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PERCEPÇÃO SUBJETIVA DE ESFORÇO DURANTE UMA SESSÃO DE EXERGAME EM HOMENS JOVENS SAUDÁVEIS

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RESUMO

Introdução: Os exergames podem ser uma ferramenta útil para promover a atividade física e aumentar a aptidão física. No entanto, pouco se sabe sobre a resposta perceptiva aos exergames. Portanto, o presente estudo objetivou avaliar a percepção subjetiva de esforço (PSE) durante uma sessão de exergames composta por exercícios físicos tradicionais realizados por homens jovens saudáveis. Materiais e Métodos: Trinta e homens jovens saudáveis praticaram o protocol Sports Athlete do exergame Hollywood Workout no XBOX 360 Kinect. PSE foi avaliada após cada exercício do protocolo Sports Athlete através de duas independentes escala comumente usadas para avaliar a PSE: Escalas de Borg (6-20) e OMNI-Resistance Exercise (OMNI-RES, 0-10). Resultados: Os participantes reportaram durante o protocolo Sports Athlete uma PSE média de 14,4±2,1 (‘ligeiramente cansativo’) e 6,2±0,3 (‘um pouco difícil’) na escala de Borg e OMNI-RES, respectivamente. A PSE durante a ‘fase principal’ do protocolo Sports Athlete protocolo foi 87,6±26,2% (Escala de Borg) e 202,3±108,5% (OMNI-RES) maior do que durante o ‘aquecimento’ (p<0,05). A PSE durante a ‘recuperação’ foi 88,0±27,7% (Escala de Borg) e 213,8±114,3% (OMNI-RES) maior do que durante o ‘aquecimento’ (p<0,05). Não foi encontrada diferença significativa na PSE entre a ‘fase principal’ e a ‘recuperação’ (p>0,05). Conclusão: Quando utilizadas as escalas de PSE, o protocolo Sports Athlete do exergame Hollywood Workout pode ser classificado como uma intensidade de ‘leve-moderada’ em homens jovens saudáveis.

Palavras-chave: Exercício. Medida. Intensidade. Jogos de movimento.

ABSTRACT

Rating of perceived exertion during a single exergame session in healthy young men

Introduction: Exergames can be a useful tool to promote physical activity and increase physical fitness. However, less is known regarding the perceptual response to exergames. Therefore, the present study aimed to evaluate the rating of perceived exertion (RPE) during a single exergame session, composed by traditional physical exercises, performed by healthy young men. Materials and Methods: Thirty-one healthy young men performed the Sports Athlete protocol of the exergame Hollywood Workout on XBOX 360 Kinect. RPE was recorded after each exercise of the Sports Athlete protocol using two independent tools currently used to assess RPE: the Borg (6-20) and OMNI-Resistance Exercise (OMNI-RES, 0-10) scales. Results: Participants reported a mean RPE in the Sports Athlete protocol of 14.4±2.1 (‘somewhat hard’) and 6.2±0.3 (‘somewhat hard’) using the Borg and OMNI-RES scales, respectively. RPE during the ‘main phase’ of the Sports Athlete protocol was 87.6±26.2% (Borg scale) and 202.3±108.5% (OMNI-RES) greater than during the ‘warm-up’ (p<0.05). RPE during the ‘cool down’ was 88.0±27.7% (Borg scale) and 213.8±114.3% (OMNI-RES) greater than during the ‘warm-up’ (p<0.05). No significant difference was found in the RPE between the ‘main phase’ and the ‘cool down’ (p>0.05). Conclusion: When used RPE scales, the Sports Athlete protocol of the exergame Hollywood Workout can classified as an exercise of ‘mild-moderate’ intensity for healthy young men.

Key words: Exercise. Measurement. Intensity. Active video game.

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INTRODUÇÃO

In the last decades, several alternative modalities of physical activity have arisen to attract the population and, consequently, to reduce sedentary behavior and increase the probability of adherence to a physical activity program (Vendramin et al., 2016; Wickham et al., 2017).

More recently, active video games (exergames) have been developed to allow for physical exercise to be performed through the interaction of the participant with movement sensors (Klompstra, Jaarsma, Stromberg, 2014).

Exergames are characterized as aerobic activities where the most common are walking, running, stair climbing, cycling, rowing, and swimming (Wu, Wu, Chu, 2015).

