot{V}O_2$max	*RPE*	*intensity*	*RPE*	*intensity*	*ETL*	*estimated time*	*ETL*	*estimated time*
65–70	6–7	very very light	9–10	very light	4–5	4 to 6 hours	5–6	3 to 4 hours
71–75	8–9	very light	11–12	light	6–7	2 to 3 hours	7–8	1 h 30 to 2 hours
76–80	10–11	very light to light	12–13	moderate	8–9	1 to 1 h30	9–10	45 min to 1 hour
81–85	11–12	light to moderate	14–15	hard	10–11	30 to 45 min	11–12	20 to 30 min
86–90	13–14	moderate	15–16	hard to very hard	11–12	20 to 30 min	13–14	10 to 15 min
91–95	14–15	hard	17–18	very hard	13–14	10 to 15 min	15–16	6 to 8 min
96–100	16–17	very hard	18–19	very very hard	15–16	6 to 8 min	17–18	3 to 4 min

RPE: Rating Scale of Perceived Exertion, 6–20, Borg [9]; ETL: Estimated Time Limit, 1–20, Garcin et al. [18]

and condition from individual regression equations. They used linear regression analysis for each subject to calculate RPE values at only 3 preselected relative reference criteria (70, 80, and 90% $\dot{V}O_2$max or HRmax) and subsequently, compiled each interpolated RPE value which derived from the individual regression equation into data and submitted these to an ANOVA analysis.

For many years, a RPE value between 12 and 16 (i.e. "somewhat hard" 12–13, and "hard": 15–16), corresponding to 40–84% of oxygen uptake reserve and 55–89% of maximal heart rate, has been recommended for training programmes [1]. Our results add some precision to these recommendations according to the sex. It is of particular interest for physical trainers who have to prescribe exercise intensities during the athletic season for groups of athletes of differing sex. Our results showed that they can prescribe the same perception ratings for a given relative velocity and time period for both male and female athletes. Therefore, as suggested by Garcin and Billat [14], RPE or ETL values allow personalization of the exercise intensity and duration during training programmes of athletes' group of both sexes. However, physical trainers must individualize their program regarding the age of the athlete [13], the type of sports training practised by the athlete [17], and the fitness level [16]. According to these previous results, we may suggest a summary statement about the relationships between the %v$\dot{V}O_2$max and RPE or ETL values for the prescription of exercise intensity (Table **2**). This statement will only concern exercise intensities which could be prescribed by trainers for moderate or high level endurance male and female runners aged between 18 and 25 years. In practice, the combination of RPE and ETL ratings could be used to individualise the prescription of training exercise intensity and duration, and would allow accurate prescription and regulation of training [14].

Moreover, we may focus attention on the fact that the RPE-ETL relationship is very similar during incremental or constant running exercises between male and female runners. It implies that there was a close relationship between hardness and exhaustion time during exercises to exhaustion, whatever the sex. Such a result has been already mentioned in previous research during incremental exercise after training [15]. This means that although RPE and ETL do not give the same information, they are probably mediated by the same factors.

Conclusions

In conclusion, the present study demonstrated that the RPE and the ETL scales are useful tools, offering subjective reflection of physiological responses during physical exercise, and enabling physical trainers to personalize the exercise intensity and duration during training programmes of athletes' groups of both sexes.

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