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DANILO EDSON DE SOUZA

VALIDITY OF RPE OF PROGRESSIVE TEST TO PRESCRIBE EXERCISE INTENSITY

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Dissertação apresentava ao Programa de Pós-Graduação Stricto Sensu em Educação Física da Universidade Federal de Pernambuco como requisito parcial à obtenção do título de Mestre em Educação Física.

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RESUMO

A literatura tem apontado que a percepção de esforço, seria o verdadeiro mecanismo gerenciador do estado de fadiga durante o exercício. Essas observações ganham robustez com as teorias de regulação cerebral de desempenho, que são descritas pelos modelos psicológico motivacional e governador central da fadiga. Com base no modelo de governador central, a conduta de autorregulação da intensidade do exercício com PSE parece ser uma alternativa viável, visto que a magnitude de esforço percebido é o resultado das interações da atividade cerebral e dos estímulos nervosos aferentes que representam alterações fisiológicas periféricas de origem metabólica e do sistema cardiopulmonar. Diante disso, o objetivo deste estudo foi testar a validade dos dados de PSE Borg 6-20 obtidos em teste de progressivo para autorregulação da intensidade do exercício. Como principais resultados identificamos que os indivíduos são capazes de auto ajustar a intensidade do exercício de caminhada e corrida em esteira ergométrica utilizando apenas as categorias de PSE da escala de Borg 6-20 obtidas em teste progressivo. As análises das medidas mostraram que as apenas as categorias 7 e 11 para o VO2 e 8, 10 e 18 para a velocidade apresentaram diferença significativa ($p<0,05$) na comparação dos dados obtidos no teste incremental com os projetados. Em conclusão, o uso dos dados de PSE Borg 6-20 gerados em testes incrementais, são fisiologicamente validos para autorregulação da intensidade do exercício de caminhada e corrida em esteira ergométrica.

Palavras chave: Exercício físico. Consumo de oxigênio. Percepção.

ABSTRACT

The literature has pointed out that the perception of effort would be the true mechanism for managing the state of fatigue during exercise. These observations gain strength with the theories of cerebral performance regulation, which are described by the psychological motivational models and central governor of fatigue. Based on the central governor model, self-regulation of exercise intensity with PSE seems to be a viable alternative, since the perceived effort magnitude is the result of interactions of brain activity and afferent nervous stimuli that represent peripheral physiological changes in metabolic origin and the cardiopulmonary system. Therefore, the aim of this study was to test the validity of the PSE Borg 6-20 data obtained in a progressive test for self-regulation of exercise intensity. As main results we identified that individuals are able to self-adjust the intensity of walking and running exercise on a treadmill using only the PSE categories of the Borg 6-20 scale obtained in a progressive test. Measurement analyzes showed that only categories 7 and 11 for VO2 and 8, 10 and 18 for speed showed a significant difference ($p < 0.05$) when comparing the data obtained in the incremental test with those projected. In conclusion, the use of PSE Borg 6-20 data generated in incremental tests is physiologically valid for self-regulating the intensity of walking and running exercise on a treadmill.

Keywords: Exercise. Oxygen consumption. Perception.

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF ABBREVIATIONS

[La] - Lactate concentration

HR - Heart rate

RPE - Rating of perceived exertion

VO2 - Oxygen volume

VO2peak - Peak peak oxygen volume

VO2max. - Maximum oxygen volume

SUMMARY

1 INTRODUCTION

The concept of subjective perception of effort emerged in the late 1950s possibly with the study of Steven and Mack who tested the validity of a scale with seven categories to assess handgrip strength measured with a dynamometer, using psychophysical data generated by the self evaluation of the subjective perception of effort (PSE) [1]. In the following decade in 1960, Borg and Dahlstrom developed a similar scale to acutely measure the intensity of perceived exertion during an aerobic exercise session [2]. Subsequently, still in the 1960s, the first research involving the Borg scale appeared, with the purpose of testing the validity and reliability of this instrument for the evaluation of PSE in exercise situations.

Borg (1961) tested the validity of a scale that had 21 categories for PSE classification, and observed satisfactory levels of correlation (Spearman =, 83), between the workload and the PSE obtained by this scale during submaximal aerobic exercise in bicycle [3]. In another study, Borg and Dahlstrom [4] demonstrated low validity (r =, 49) between workload and PSE, but high reliability (r =, 96) in anaerobic tests on a stationary bicycle. Similarly, the study by Borg (1962) revealed moderate reliability (r =, 061) and low validity (r =, 50), when comparing the data obtained by this instrument and the workload generated with anaerobic tests on a stationary bicycle. [5].

Later, in 1970, a new version of the PSE scale appeared in the literature, formed by 15 categories numbered 6 to 20, where 6 indicates “without any effort” and 20 the “maximum effort”, this tool was named Borg scale 6- 20 [6]. Unlike the instruments previously created, this scale showed high coefficients of validity (r>, 80) between the classification of PSE and variables such as oxygen volume (VO2), heart rate (HR) and lactate concentration [La] [7, 8]. In contrast to these findings, a meta-analysis published in 2002 showed that the validity coefficients may be lower than conventionally thought, since the weighted averages of the validity coefficients presented in the literature and systematized in this study were 0.63 ± 0.67 and with confidence interval (CI) [0.61 - 0.65] for heart rate, 0.70 ± 0.72 CI [0.67 - 0.76] for blood lactate, 0.68 ± 0.83 CI [0.61 - 0.72] for% VO2máx and 0.62 ± 0.77 CI [0.73 - 0.80] for VO2 [9]. Even so, even with moderate correlation values, the Borg scale 6-20 seems to be valid for measuring [10, 11], and prescribing exercise intensity [12, 13].

Regarding the exercise prescription with Borg 6-20, the literature has pointed out that the self-regulation of intensity with the PSE scale can be based on a centrally adjusted effort model, where the perception of effort in exercise situations is the result of the interaction

between the brain activity and nerve stimuli that translate changes in peripheral metabolic compounds and cardiovascular responses as the exercise is performed [14, 15]. Different from what traditionally the physiological model pointed out about the tolerable duration of the exercise being limited by the central nervous system and by peripheral factors, through the deficit in the distribution of oxygen to the tissues and the metabolic and ionic changes observed in the active muscles during the effort. These new models of central control based on perceived effort can provide a unified theory of exercise tolerance, since PSE is a key tool for voluntary intensity control [16].

Based on the models of central effort control, self-regulation of exercise intensity with Borg 6-20 seems to be a promising alternative, due to the magnitude of the effort being regulated by internal factors inherent to the individual and his perception of effort during the activity. In order to verify this hypothesis, a series of studies have tested the accuracy of the PSE data obtained in graduated tests for prescription of exercise intensity [12, 13, 17-20]. Comparing measures of heart rate, oxygen consumption, and power in an ergometer cycle, generated in an incremental exercise test with measures obtained in perceptually controlled prescriptions, using only the Borg 6-20 scale to self-regulate the exercise intensity (Table 1).

Respectively, the studies by Dunbar et al. (1992) and Kang et al. (1998) observed that self-regulated exercise with Borg 6-20 categories equivalent to 50% of VO2max [13], 50% and 70% of VO2peak [12] did not present measures of oxygen consumption, heart rate and cycle power ergometer, significantly different from those observed in the incremental exercise test. However, in contrast to these findings, Marriott et al. (1996) demonstrated that self-regulation with categories 11, 13, 15 and 19 of this PSE scale, presented HR and power measurements in an ergometer cycle different from those previously described as a target [20]. Similarly, Kang et al. (2009) also observed differences in the comparisons of these measures in exercise sessions lasting 20 and 40 minutes, and self-regulating intensity with the categories relating to 50% and 75% of VO2peak [19].

This scientific panorama that existed until then, presents limitations that can attribute bias to the recommendation of Borg 6-20 data for self-regulation of exercise intensity. For example, intentionally choosing the categories of this PSE scale without taking into account the number of categories that each individual describes during the progressive test [20]. And the validation of a maximum of two categories relative to the percentage fractions of the reserve heart rate [18] or the maximum oxygen volume [13, 17] and peak [12, 19]. Limiting decision

making on the recommendation of Borg 6-20 data obtained in graduated tests for self-regulation of exercise intensity.

In view of these limitations presented in the literature, the objective of this dissertation was to verify the validity of the PSE Borg 6-20 data obtained in a graduated exercise test for self-regulation of exercise intensity.