In these activities, visual and auditory stimuli are combined with different types of equipment, such as balance boards, dance mats, gym equipment, cameras, remote controls with an accelerometer, heart rate monitors, and other types of sensors and inputs that allow players move to play (Baracho, Gripp, Lima, 2012).

Considering that exergames require movement of several body segments, they can be a useful tool against physical inactivity (Staiano, Calvert, 2011).

In fact, it has been demonstrated that exergames can motivate people to become physically active (Staiano, Calvert, 2011), stimulate healthy habits (Brox, Fernandez-Luque, Tøllefsen, 2011), increase energy expenditure and oxygen consumption (Wu, Wu, Chu, 2015), and promote important changes in body composition (Baranowski et al., 2013).

Furthermore, exergames seem to have large effect sizes on enjoyment over sedentary activities (Gao et al., 2015).

In addition, exergames have been used strategically in rehabilitation protocols in special populations such as the elderly (Palacios-Navarro, Garcia-Magarino, Ramos-Lorente, 2015).

Recently, Viana et al., (2017) demonstrated that exergames promote anxiolytic effects in young women and that an exergame that mimics calisthenics evoked increased physiological variables during its practice (Viana et al., 2018).

Despite the important advances in the understanding of the impact of exergames on health parameters (Gao et al., 2015), little is known about the use of rating of perceived exertion (RPE) to monitor exergame intensity. It is important to note that evaluation of RPE is one of the most commonly used measures for the identification, prescription, and monitoring of intensity during physical exercise (Peñailillo, Mackay, Abbiss, 2017). In addition, RPE scales are feasible, low cost, and easy to use.

In this sense, two of the most widely used RPE scales are the Borg (Borg, 1982) and OMNI-Resistance Exercise (OMNI-RES) scales (Robertson et al., 2003).

The Borg scale aims to examine localized RPE (upper or lower limbs) or the entire body through a numerical scale ranging from 6 to 20 using words ranging from 'very easy' to 'exhaustive'(Borg, 1982). The OMNI-RES also aims to evaluate the RPE of the whole body but uses images and a numerical scale ranging from 0 ('extremely easy') to 10 ('extremely difficult') (Robertson et al., 2003).

While there is information regarding the RPE during exergames performed by children and adolescents (Azevedo et al., 2014; Gao et al., 2015; Lau et al., 2015), special populations (Mat Rosly et al., 2017), and healthy adults (Barkley, Penko, 2009; Perron, Graham, Hall, 2012; Viana et al., 2017), there is, so far as we are aware, little information regarding RPE during exergames that simulate traditional physical exercises performed by healthy adults in a gym environment (Kraft et al., 2011; Lau et al., 2015; Mcdonough et al., 2018; Perron, Graham, Hall, 2012). In a practical context, this will provide important information about the use of this technology, especially with respect to determining physical exercise intensity.

Therefore, the present study aims to evaluate the RPE during a single exergame session, composed by traditional physical exercises, performed by healthy young men. It is hypothesized that the mean RPE during the exergame will correspond to an exercise of mild-moderate intensity, according to the classification of the American College of Sports Medicine (Garber et al., 2011).

MATERIALS AND METHODS

Thirty-one young men (age 24.2 ± 3.3 years, height 1.77 ± 0.07 m, body mass 74.9 ± 11.1 kg, body mass index 24.0 ± 3.2 kg/m^2) were recruited through social media and direct contact. The inclusion criteria were: (i) to be physically active; (ii) asymptomatic, (iii) non-users of exergames according to White,

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Schofielf, Kilding (2011) criteria; and (iv) to respond “no” to all questions of the Physical Activity Readiness Questionnaire (PAR-Q) (Canadian Society for Exercise Physiology, 2002).

The exclusion criteria were any orthopedic limitation that could interfere in the performance of the test. All experimentais procedures were approved by the institutional Research Review Board (nº 1.459.010) and conformed to the principles outlined in the Declaration of Helsinki.

Each participant reported to the laboratory on a single day during which anamnesis, anthropometric evaluation, and practice of an exergame session on XBOX 360 Kinect was performed.