Table 1 - State of art studs comparation GTX vs RPEprescription

Reference	Categories of Borg RPE	Differences (GTX vs RPEprescrition)								
			RPE	VO_2 ($l.min^{-1}$)		RPE	HR ($beats.min^{-1}$)		RPE	Power output (watts)
Dunbar et al. 1992	RPE equivalent to 50 e 70% VO_2máx.	Treadmill (8min)	50%	-0.35	Treadmill (8min)	50%	-10.38	Cycle ergometer (8min)	50%	-10.86
			70%	-0.73		70%	-26.85		70%	-7.31
		Cycle ergometer (8min)	50%	-0.06	Cycle ergometer (8min)	50%	-2.53			
			70%	-0.00		70%	-6.99			
Dunbar et al. 1994	RPE equivalent to 60%VO_2máx.	Data not reported								
			RPE	VO_2 ($ml.kg^{-1}.min^{-1}$)		RPE	HR ($beats.min^{-1}$)			
Glass et al. 1992	RPE equivalent to 75%HRreserve	Treadmill (10min)	75%	3.00	Treadmill (10min)	75%	6.90			
			RPE	VO_2 ($l.min^{-1}$)		RPE	HR ($beats.min^{-1}$)		RPE	Power output (watts)
Kang et al. 1998	RPE equivalent to 50 e 70% VO_2peak	Cycle ergometer (8min)	50%	-0.11	Cycle ergometer (8min)	50%	-4.00	Cycle ergometer (8min)	50%	-7.50
			70%	-0.20		70%	-5.00		70%	-11.30
		Arm crank (8min)	50%	0.02	Arm crank (8min)	50%	-1.00	Arm crank (8min)	50%	0.30
			70%	-0.04		70%	-1.00		70%	-11.30
			RPE	VO_2 ($ml.kg^{-1}.min^{-1}$)		RPE	HR ($beats.min^{-1}$)		RPE	Power output (watts)
Kang et al. 2009	RPE equivalent to 50 e 75% VO_2peak	Cycle ergometer (20min)	50%	1.60	Cycle ergometer (20min)	50%	14.20	Cycle ergometer (20min)	50%	17.10
			70%	1.60		70%	8.80		70%	31.30
		Cycle ergometer (40min)	50%	1.60	Cycle ergometer (40min)	50%	10.40	Cycle ergometer (40min)	50%	13.60
			70%	2.60		70%	7.30		70%	36.60
						RPE	HR ($beats.min^{-1}$)		RPE	Power output (watts)
Marriott & Lamb 1996	11,13,15,17 e 19					11	11.20		11	36.80
						13	17.50		13	35.00
					Rowing ergometer (3min)	15	3.20	Rowing ergometer (3min)	15	52.20
						17	0.40		17	24.50
						19	-5.70		19	49.80

VO_2máx: maximum volume of oxygen; VO_2peak:volume of oxygen of peak; VO_2: volume of oxygen; RPE: rating of perceived exertion;HR: heart rate; HRreserve: heart rate reserve; GTX : graded exercise test; min: minuto.

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2 VALIDITY OF RPE OF PROGRESSIVE TEST TO PRESCRIBE EXERCISE INTENSITY

2.1 ABSTRACT

According to the literature, the perception of effort would be the true mechanism managing the state of fatigue during exercise. These observations gain robustness with brain performance regulation theories, which are based on psychological motivational models and the central governor of fatigue. Based on the latter model, self-regulation of exercise intensity using the rating of perceived exertion (RPE) appears to be a viable alternative since the magnitude of perceived exertion is the result of interactions between brain activity and afferent nerve stimuli that represent peripheral metabolic alterations and changes in the cardiopulmonary system. Therefore, the objective of this study was to test the validity of Borg RPE 6-20 data obtained in a progressive test for self-regulation of exercise intensity. As main results we identified that individuals are able to self-adjust the intensity of walking and running exercise on a treadmill using only the RPE categories of the Borg 6-20 scale obtained in a progressive test. Analysis of the measurements showed that only categories 7 and 11 for VO_2, and categories 8, 10 and 18 for velocity differed significantly ($p < 0.05$) when the data obtained in the incremental test were compared with those projected. In conclusion, the use of Borg RPE 6-20 data generated in incremental tests is physiologically valid for the self-regulation of exercise intensity and treadmill running. Keywords - RPE, Aerobic Exercise, Borg 6-20 Scale

2.2 INTRODUCTION

The literature has proposed different models to explain the mechanisms that determine the state of fatigue promoted by exercise [1, 2]. Among these models, the traditionally known physiological model presumes that the tolerable duration of exercise is limited by the central nervous system and by peripheral factors through the deficit in the distribution of oxygen to the tissues and the metabolic and ionic changes observed in active muscles during effort [1]. In contrast to this traditional model, other studies have indicated that perceived exertion would be the true mechanism for managing the state of fatigue during exercise [2]. These observations gain robustness with brain performance regulation theories, which are based on psychological motivational models [3] and the central governor of fatigue [4].

Based on the central governor model of fatigue, self-regulation of exercise intensity using the rating of perceived exertion (RPE) appears to be a viable alternative since the magnitude of perceived exertion is the result of interactions between brain activity and afferent

nerve stimuli that represent peripheral metabolic alterations and changes in the cardiopulmonary system [5]. This model of central regulation also indicates that an increase in afferent nerve stimulation is linearly related to the increase in the RPE rate during physical exercise [6], thus enabling the prediction of exercise time to exhaustion [4, 7] and, supposedly, the control of exercise intensity using RPE scales [8-10].

In order to test the validity of RPE scales for the self-regulation of exercise intensity, a number of investigations have used Borg 6-20 data obtained in incremental tests for aerobic training prescription in populations of healthy [11-14] and physically active individuals [15, 16]. Regardless of the characteristic of the sample, these studies were based on the existence of linearity between RPE and measures such as heart rate (HR) [11, 14-16], oxygen consumption (VO_2) [11, 13] and cycle ergometer power [11, 14, 15], to test this hypothesis. The results showed that self-regulation of exercise intensity using RPE is a valid tool to describe a previously suggested target intensity [11, 14, 15]. Despite the scientific importance of the findings, these studies have methodological limitations that make it impossible to recommend Borg 6-20 data for exercise self-regulation: for example, the validation of scale categories related only to 50% HRreserve [16], 50 and 70% VO_2max [11, 12] and VO_2peak [13, 14], or even the choice and intentional categories without considering the number that each individual describes during the progressive exercise test [15].

2.3 GENERAL OBJECTIVE

In view of this scientific scenario, the objective of this study was to test the validity of Borg RPE 6-20 data obtained in a progressive test for self-regulation of exercise intensity.

2.4 METHOD

2.4.1 Participants

The sample was selected intentionally and consisted of healthy individuals older than 18 years, classified as low risk of medical intercurrences by the Pre-Participation Questionnaire in Physical Activity Programs of the AHA/ACSM (2017). The sample size was calculated using the Gpower 3.1.9.2 program (Franz Faul, Universität Kiel, Germany) taking into account an effect size of 0.30, α of 0.05, and sample power of 80%. The estimated sample size was n = 65. However, considering a possible sample loss, we recruited 70 subjects. Individuals who did not participate in one of the stages of the research or who had diseases that impaired their continuation in the study were excluded from the sample. All volunteers signed a free and informed consent form before starting the activities of this study. The procedures were carried

out in accordance with the ethical standards set forth in document [17] and were approved by the Ethics Committee of the Federal University of Pernambuco (Approval No. 2707294).

2.4.2 Experimental design

After signing the consent form, the participants were submitted to risk stratification, anthropometry, collection of information to be entered into the gas analyzer software (name, age, and level of physical activity), and familiarization with the RPE scale (Borg 6-20). At the end of this stage, the volunteer performed an incremental treadmill test (Super ATL model, Inbramed, Porto Alegre, Brazil) using a heart rate monitor (H7, Polar Electro Oy, Kempele, Finland) and a mask connected to the gas analyzer (CORTEX Biophysik GmbH, Leipzig, Germany). Respecting the minimum interval of 48 h, self-regulated treadmill exercises lasting 3 min were performed and the intensity was adjusted using only the Borg scale categories 6-20 described by the individual during the incremental test. The categories were ordered by randomization and the recovery time between sessions was fixed so that the individuals could retrieve the resting VO_2 and classify their RPE as “6 - No effort”. This procedure was repeated until all categories of the scale were considered. In the trials we investigated the consistency between the VO_2 and velocity data obtained in the incremental test and the data obtained in the self-regulated prescription using the Borg 6-20 scale in order to verify the content validity of the RPE data obtained in the incremental test for exercise self-regulation.

2.4.3 Anthropometry

Body weight was measured using a digital scale (PL 200, Filizola SA, São Paulo, Brazil; precision of 0.1 kg, measured with the Inmetro seal), and height was measured with a professional Sanny stadiometer (São Paulo, Brazil) to the nearest 0.1 cm.

2.4.4 Maximum incremental exercise test (GTX)

First, the volunteer was submitted to a seated 5-min rest for the monitoring of VO_2 and HR with a gas analyzer (CORTEX Biophysik GmbH, Leipzig, Germany) calibrated according to the manufacturer’s instructions and a heart rate monitor (H7, Polar Electro Oy, Finland), respectively. Next, still using the equipment, the incremental treadmill test (Super ATL, InbraSport, Brazil) was started at an initial velocity of 5 $km.h^{-1}$ and 1% inclination, with increments of 1 $km.h^{-1}$ every minute until voluntary exhaustion. At the time of the test, the subjects were kept blind to the information generated by the gas analyzer, treadmill speed, and

HR. The subjective perception of exertion and the HR were collected during the final 10 seconds of each stage.

2.4.5 Self-regulated exercise using RPE

The exercise started with standardized warm-up consisting of a 5 $km.h^{-1}$ walk for 3 min. The self-regulated exercise was then performed for 3 min on a treadmill (Super ATL, InbraSport, Brazil) using the RPE scale (Borg 6-20) for intensity selection. The velocity of the treadmill was regulated by the volunteer taking into consideration only the intensity of the randomly selected scale. The "6 - No effort" category was not considered for exercise prescription because it describes the resting state. During the self-regulated exercise, the individuals did not have access to the information shown on the display of the treadmill (speed, distance and time), nor to the VO_2 or HR monitored every minute. The self-regulated exercises were performed using the same equipment as in the incremental test (H7 heart rate monitor, Polar Electro Oy, Finland; gas analyzer, CORTEX Biophysik GmbH, Leipzig, Germany).

2.4.6 Statistical analysis

To verify the validity of the Borg 6-20 data for exercise self-regulation, we compared the magnitudes of VO_2max and maximum velocity responses for each RPE category generated in the incremental test with those obtained in the third minute of the exercise self-regulated by the Borg RPE 6-20 using one-way ANOVA for each variable investigated. When a significant difference ($p < 0.05$) was identified, Bonferroni's post hoc test was applied. The analyses were performed using the SPSS software version 17.

2.5 RESULTS

The characteristics of the sample are described in Table 1. Sixty-seven participants (38 men and 29 women) completed all stages of the study. Three participants were excluded from the sample because they did not complete all stages of the research.

Table 1 - Characterization of the sample

Variables	Mean (SD)
Age (years)	37,0 (10,4)
Weight (kg)	71,4 (9,8)
Height (m)	1,7 (0,1)
BMI ($kg.m^{-2}$)	24,6 (2,8)
Level of physical activity ($hours.week^{-1}$)	3,9 (2,0)
Maximum volume of oxygen ($mL.kg\text{-}1.min^{-1}$)	39,5 (9,2)

Values are Mean (SD); BMI - body mass index

2.5.1 VO_2max

The analysis of the VO_2 measurements showed a difference for the categories 7 and 11 when the data obtained in the incremental test were compared with those projected in the third minute of the exercise using the Borg RPE 6-20 self-regulated intensity (Table 2).

Table 2 - Comparison of $\%VO_{2máx\ GTX}$ vs $\%VO_{2máx\ projected}$

		% VO2máx GXT	% VO2máx projected		Confidence interval		Diff intragroup
Borg	N	Mean (SD)	Mean (SD)	Diff	-95%	95%	Categories of Borg equivalent in projection
7	82	24,34* (9,02)	41,57* (18,91)	-17,23	-21,38	-13,07	8, 9, 10
8	33	38,99 (16,20)	40,29 (11,37)	-1,29	-8,00	5,42	7, 9, 10
9	47	43,70 (14,14)	47,66 (14,92)	-3,96	-10,21	2,30	7, 8, 10
10	31	55,11 (15,16)	50,88 (18,00)	4,23	-3,50	11,96	7, 8, 9, 11
11	58	54,89* (16,36)	63,55* (20,88)	-8,65	-15,53	-1,78	10, 12, 13
12	52	62,91 (15,19)	66,09 (19,53)	-3,18	-9,68	3,32	11, 13, 14
13	51	67,19 (13,14)	73,46 (20,92)	-6,27	-13,27	0,73	11, 12, 14, 15, 16, 17, 18
14	50	74,60 (11,59)	77,82 (18,98)	-3,22	-8,93	2,49	12, 13, 15, 16, 18, 19
15	47	80,46 (9,84)	82,54 (13,78)	-2,08	-6,63	2,47	13, 14, 16, 17, 18, 19
16	28	83,50 (8,43)	85,65 (15,56)	-2,06	-8,34	4,22	13, 14, 15, 17, 18, 19, 20
17	40	88,42 (8,49)	90,58 (13,87)	-2,16	-6,59	2,26	15, 16, 18, 19, 20
18	21	89,26 (4,60)	90,42 (10,39)	-1,16	-6,81	4,48	14, 15, 16, 17, 19, 20
19	23	89,75 (7,45)	82,13 (17,46)	7,62	-0,36	15,60	14, 15, 16, 17, 18, 20
20	66	100,00 (0,00)	96,66 (15,44)	3,34	-0,45	7,14	16, 17, 18, 19

* = * *t test intergroup* - $p < 0.05$ GTX versus projected; N - sample size; SD - standard deviation; VO2máx - maximum volume of oxygen

Figure 1 shows the average loads of $\%VO_2max$ for each category of the Borg 6-20 scale in the maximum incremental test and in the exercise with load projection. Analysis of variance demonstrated differences in $\%VO_2max$ between the incremental test and the load projection using the Borg categories ($F(13, 615) = 58.32$, $p = 0.001$). The post hoc test revealed no difference in $\%VO_2max$ between some categories during load projection (Table 2).

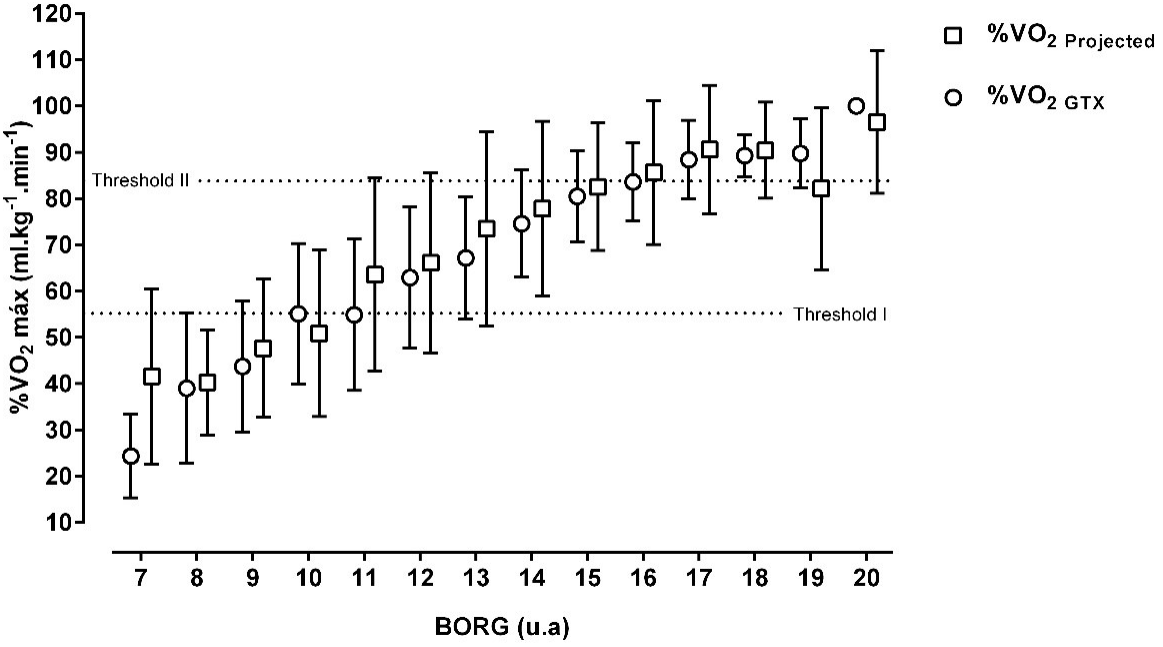

Figure 1 - Comparison of $\%VO_{2máx\ GTX}$ vs $\%VO_{2máx\ projected}$

2.5.2 Velocity

Comparisons of the velocity measurements revealed a significant difference between the data obtained in the incremental test with those projected in the third minute of the exercise with intensity self-regulated by Borg RPE 6-20 for categories 8, 10 and 18 (Table 3).