We chose the XBOX 360 Kinects because it was the only console available in our lab. RPE was evaluated throughout the exergame session. Participants were instructed to eat a standardized meal, not to participate in any strenuous exercise, and not to consume any stimulant or alcohol in the 24 hours before the session. The temperature and relative humidity in the testing laboratory ranged from 21 to 23°C and 55 to 65%, respectively, for all trials.

Although the exergame Hollywood Workout (Majesco, New York City, NY, USA) has many different exercise protocols, the Sports Athlete protocol was chosen in the exergame session as this protocol is similar to workouts usually performed in exercise facilities.

Briefly, the Sports Athlete protocol consists of three phases: warm-up (four exercises performed only one set each one), main phase (three exercises performed three sets each one as a circuit), and cool-down (four exercises performed only one set each one), with a total exercise time of ~20 minutes; and transitions between exercises of 8-9 minutes, for a total session of 28-29 minutes.

It is important to highlight that the exercise time is fixed by the exergame Hollywood Workout and it was not possible to change; however, for the transition time the participants were informed to transited to the next exercise as quick as possible. For details about this exergame, see Table 1.

An experienced physical education professional accompanied each participant during the exergame session.

Table 1 - Participant’s performance in each phase of Sports Athlete protocol of the exergame Hollywood Workout (n=31).

Phase (exercise)	Repetitions proposed by the exergame	Repetitions performed	Percentage of repetitions proposed by the exergame
Warm-up	97	173 ± 17	179 ± 18
Jog	25	75 ± 10	301 ± 40
Trunk Crosses	20	25 ± 6	126 ± 30
Jumping Jacks	40	63 ± 7	158 ± 18
Ice Skaters	12	10 ± 7	80 ± 62
Main	181	275 ± 47	157 ± 27
Push Ups (1)	12	20 ± 8	165 ± 69
Skater Lunges (1)	16	27 ± 7	171 ± 43
Bicycle Crunches (1)	25	35 ± 9	109 ± 28
Push Ups (2)	15	19 ± 9	127 ± 59
Skater Lunges (2)	24	34 ± 10	143 ± 45
Bicycle Crunches (2)	25	45 ± 13	139 ± 35
Push Ups (3)	15	17 ± 7	111 ± 47
Skater Lunges (3)	24	37 ± 8	153 ± 34
Bicycle Crunches (3)	25	42 ± 13	169 ± 52
Cool down	110	209 ± 26	190 ± 24
Punches	25	41 ± 10	162 ± 38
Jump Rope	40	107 ± 8	268 ± 44
Side Shuffles	20	31 ± 5	151 ± 25
Mountain Climbers	25	31 ± 13	122 ± 53

Note: Data presented are mean ± standard deviation. 1: set 1; 2: set 2; 3: set 3.

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RPE was recorded after each exercise performed in the Sports Athlete protocol using the Borg 6-20 (Borg, 1970) and OMNI-RES scales (Robertson et al., 2003).

The Borg scale is composed of a numeric scale ranging from 6 to 20 points (Borg, 1970). A RPE of 6 was associated with “very, very light” effort, and a rating of 20 was considered to be maximal effort and associated with the most stressful exercise ever performed (Borg, 1970).

Although subjective, the Borg 6-20 scale has been found to correlate well with the objective measures of workload level and heart rate (Borg, Kaijser, 2006; Borg, 1982). The OMNI-RES scale has both verbal and mode-specific pictorial descriptors distributed along a comparatively narrow numerical response range of 0 to 10 (“extremely easy” to “extremely hard”, respectively) (Robertson et al., 2003).

These characteristics make the OMNI-RES scale useful for controlling the intensity of resistance exercises (Naclerio, Chapman, Larumbe-Zabala, 2015).

Although it has been suggested that the OMNI-RES scale is more user-friendly because it provides both pictorial and verbal descriptors of exertion (Utter et al., 2004), we used both the Borg and OMNI-RES scales as they are two independent tools currently used to assess RPE (Irving et al., 2006).

Participants were instructed to report the RPE value indicating a number corresponding to the Borg (6-20) and OMNI-RES (0-10) scales at the end of each set of the Sports Athlete protocol of the exergame Hollywood Workout.

At the beginning of the session, the participants were presented the scales and asked to report values related to whole body (upper limbs, lower limbs, and/or ‘shortness of breath’).