Table 3 - Comparison of $\%Speed_{GTX}$ vs %Speed projected

		% Speed GXT	% Speed projected		Confidence interval		Diff intragroup
Borg	N	Mean (SD)	Mean (SD)	Diff	-95%	95%	Categories of Borg equivalent in projection
7	87	39,60 (6,97)	40,28 (18,13)	-0,68	-4,32	2,96	8, 9 , 10
8	33	48,16* (8,90)	40,04* (8,99)	8,12	3,88	12,37	7, 9, 10
9	50	52,26 (10,60)	47,22 (14,59)	5,03	0,52	9,55	7, 8, 10, 11
10	31	58,64*(10,57)	50,58* (16,43)	8,07	1,51	14,62	7, 8, 9, 11, 12
11	60	59,08 (11,66)	55,63 (13,16)	3,45	-0,75	7,64	9, 10, 12
12	52	63,67 (11,62)	61,02 (16,18)	2,65	-1,66	6,96	10, 11, 13
13	52	69,20 (10,14)	70,85 (14,79)	-1,65	-6,17	2,87	12, 13
14	50	73,70 (10,01)	73,96 (14,63)	-0,26	-4,90	4,38	13, 15, 16
15	47	79,65 (9,65)	83,03 (13,12)	-3,38	-7,95	1,20	14, 16, 17, 19
16	28	82,37 (8,55)	85,80 (11,80	-3,43	-9,54	2,68	14, 15, 17, 18, 19
17	40	86,56 (9,21)	91,14 (15,80)	-4,59	-9,78	0,61	15, 16, 18, 19
18	21	89,51* (4,07)	99,36* (17,24)	-9,85	-18,48	-1,22	16,17, 19, 20
19	23	88,42 (8,38)	94,84 (17,52)	-6,42	-13,25	0,42	15, 16, 17, 18, 19, 20
20	67	100,00 (0,00)	103,78 (16,56)	-3,79	-7,83	0,25	18, 19

* = * *t test intergroup* - $p < 0.05$ GTX versus projected; N - sample size; SD - standard deviation

Figure 2 depicts the average loadings of % velocity for each category of the Borg 6-20 scale in the maximum incremental test and in the exercise with load projection. Analysis of variance identified a difference in speed between the incremental test and the load projection using the Borg categories (F (13, 627) = 99.05, p = 0.001). Similar to the findings for %VO_2max, the post hoc test identified no difference in % velocity between some categories during load projection (Table 3).

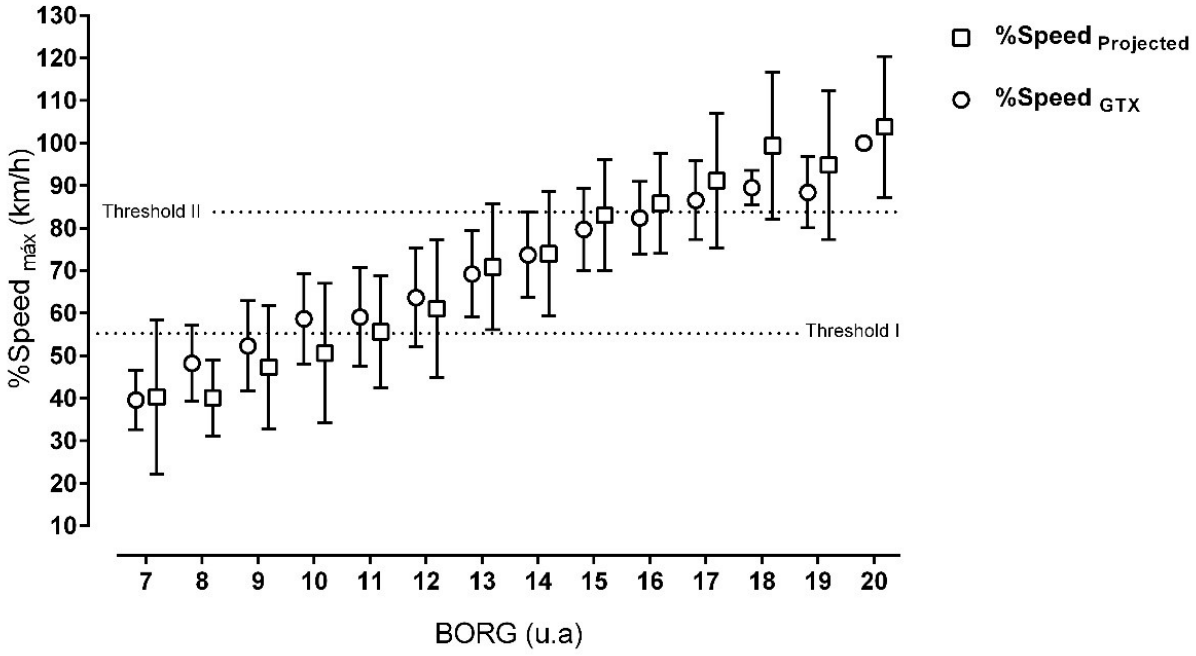

Figure 2 - Comparison of %Speed $_{GTX}$ vs %Speed $_{projected}$

2.6 DISCUSSION

The objective of the present study was to test the validity of Borg RPE 6-20 data obtained in a progressive exercise test for self-regulation of exercise intensity using as criteria the VO_2 and speed associated with RPE categories, both obtained in an incremental test. As main results we identified that the individuals were able to self-regulate the intensity of walking and running exercise on a treadmill using only the RPE categories of the Borg 6-20 scale. These findings strengthen the neuroscientific theory of the central control of effort [3, 5, 6, 18], since the physiological changes observed during the experiment (for example, in VO_2), supposedly triggered by afferent nerve activities, allowed the individual to identify the exercise intensity and to subsequently adjust the velocity of the treadmill to the previously fixed target RPE.

In our study, the comparison of the percentages of maximum oxygen consumption (%VO_2max GTX vs %VO_2max projected) showed that the Borg RPE 6-20 data obtained in the incremental test are mostly valid to self-regulate exercise intensity. These findings corroborate those reported in the literature for the categories equivalent to 50% VO_2max in treadmill exercises [11] 50% VO_2peak in cycle ergometer exercises [14], and 70% VO_2peak in arm cycle ergometer exercises [14], with a mean difference between estimated and produced VO_2 of -0.35, -0.11 and -0.04 l.min^{-1}, respectively. On the other hand, they disagree with the findings of Kang et al [14] and Dunbar et al [11] for the categories related to 70% VO_2peak and 70% VO_2max, respectively. These authors reported mean differences of -0.20 and -0.73 l.min^{-1}, respectively, between estimated and produced VO_2 and did therefore not recommend the use of this scale for exercise prescription at this intensity. Also regarding VO_2, the low energy demand of the self-regulated activity using category 7 of this scale, or perhaps the delay in the understanding of this demand, seems to compromise the precision of the individual in adjusting the treadmill speed, and thus the consumption referring to this load (Figures 1 and 2, Table 2). On the other hand, category 7 may not have a practical application in exercise prescription because it is a very low effective load. The overestimation observed for category 11 may be explained by the proximity of this intensity to the transition range of threshold I at which an increase in VO_2 occurs due to the predominance of aerobic metabolism (Figures 1 and 2, Table 2). Apparently, the metabolic changes that occur in this intensity range may impair understanding and consequently the decision-making of individuals for the self-regulation of exercise.

The comparison of the percentages of velocity (%velocity GTX vs %velocity projected) also suggests that the Borg 6-20 scale seems to be a good strategy for the self-regulation of exercise intensity since perceptually regulated exercise sessions had velocities similar to those defined as targets. Similar to literature data for output power [11, 14, 15], these findings strengthen the hypothesis that the Borg RPE 6-20 scale can individually replace the performance measures traditionally used to regulate the intensity of exercise. However, this fact needs to be better investigated since studies on this subject are still preliminary and so far do not support the recommendation of this tool for the self-regulation of exercise intensity, especially when the focus is the improvement of sports performance.

Our findings showed that the participants tended to underestimate the velocity at the intensities below threshold I, with the observation of heterogeneity in self-regulated exercises for categories 8 and 10. Similarly, we observed a trend towards the overestimation of intensities above category 13, with the participants exhibiting heterogeneity in self-regulated activities for

category 18 (Table 3, Figure 2). These trends can be explained by the arrangement of verbal descriptors in the Borg 6-20 scale since the words “light” and “intense” present in the verbal descriptors of the categories seem to influence the decision-making of individuals during exercise self-regulation. Our data are insufficient to support or refute this hypothesis, which should be better investigated in future studies.