A RPE of 0 was associated with no effort (rest), and a RPE of 10 was considered to be maximal effort and associated with the most stressful exercise ever performed (Lagally, Amorose, Rock, 2009). The scales were fixed in a visible place in the laboratory.

Using to the Borg and OMNI-RES scales, RPE following the ‘warm-up’ and ‘main phase’ of the Sports Athlete protocol presented a non-normal distribution (p>0.05) according to Shapiro-Wilk tests. All other variables presented a normal distribution (p<0.05).

The Friedman test was used to compare the differences between the RPE assessed after each exercise performed, and between the mean RPE of the ‘warm-up’, ‘main phase’, and ‘cool-down’ periods of the exergame session. All statistical analyses were performed with GraphPad Prism 5.0 (San Diego, CA, USA). The significance level was set p<0.05. Data are shown as the means ± standard deviation.

RESULTS

No symptoms or clinical complications occurred during the tests. Over the course of 30.6 ± 1.4 minutes, participants performed a total of 658 ± 66 repetitions in Sports Athlete of the exergame Hollywood Workout, corresponding to a score of 112,940 ± 11,934 points [~182 ± 19% of score proposed by the exergame (66,200 points)]. Ice Skaters and Jump Rope were the exercises in which participants had a worse (10 ± 7 repetitions) and better performance (107 ± 8 repetitions; p<0.05), respectively (~80 ± 62% and 268 ± 44% of the repetitions proposed by the exergame).

Table 1 shows the participant’s performance in each phase of the Sports Athlete protocol.

Overall, the RPE in the exergame session was 14.4 ± 2.1 (Borg; ‘somewhat hard’) and 6.2 ± 0.3 (OMNI-RES; ‘somewhat hard’). RPE during the ‘main phase’ was 87.6 ± 26.2% (Borg) and 202.3 ± 108.5% (OMNI-RES) greater compared with the ‘cool down’ (p<0.05). RPE during the ‘cool down’ was 88.0 ± 27.7% (Borg) and 213.8 ± 114.3% (OMNI-RES) greater than in the ‘warm-up’ (p<0.05). No significant difference was found in the mean RPE between the ‘main phase’ and ‘cool down’ according to both scales (p>0.05) (Figure 1).

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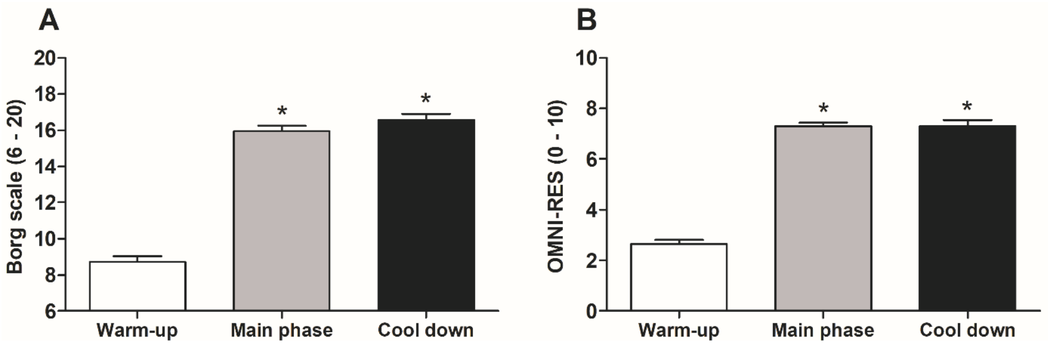

Figure 1 - Rating of perceived exertion during the Sports Athlete protocol using the Borg (A) and OMNI-RES (B) scales. Data presented are mean ± standard deviation. *p<0.05 vs. 'warm-up'.

The lower [7.0 ± 1.5 (Borg) and 1.4 ± 1.1 (OMNI-RES)] and greater RPE values [18.6 ± 1.5 (Borg) and 8.9 ± 1.0 (OMNI-RES)] were reported following the Jog ('warm-up') and Bicycle Crunches exercises (set 3 of the 'main phase'), respectively.

Approximately 23, 25, and 30% of the participants reported maximal RPE values following the Push Ups (set 3 of 'main phase'), Bicycle Crunches (set 3 of the 'main phase'), and Mountain Climbers (last exercise of the 'cool down'), respectively.

Figure 2 shows the RPE of the participants using the Borg and OMNI-RES scales throughout the Sports Athlete protocol.