The similarities indicated by the post hoc test for the adjacent categories of the Borg 6-20 scale (Tables 2 and 3) suggest that this tool may present an exacerbated number of points for the perceptual adjustment of exercise intensity, considering that the disturbances of homeostasis generated during exercise produced different perceptions of effort but did not result in significant changes in VO_2 or speed. This fact scientifically justifies a reduction in the original size of the scale. On the other hand, it does not support the intentional choice of categories as performed in previous studies [19-22], since the physiological changes that occur in a given range of exercise intensity apparently can be attributed to a set of adjacent categories of the Borg 6-20 scale and not to a single category.

Taken together, our findings suggest that the exercise prescriptions below threshold I should be made using the interval between categories 7 and 10, the prescriptions between thresholds I and II should be made respecting the range of categories 11 to 15, and the prescriptions above threshold II should follow the interval between categories 16 and 20 (Figures 1 and 2). However, new studies are necessary to add more robustness to this hypothesis by analyzing the magnitude of the least perceived difference and the differential threshold of each category of this scale using psychophysical methods for direct quantitative estimation [23], in order to evaluate the possibility of grouping these adjacent categories or even to propose a new scale for the self-regulation of exercise intensity. Nevertheless, the Borg RPE 6-20 scale is a tool with good validity for prescribing the intensity of walking and running on a treadmill.

2.7 CONCLUSION

The use of Borg RPE 6-20 data generated in incremental tests is physiologically valid for the self-regulation of exercise intensity and treadmill running. However, further studies should test the validity of Borg 6-20 data for exercise self-regulation outside the laboratory environment in recreational and high-performance sports activities. In addition, future research should investigate the reliability and the impact of time on the intensity of perceptually regulated exercise, as these were limitations of our study.

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3 FINAL CONSIDERATIONS

The aim of our study was to test the validity of the RPE Borg 6-20 data obtained in a progressive test for the self-regulation of the intensity of aerobic exercise. As main findings we identified that individuals are able to self-adjust the intensity of walking and running on a treadmill using only the categories of Borg 6-20 RPE obtained in a previous progressive test. New studies should confirm our findings using different types of incremental tests in order to improve our findings.

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APPENDIX A – RAW DATA

ID	Velocity (km/h)	Borg	VO_2 Test 30'' ini	VO_2 Teste 30''fin	VO_2 Test 1'	Velocity Max. Traning (km/h)	VO_2 Training 1'	VO_2 Traning 2'	VO_2 Training 3'
1	5.00	7	4.50	8.00	6.60	5.10	9.14	12.67	13.00
	6.00	8	10.75	11.00	10.80	5.50	8.14	12.67	14.50
	7.00	9	12.25	14.00	12.60	8.10	8.14	18.00	21.67
	8.00	11	15.75	18.00	16.20	8.70	11.29	26.83	32.00
	9.00	11	21.00	22.33	21.20	8.70	11.29	26.83	32.00
	10.00	12	24.25	26.00	24.60	9.10	11.14	22.00	25.17
	11.00	13	26.25	26.67	26.40	10.50	10.57	25.17	29.17
	12.00	14	28.75	30.00	29.00	11.30	9.29	24.00	29.83
	13.00	15	30.75	31.33	30.80	11.90	11.29	26.83	32.00
	14.00	18	34.75	38.00	35.40	14.30	11.43	28.33	34.50
	15.00	20	40.00		40.00	16.70	11.57	28.67	36.00
2	5.00	7	4.00	6.00	5.20	4.10	5.86	10.00	10.33
	6.00	8	9.25	12.33	10.50	5.90	6.00	11.83	12.50
	7.00	9	14.25	16.33	15.17	6.10	7.14	12.83	14.83
	8.00	11	19.25	21.33	20.17	7.10	7.29	20.33	23.83
	9.00	13	24.25	27.00	25.33	10.70	11.57	28.50	31.17
	10.00	14	29.25	30.33	29.67	10.30	7.71	24.00	29.83
	11.00	15	31.25	33.00	32.00	10.10	6.43	23.50	29.17
	12.00	17	34.50	35.00	34.67	10.30	9.71	25.00	29.50
	13.00	20	36.00		36.00	12.70	10.14	31.00	28.33
3	5.00	7	5.67	6.67	6.17	2.10	7.71	9.17	10.67
	6.00	8	4.25	7.67	5.67	4.50	6.71	10.83	13.17

	7.00	11	13.00	15.67	14.00	4.50	7.43	11.50	13.17
	8.00	12	17.25	18.67	17.83	5.70	8.00	12.17	15.67
	9.00	14	19.75	23.67	21.17	7.70	8.57	21.67	27.00
	10.00	14	25.75	27.33	26.50	7.70	8.57	21.67	27.00
	11.00	14	27.50	29.00	28.17	7.70	8.57	21.67	27.00
	12.00	15	30.25	31.00	30.67	9.90	7.43	20.50	30.50
	13.00	17	32.25	32.67	32.33	12.90	13.43	32.17	38.50
	14.00	20	34.75	36.00	35.17	14.50	8.00	26.50	40.17
4	5.00	7	6.67	7.67	7.17	2.10	10.00	12.50	11.67
	6.00	8	12.25	14.00	12.83	3.30	8.29	10.83	12.83
	7.00	9	14.25	15.67	14.83	5.30	6.86	14.50	18.83
	8.00	9	16.00	16.33	16.17	5.30	6.86	14.50	18.83
	9.00	11	20.25	22.33	21.17	5.90	9.00	18.33	19.83
	10.00	12	24.50	25.67	25.00	6.30	8.86	18.33	21.00
	11.00	14	33.25	35.67	34.00	8.70	10.14	25.17	31.33
	12.00	16	37.00	39.00	37.83	11.70	12.43	31.83	38.33
	13.00	17	41.00	42.00	41.50	13.50	13.14	36.00	40.17
	14.00	20	43.00		43.00	15.70	9.29	24.50	38.00
5	5.00	7	6.00	8.67	7.33	4.70	8.86	14.00	17.33
	6.00	9	13.00	16.00	14.17	5.90	9.29	15.67	20.67
	7.00	11	23.25	26.00	24.17	6.70	9.14	24.00	31.50
	8.00	13	29.75	29.67	29.67	8.10	15.00	32.83	34.17
	9.00	14	30.00	31.67	30.67	9.90	10.14	34.50	38.50
	10.00	15	33.00	34.67	33.83	10.30	8.14	25.83	40.67
	11.00	16	35.50	37.00	36.00	10.90	10.29	36.17	40.50
	12.00	17	36.75	38.00	37.00	11.10	18.14	39.83	43.50
	13.00	18	38.75	39.33	39.00	12.90	16.71	40.67	45.00
	14.00	19	41.75	42.67	42.17	14.10	18.43	46.00	53.67

	15.00	20	42.50	44.67	43.33	16.50	10.43	39.67	51.17
6	5.00	7	5.67	7.33	6.50	6.70	7.00	12.17	16.67
	6.00	9	11.25	14.33	12.50	7.10	6.71	13.17	21.50
	7.00	11	15.00	17.00	16.00	10.10	8.14	24.00	27.67
	8.00	11	20.00	22.67	21.17	10.10	8.14	24.00	27.67
	9.00	11	24.75	28.00	26.17	10.10	8.14	24.00	27.67
	10.00	12	29.25	28.67	29.00	11.90	8.29	22.33	28.67
	11.00	12	29.25	31.00	30.00	11.90	8.29	22.33	28.67
	12.00	14	31.75	33.00	32.17	13.10	9.14	28.00	33.83
	13.00	18	34.50	34.67	34.50	15.30	8.14	22.00	30.17
	14.00	20	36.50	38.00	37.00	16.50	7.57	19.67	29.67
7	5.00	7	10.00	15.67	12.83	4.30	10.57	15.33	16.50
	6.00	9	20.25	23.00	21.33	5.30	10.14	18.00	20.00
	7.00	12	23.75	26.00	24.83	7.10	11.86	24.50	28.00
	8.00	15	28.25	31.00	29.67	11.90	12.00	34.33	45.17
	9.00	17	35.75	36.00	36.00	10.90	12.14	34.83	44.50
	10.00	17	38.25	39.33	39.00	10.90	12.14	34.83	44.50
	11.00	19	41.00	41.33	41.50	12.90	11.86	32.17	45.67
	12.00	19	44.50	47.33	45.67	12.90	11.86	32.17	45.67
	13.00	19	47.00	47.33	46.83	12.90	11.86	32.17	45.67
	14.00	19	49.75	51.33	50.33	12.90	11.86	32.17	45.67
	15.00	19	51.75	52.33	51.83	12.90	11.86	32.17	45.67
	16.00	19	55.00	57.50	56.00	12.90	11.86	32.17	45.67
	17.00	20	58.33	60.00	59.00	16.10	13.29	32.00	50.50
8	5.00	11	6.00	8.33	7.17	8.30	10.29	27.50	31.50
	6.00	11	13.50	15.00	14.00	8.30	9.71	26.83	32.83
	7.00	11	16.75	18.00	17.17	8.30	9.71	26.83	32.83
	8.00	12	20.50	21.67	20.83	9.30	9.71	26.83	32.83