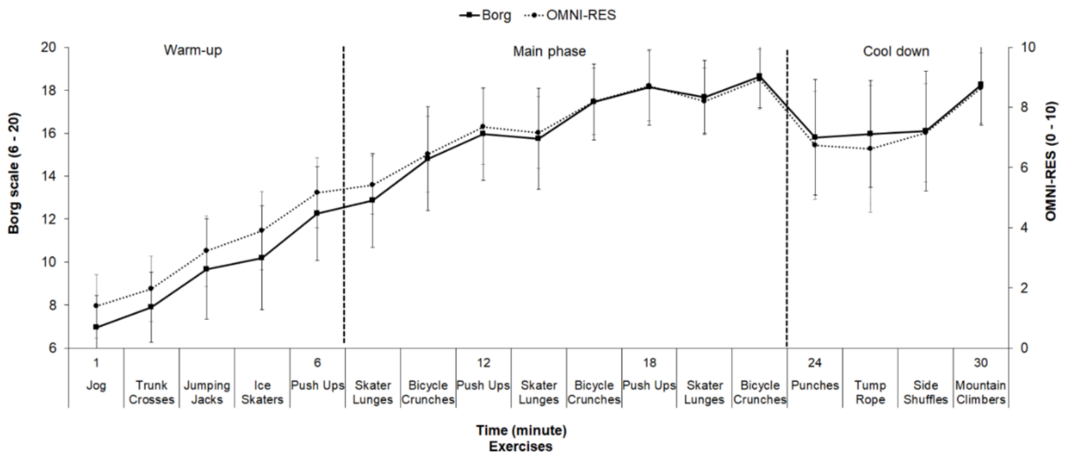

Figure 2 - Rating of perceived exertion assessed by the Borg and OMNI-RES scales throughout the Sports Athlete protocol. Data presented are mean ± standard deviation.

DISCUSSION

The main aim of the present study was to evaluate the RPE during a single exergame session, composed by traditional physical exercises, performed by healthy young men. The results showed that the participants reported a mean RPE of 'somewhat hard' [14.4 ± 2.1 (Borg) and 6.2 ± 0.3 (OMNI-RES)].

The American College of Sports Medicine suggests that physical exercise should have a minimum intensity corresponding to 12-13 ('somewhat hard') on the Borg scale to evoke the benefits of aerobic training (Pescatello et al., 2014).

Therefore, the Sports Athlete of the exergame Hollywood Workout may be a useful tool to improve cardiorespiratory fitness and as an alternative to traditional exercise protocols. However, the user would need to perform weekly exercise of at least 150 minutes, which corresponds to five or more sessions of the Sports Athlete protocol per week.

One advantage of the Sports Athlete protocol compared to traditional activities (e.g., running and cycling) is the performance of exercises for lower and upper limbs, thus being a training protocol for the whole body.

Similar results in RPE behavior were found in previous studies (Barkley, Penko, 2009; Kraft et al., 2011; Mcdonough et al.,

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2018; Perron, Graham, Hall, 2012; Viana et al., 2017).

Kraft et al., (2011) evaluated the RPE of 37 adolescents/adults in three situations: traditional cycle ergometer, cycling exergame, and the exergame Dance Dance Revolution (DDR).

The authors found that RPE using the OMNI-RES scale was significantly higher during the cycling exergame (4.2 ± 1.5) and the traditional cycle ergometer (3.8 ± 1.2) than in the exergame DDR (2.7 ± 1.3).

Lau et al., (2015) evaluated the RPE of 21 Chinese children during three types of exergames (running, table tennis, and dancing) and found that the RPE ranged from 1.29 to 5.29 using the OMNI-RES (0 to 10).

Mat Rosly et al., (2017) assessed RPE through an adapted Borg scale (0 to 10 points) (Borg, 1982), and showed that individuals with spinal cord injury reported an RPE of 5.2 ± 2.1 (tennis), 6.7 ± 2.2 (boxing), 7.3 ± 1.3 (Gladiator Duel), and 7.3 ± 1.3 (Kayaking) following exergame practice on Play Station 3 Move. In other words, exergame practice elicited a moderate intensity based on RPE (Garber et al., 2011).

Viana et al., (2017) observed an RPE using the Borg scale of 12 ± 1 ('fairly light' intensity) during a 20-minute session of the exergame Zumba Fitness performed by healthy young women.