	9.00	12	26.25	28.33	27.17	9.30	9.71	26.83	32.83
	10.00	13	30.25	31.00	30.67	12.70	14.43	36.00	39.83
	11.00	13	32.00	33.67	32.83	12.70	14.43	36.00	39.83
	12.00	14	35.25	36.00	35.50	13.30	19.29	39.50	42.33
	13.00	14	36.75	37.67	37.17	13.30	19.29	39.50	42.33
	14.00	16	39.50	40.00	39.67	15.30	14.43	38.50	43.17
	15.00	17	41.75	42.00	41.83	18.10	11.00	39.83	44.83
	16.00	19	44.00	44.50	44.20	18.10	18.71	38.50	47.33
	17.00	20	45.33	46.50	45.80	18.10	14.00	34.50	40.50
	5.00	7	6.00	10.67	8.33	3.30	7.29	10.00	11.83
	6.00	10	13.25	15.00	14.00	4.90	7.29	10.67	13.67
	7.00	12	15.75	18.00	16.67	6.10	7.57	13.00	14.33
	8.00	13	21.25	23.33	22.17	6.70	6.57	13.33	18.17
9	9.00	14	25.75	27.00	26.33	9.30	9.14	23.50	28.33
	10.00	14	29.50	30.67	30.00	10.50	9.14	23.50	28.33
	11.00	16	33.50	35.33	34.17	9.90	8.43	25.83	33.17
	12.00	17	37.25	37.67	37.50	10.90	9.57	27.33	34.67
	13.00	19	40.75	42.00	41.33	12.10	12.86	33.00	39.17
	14.00	20	42.50	42.67	42.67	12.10	11.14	33.50	42.67
	5.00	7	5.33	9.67	7.50	3.10	7.57	10.83	12.83
	6.00	10	14.25	16.00	14.83	6.10	12.14	19.00	19.33
	7.00	13	19.00	22.00	20.00	9.30	9.14	20.67	36.33
	8.00	14	25.00	28.67	26.67	8.70	9.14	16.67	28.83
10	9.00	15	34.00	35.33	34.67	11.30	10.71	30.17	43.17
	10.00	16	39.25	38.00	38.83	13.30	8.71	21.33	42.00
	11.00	16	40.75	42.33	41.33	13.30	8.71	21.33	42.00
	12.00	16	45.50	48.00	46.50	13.30	8.71	21.33	42.00
	13.00	18	49.25	50.67	49.83	15.10	10.29	21.33	43.83

	14.00	19	52.50	53.33	52.83	16.30	11.00	17.00	33.50
	15.00	20	55.50	57.33	56.33	16.90	12.29	30.83	39.83
	5.00	7	7.00	11.33	9.17	5.10	5.14	10.17	10.50
	6.00	10	14.25	18.33	16.00	9.90	6.57	26.33	30.33
11	7.00	11	21.75	22.67	22.00	5.50	7.00	15.50	14.33
	8.00	17	23.50	25.00	24.17	7.90	9.43	24.33	24.83
	9.00	20	27.25	28.00	27.25	8.70	5.71	13.50	26.17
	5.00	7	6.67	9.00	7.83	4.50	9.14	12.67	13.00
	6.00	11	12.75	15.33	14.00	8.30	13.29	26.00	24.67
	7.00	12	21.50	27.00	23.33	6.50	9.71	17.67	19.50
	8.00	13	27.75	27.67	27.83	10.10	8.43	24.67	27.67
	9.00	14	30.00	32.00	30.67	11.90	11.00	27.50	30.83
	10.00	14	33.25	34.67	33.67	11.90	11.00	27.50	30.83
12	11.00	15	35.50	36.33	35.83	13.10	12.00	29.33	35.50
	12.00	15	37.75	40.00	38.67	13.10	12.00	29.33	35.50
	13.00	15	41.00	42.33	41.50	13.10	12.00	29.33	35.50
	14.00	16	44.75	47.33	45.67	14.30	14.00	32.67	39.50
	15.00	17	49.50	50.00	49.67	13.30	10.43	28.83	37.33
	16.00	19	54.67	55.00	54.80	16.70	12.29	31.83	42.33
	17.00	20	56.00		56.00	17.90	11.86	31.83	43.00
	5.00	7	7.33	13.00	10.17	3.30	8.29	12.67	12.67
	6.00	7	17.00	19.00	17.67	3.30	8.29	12.67	12.67
	7.00	11	18.75	21.00	19.67	8.10	11.86	23.00	28.83
	8.00	12	24.00	28.67	25.83	7.50	9.43	21.50	30.00
13	9.00	12	32.25	34.00	33.17	7.50	9.43	21.50	30.00
	10.00	12	36.00	39.33	37.17	7.50	9.43	21.50	30.00
	11.00	12	35.75	36.33	36.00	7.50	9.43	21.50	30.00
	12.00	13	39.25	42.33	40.67	10.50	14.86	36.67	40.50

	13.00	14	45.25	45.33	45.33	9.50	10.00	28.17	35.67
	14.00	15	47.00	48.67	47.67	11.30	15.00	39.67	47.33
	15.00	15	51.25	52.67	52.00	11.30	15.00	39.67	47.33
	16.00	18	53.00	55.00	53.80	14.50	11.86	38.17	49.33
	17.00	20	54.67	58.00	56.00	21.90	10.43	38.00	51.00
14	5.00	7	8.00	12.00	10.00	12.30	16.86	34.00	36.83
	6.00	7	14.75	16.67	15.50	12.30	16.86	34.00	36.83
	7.00	7	17.00	20.00	18.17	12.30	16.86	34.00	36.83
	8.00	7	21.25	23.67	22.33	12.30	16.86	34.00	36.83
	9.00	7	28.25	32.67	29.83	12.30	16.86	34.00	36.83
	10.00	9	34.50	35.67	35.00	12.70	16.00	35.50	39.83
	11.00	9	37.00	38.00	37.50	12.70	16.00	35.50	39.83
	12.00	9	39.25	41.00	39.83	12.70	16.00	35.50	39.83
	13.00	11	40.00	41.00	40.50	10.10	8.71	24.00	29.50
	14.00	11	42.75	42.67	42.67	10.10	8.71	24.00	29.50
	15.00	13	42.00	43.67	42.67	13.30	16.00	35.33	38.50
	16.00	20	45.33	46.00	45.50	13.70	15.86	34.67	39.50
15	5.00	7	5.33	7.00	6.17	2.80	6.29	8.00	7.67
	6.00	11	7.75	10.67	9.00	3.90	6.43	9.83	10.50
	7.00	11	13.75	15.00	14.17	3.90	6.43	9.83	10.50
	8.00	13	16.50	18.00	17.17	5.50	6.86	13.17	15.67
	9.00	14	20.75	23.33	21.83	7.90	7.57	20.00	26.83
	10.00	15	27.50	29.67	28.17	6.70	8.00	16.17	23.33
	11.00	17	30.75	31.67	31.00	9.30	8.43	24.50	29.17
	12.00	20	31.50	32.00	31.50	11.30	8.86	20.50	29.67
16	5.00	7	8.00	11.67	9.83	4.10	6.43	10.00	10.83
	6.00	7	14.50	17.00	15.33	4.10	6.29	11.83	17.00
	7.00	10	18.00	19.67	18.83	6.70	6.29	11.83	17.00