Barkley, Penko (2009) evaluated 12 healthy adults of both sexes and found RPE values using the Borg scale of 13.3 ± 1.7 ('somewhat hard') during the exergame Wii Sports Boxing.

Perron, Graham, Hall (2012) evaluated the RPE of 30 adults following a 30-minute treadmill walk and a ~40-minute practice of the exergame Island Cardio Blast protocol from the EA Sports Active console and found that RPE according to the Borg scale (13.1 ± 1.9; 'somewhat hard') was significantly greater during the exergame compared with treadmill walking (11.6 ± 2.0; 'fairly light'). It is important to highlight that these studies were performed with different individuals, which makes comparisons difficult.

When evaluating the different phases of the Sport Athlete protocol, significant differences were found in the RPE during the 'warm-up' and 'main phase'. The 'warm-up' intensity was lower than the 'main phase', following the recommendations for exercise prescription (Powers, Howley, 2017).

This is an important aspect, since the warm-up may be related to a reduced probability of muscular injuries due to stretches or dislocations (Woods, Bishop, Jones, 2007), in addition to influencing physical performance (Fradkin, Zazryn, Smoliga, 2010).

On the other hand, maintenance of the RPE values occurred at the end of the 'cool down' (Figures 1 and 2), which does not follow the recommendations for exercise prescription (Pescatello et al., 2014; Powers, Howley, 2017), since a 'cool-down' period should provide a gradual decrease in exercise intensity (Powers, Howley, 2017).

A possible explanation for the high intensity of the 'cool-down' may be related to the Mountain Climbers exercise, since on average the participants reported RPE values near or at the maximum (Borg: 18.3 ± 1.9 and OMNI-RES: 8.6 ± 1.2). Among the exercises that constituted the 'cool down', Mountain Climbers was the only one in which 30% of the participants reached a maximum RPE, which likely influenced the increase in RPE at the end of the session (Figures 1 and 2).

Considering that approximately 23, 25, and 30% of the participants reached maximum effort in the Push Ups (set 3), Bicycle Crunches (set 3), and Mountain Climbers exercises, a situation characterized by the literature as momentary muscular failure, we can assume that the Sports Athlete protocol of the exergame Hollywood Workout will impact musculoskeletal conditioning.

Finally, exergames may be more effective in learning to perform exercises than other similar forms of physical exercise, such as DVDs that involve only demonstrations (Limperos, 2014).

Consequently, proficiency in performing the movements (Reynolds et al., 2014), body profile of the avatars (Li, Lwin, Jung, 2014), and appropriate feedback promoted by exergames can influence attitude and performance (Lyons, 2015), since the individuals care about the score (Sun, Lee, 2013).

To the best of our knowledge, this is the first study to evaluate RPE in an exergame that includes a group of calisthenics exercises (e.g., jogging, cycling, push-ups, jump rope) that are commonly practiced in gyms and similar facilities.

Additionally, RPE intensity assessment is a simple and inexpensive way to collect information about exergame intensity. Thus, the results of the present study can be

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extrapolated to physical activity facilities where these exercises are performed by healthy young men.

On the other hand, it would be interesting to see long-term studies with repeated use of the Sports Athlete protocol being conducted in order to confirm inferences regarding the improvement of physical fitness levels and possible changes in body composition.

Moreover, studies comparing RPE and enjoyment after performing traditional physical exercises through exergames versus performing the same exercises in 'real world' settings (physical exercise facilities) are need.

As limitations of the present study, blood lactate concentrations could contribute to metabolic stress, since many participants reported a high sensation of peripheral muscle fatigue and ~23-30% of the participants reported maximum RPE values following some of the exercises. However, RPE scales are feasible, easy to use and low-cost way to prescribing and monitoring the intensity during physical exercises.

As a second limitation, it was not possible to identify the time that participants spent above 12-13 on the Borg (6-20) scale since the RPE was recorded only after the end of each exercise of the Sports Athlete protocol of the exergame Hollywood workout. This data could provide important information regarding the time that participants spent at moderate intensity.

CONCLUSIONS

When used RPE scales, the Sports Athlete protocol of the exergame Hollywood Workout can classified as an exercise of 'mild-moderate' intensity for healthy young men.

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