	8.00	11	23.00	24.67	23.83	8.50	8.29	22.00	25.83
	9.00	11	29.75	32.00	30.67	8.50	8.29	22.00	25.83
	10.00	12	33.25	34.67	33.83	8.30	6.71	16.50	24.67
	11.00	13	35.50	38.33	36.50	12.70	9.29	30.50	36.17
	12.00	16	38.25	38.33	38.33	15.90	10.29	28.83	38.33
	13.00	17	40.00	41.67	40.50	15.50	8.43	23.33	36.50
	14.00	18	43.25	43.00	43.00	15.70	8.14	20.33	36.67
	15.00	19	43.50	44.33	43.83	19.10	9.86	31.17	41.50
	16.00	20	46.67	49.50	47.80	22.70	9.14	26.67	37.00
17	5.00	7	6.67	10.33	8.50	5.10	7.57	13.17	14.33
	6.00	7	14.75	17.67	16.00	5.10	7.57	13.17	14.33
	7.00	9	18.50	21.00	19.50	6.30	8.00	15.33	17.83
	8.00	10	24.00	27.00	25.17	6.70	8.86	17.17	20.50
	9.00	11	29.00	31.33	29.83	6.90	8.43	17.33	19.83
	10.00	13	32.50	35.00	33.50	8.90	8.14	14.83	22.33
	11.00	14	37.00	38.67	37.67	10.10	8.57	22.33	31.50
	12.00	20	40.50	42.00	40.50	10.10	8.29	25.00	35.00
18	5.00	7	5.00	8.00	6.50	4.30	8.86	12.17	12.00
	6.00	9	12.50	15.33	13.50	4.90	8.43	13.00	12.50
	7.00	11	16.00	18.67	17.17	6.70	9.71	18.17	19.17
	8.00	12	22.75	24.67	23.33	9.60	11.71	24.83	27.67
	9.00	13	25.50	26.67	26.00	8.30	15.29	28.33	25.33
	10.00	14	29.50	32.00	30.50	12.30	13.00	31.83	35.00
	11.00	16	33.25	34.00	33.50	9.70	16.29	25.00	26.33
	12.00	18	35.50	35.67	35.50	10.90	15.29	33.00	37.20
	13.00	20	38.50	40.00	39.17	12.30	13.57	34.83	35.50
19	5.00	7	5.33	8.67	7.00	5.90	8.00	17.17	19.33
	6.00	9	11.50	13.00	12.00	6.90	9.43	17.83	23.83

	7.00	12	14.00	17.67	15.50	8.70	10.00	29.33	36.50
	8.00	14	22.50	24.00	23.00	11.10	9.71	24.50	27.33
	9.00	16	25.00	26.67	25.67	11.70	10.71	27.17	30.50
	10.00	16	26.50	28.33	27.33	11.70	10.71	27.17	30.50
	11.00	17	29.50	30.33	29.83	12.50	11.43	29.00	33.50
	12.00	17	31.25	32.00	31.50	12.50	11.43	29.00	33.50
	13.00	18	33.75	34.00	33.83	12.40	13.43	29.50	33.33
	14.00	20	35.75	37.33	36.33	13.70	8.00	23.83	30.33
	5.00	7	5.33	8.67	7.00	5.10	7.71	13.83	16.17
	6.00	7	11.25	12.33	11.67	5.10	7.71	13.83	16.17
	7.00	9	13.50	15.33	14.33	5.90	8.71	15.33	18.50
	8.00	11	19.00	21.00	19.83	9.50	11.14	27.50	32.33
	9.00	12	25.50	28.00	26.50	11.10	15.29	31.33	34.00
20	10.00	14	30.00	30.00	30.00	12.50	13.57	33.33	37.00
	11.00	15	30.50	31.00	30.67	13.50	14.57	33.50	37.00
	12.00	16	32.00	31.00	31.50	11.90	11.43	27.83	32.17
	13.00	18	31.00	32.00	31.33	14.10	14.86	32.67	35.67
	14.00	19	33.75	34.67	34.17	14.50	9.57	30.00	36.33
	15.00	20	36.00		36.00	15.30	13.71	33.67	36.83
	5.00	7	7.33	10.33	8.83	7.90	8.00	17.67	21.83
	6.00	7	12.75	16.67	14.33	7.90	8.00	17.67	21.83
	7.00	9	16.50	20.00	18.17	11.90	7.00	10.50	25.00
	8.00	9	23.75	25.00	24.33	11.90	7.00	10.50	25.00
21	9.00	11	26.50	27.67	27.17	11.10	9.57	24.17	30.33
	10.00	11	30.00	31.00	30.33	11.10	9.57	24.17	30.33
	11.00	11	31.00	33.00	31.83	11.10	9.57	24.17	30.33
	12.00	13	34.00	35.00	34.50	12.70	10.14	28.17	31.33
	13.00	13	37.50	39.00	38.00	12.70	10.14	28.17	31.33

	14.00	15	39.75	41.33	40.50	10.00	8.57	20.50	26.83
	15.00	17	43.25	43.33	43.17	13.90	11.00	30.17	40.83
	16.00	19	44.67	42.50	43.80	13.70	9.57	22.33	31.50
	17.00	20	47.67	47.33	47.50	18.70	11.57	32.83	43.67
22	5.00	7	7.00	9.33	8.17	4.70	10.57	15.00	15.67
	6.00	7	12.75	16.67	14.17	4.70	10.57	15.00	15.67
	7.00	7	19.25	23.67	21.00	4.70	10.57	15.00	15.67
	8.00	8	29.00	30.67	29.50	4.30	9.00	12.17	13.83
	9.00	9	30.75	33.00	31.50	4.90	8.57	14.00	14.33
	10.00	9	34.00	36.00	34.83	4.90	8.57	14.00	14.33
	11.00	10	37.50	38.67	38.00	5.70	9.57	15.50	18.67
	12.00	11	38.50	39.33	38.83	5.70	13.14	25.17	24.83
	13.00	12	41.00	42.00	41.33	12.20	16.86	36.83	37.17
	14.00	14	42.50	43.00	42.83	12.50	15.86	36.50	40.67
	15.00	16	46.00	47.00	46.33	14.50	15.43	37.83	39.67
	16.00	20	48.00		48.00	16.70	10.57	34.67	42.67
23	5.00	8	7.00	8.00	7.50	2.90	8.29	9.67	10.83
	6.00	9	10.75	14.67	12.33	2.30	9.57	9.67	10.33
	7.00	12	16.50	19.67	17.67	6.10	7.00	12.00	15.67
	8.00	14	21.25	22.33	21.67	7.10	6.29	10.83	15.33
	9.00	15	25.00	26.67	25.50	8.70	8.71	18.83	26.50
	10.00	16	28.75	30.00	29.17	8.50	9.29	19.00	25.67
	11.00	20	30.75	32.00	30.75	8.70	9.71	17.00	26.17
24	5.00	7	6.33	11.33	8.83	4.50	9.57	12.67	13.67
	6.00	9	13.75	16.33	14.83	5.70	12.00	15.83	16.33
	7.00	13	17.75	19.33	18.50	7.70	8.86	18.83	21.67
	8.00	14	22.50	25.00	23.67	13.50	9.00	24.17	32.33
	9.00	15	27.75	29.00	28.33	16.30	11.14	23.33	30.83

	10.00	16	30.75	31.33	31.00	15.90	11.43	27.50	33.67
	11.00	17	34.00	37.67	35.50	17.50	11.00	27.00	32.33
	12.00	18	39.25	40.33	39.83	19.10	10.29	24.33	35.50
	13.00	19	41.50	42.33	41.83	13.30	8.43	13.67	23.50
	14.00	19	43.75	45.00	44.17	13.30	8.43	13.67	23.50
	15.00	20	46.75	47.00	46.83	21.90	11.00	26.50	35.33
25	5.00	7	3.67	5.33	4.50	6.30	5.71	12.17	17.67
	6.00	8	6.00	7.33	6.50	5.70	5.14	8.67	10.83
	7.00	12	8.50	10.00	9.17	8.20	7.14	11.50	18.83
	8.00	13	11.75	13.00	12.33	7.70	5.86	17.33	20.17
	9.00	14	16.25	17.00	16.50	9.30	7.00	19.83	25.67
	10.00	16	18.50	19.00	18.83	10.10	6.43	19.00	26.33
	11.00	18	22.00	22.67	22.17	11.70	6.00	17.50	24.33
	12.00	20	24.00	25.00	24.33	11.30	7.57	19.67	27.83
26	5.00	7	5.00	7.33	6.17	3.50	6.86	10.00	10.00
	6.00	9	12.00	14.00	12.83	3.90	6.14	12.00	14.00
	7.00	10	15.75	17.33	16.33	4.10	8.29	13.67	14.17
	8.00	11	20.25	21.00	20.50	4.10	5.71	11.17	13.33
	9.00	12	21.75	22.67	22.17	4.30	7.14	13.50	15.17
	10.00	16	23.75	24.00	23.83	5.70	6.71	15.83	20.33
	11.00	20	25.25	27.00	26.17	8.50	9.29	20.33	21.83
27	5.00	7	4.33	7.67	6.00	2.30	6.00	8.33	8.17
	6.00	7	9.75	11.67	10.50	2.30	6.00	8.33	8.17
	7.00	8	13.25	14.00	13.67	3.90	8.14	10.17	9.83
	8.00	8	16.75	19.33	17.67	3.90	8.14	10.17	9.83
	9.00	9	21.00	23.00	21.83	3.70	6.14	9.17	8.67
	10.00	10	24.50	24.67	24.50	4.50	7.57	10.67	11.00
	11.00	15	26.00	26.67	26.33	9.50	8.86	21.33	24.67

	12.00	20	28.00		28.00	11.40	11.14	25.00	28.83
28	5.00	7	8.33	12.67	10.50	8.70	12.00	26.17	30.00
	6.00	7	13.75	16.00	14.50	8.70	12.00	26.17	30.00
	7.00	8	17.00	19.33	18.00	7.10	10.86	23.00	26.50
	8.00	8	23.75	25.00	24.17	7.10	10.86	23.00	26.50
	9.00	9	26.00	26.00	26.00	7.10	13.86	25.67	25.00
	10.00	10	26.75	28.00	27.33	8.50	8.71	21.67	26.67
	11.00	11	31.50	32.00	31.67	7.30	11.14	17.83	25.00
	12.00	13	33.75	34.33	34.00	9.90	13.86	29.00	32.50
	13.00	15	35.00	36.00	35.33	12.10	13.57	30.83	33.17
	14.00	20	38.00	38.50	38.20	12.90	9.57	25.00	35.50
29	5.00	7	4.33	6.00	5.17	6.30	8.14	16.00	21.17
	6.00	11	8.75	11.00	9.67	7.10	9.29	19.33	24.00
	7.00	12	13.50	15.33	14.33	7.90	10.14	21.83	25.50
	8.00	13	17.00	18.00	17.33	9.30	8.71	22.33	28.83
	9.00	15	21.25	22.67	21.67	9.30	9.29	23.17	28.50
	10.00	16	23.75	26.00	24.67	7.70	9.14	20.83	23.60
	11.00	20	28.25	28.67	28.50	9.50	7.57	18.33	26.50
30	5.00	7	6.00	9.00	7.50	4.30	8.86	11.83	13.50
	6.00	8	14.00	16.33	14.83	5.50	7.43	14.17	14.50
	7.00	9	17.50	19.33	18.33	5.90	8.43	14.67	15.17
	8.00	10	24.00	27.33	25.33	6.50	11.00	18.17	16.33
	9.00	10	28.75	28.00	28.50	6.50	11.00	18.17	16.33
	10.00	15	31.00	32.00	31.50	11.50	10.43	30.17	34.00
	11.00	15	34.75	35.67	35.00	11.50	10.43	30.17	34.00
	12.00	17	36.75	36.67	36.67	14.30	14.29	31.83	37.33
	13.00	17	40.50	37.33	38.83	14.30	14.29	31.83	37.33
	14.00	20	41.50	45.33	43.00	15.10	10.86	30.17	39.50

31	5.00	7	4.33	6.00	5.17	6.50	5.86	6.33	9.67
	6.00	11	8.25	11.00	9.33	8.90	7.86	19.00	34.67
	7.00	12	12.50	14.67	13.50	8.90	8.00	22.00	27.17
	8.00	14	18.50	20.67	19.33	12.90	5.57	12.33	31.17
	9.00	15	21.25	23.00	22.17	11.30	11.71	28.67	32.33
	10.00	17	25.25	25.67	25.33	12.90	6.86	16.00	33.33
	11.00	20	26.25	28.33	27.17	14.10	9.14	30.67	39.50
32	5.00	7	5.67	9.00	7.33	3.70	7.43	9.67	10.17
	6.00	9	13.25	14.33	13.67	3.90	7.43	10.00	10.83
	7.00	12	17.00	19.00	17.83	5.70	8.43	13.67	14.33
	8.00	14	21.25	21.67	21.50	6.70	9.14	15.67	17.67
	9.00	17	22.50	23.67	23.00	8.70	8.43	21.67	25.50
	10.00	20	24.50	25.50	24.80	11.30	14.00	25.83	29.33
33	5.00	9	7.33	11.00	9.17	6.10	8.00	14.17	16.83
	6.00	12	13.00	14.33	13.50	8.10	8.43	19.83	26.17
	7.00	13	15.25	16.33	15.67	8.90	11.00	25.17	31.17
	8.00	14	19.75	23.00	21.00	9.70	13.43	29.50	33.83
	9.00	15	25.25	25.33	25.17	11.10	8.29	19.67	31.00
	10.00	16	27.00	27.00	27.00	11.90	9.43	26.67	34.67
	11.00	17	28.75	30.00	29.17	10.30	8.00	14.33	22.00
	12.00	20	31.25	32.00	31.50	12.10	10.43	26.83	35.33
34	5.00	8	6.00	8.00	7.00	6.50	7.43	12.50	14.33
	6.00	9	11.00	11.67	11.17	8.90	9.14	24.17	27.33
	7.00	11	14.25	15.00	14.50	8.70	9.00	24.33	30.50
	8.00	11	18.75	21.33	19.67	8.70	9.00	24.33	30.50
	9.00	13	23.00	23.67	23.17	11.30	9.14	27.33	32.17
	10.00	15	26.50	30.67	28.00	12.20	8.86	31.67	33.17
	11.00	16	28.50	30.33	29.33	13.10	11.29	31.17	36.00

	12.00	19	34.50	36.00	35.00	13.90	11.86	31.50	36.67
	13.00	20	37.00	38.67	37.67	14.30	9.14	30.67	39.50
35	5.00	7	5.00	8.33	6.67	4.10	7.14	10.83	11.83
	6.00	8	12.50	15.00	13.33	4.90	7.00	12.50	13.67
	7.00	9	14.75	16.00	15.33	5.50	7.86	14.33	14.33
	8.00	12	19.75	21.67	20.50	6.90	7.29	13.50	17.00
	9.00	20	22.00	23.67	22.67	7.30	7.29	13.50	18.00
36	5.00	8	5.33	7.33	6.33	3.50	5.86	12.50	14.50
	6.00	10	9.25	11.67	10.17	5.50	4.71	11.83	18.17
	7.00	10	15.00	17.33	15.83	5.50	4.71	11.83	18.17
	8.00	14	18.50	20.67	19.50	12.50	5.43	14.33	28.17
	9.00	17	25.25	26.00	25.50	14.50	6.29	21.17	31.17
	10.00	18	27.75	29.00	28.17	14.80	8.00	23.83	30.33
	11.00	19	31.25	33.33	32.00	17.50	10.00	29.33	36.50
	12.00	20	34.00	35.33	34.67	17.90	10.86	30.17	39.50
37	5.00	7	3.33	7.00	5.17	9.50	10.14	23.67	27.67
	6.00	7	9.75	11.33	10.33	9.50	10.14	23.67	27.67
	7.00	10	13.00	15.00	13.83	6.50	8.71	19.17	21.67
	8.00	11	18.50	19.33	18.83	7.10	10.71	21.17	23.00
	9.00	11	20.75	21.00	20.83	7.10	10.71	21.17	23.00
	10.00	12	23.50	25.67	24.33	9.70	10.57	22.33	26.50
	11.00	13	26.50	28.33	27.17	8.30	9.00	23.17	25.83
	12.00	17	31.25	31.67	31.33	10.30	13.29	29.67	33.17
	13.00	20	32.00	31.50	32.00	12.10	18.00	33.00	35.33
38	5.00	7	5.67	8.67	7.17	6.10	8.29	11.83	12.00
	6.00	8	11.75	13.00	12.17	6.50	6.43	12.33	14.83
	7.00	8	15.00	16.00	15.33	6.50	6.43	12.33	14.83
	8.00	8	18.75	20.33	19.33	6.50	6.43	12.33	14.83

	9.00	8	24.00	26.33	24.83	6.50	6.43	12.33	14.83
	10.00	8	27.50	28.67	27.83	6.50	6.43	12.33	14.83
	11.00	9	26.50	25.33	26.33	10.50	9.43	22.17	28.17
	12.00	10	31.25	32.33	31.67	9.30	9.71	19.17	22.17
	13.00	12	32.50	34.00	33.00	12.50	9.57	26.00	32.83
	14.00	14	38.00	39.67	38.33	13.50	12.86	31.67	37.50
	15.00	20	40.25	41.67	40.83	15.90	12.00	35.17	43.00
	5.00	7	6.67	10.33	8.50	6.70	9.14	16.00	15.50
	6.00	9	14.25	17.33	15.33	7.70	9.29	18.00	19.33
	7.00	10	19.50	22.00	20.50	10.10	8.43	20.17	23.33
	8.00	11	24.50	27.00	25.50	8.70	10.14	22.67	27.33
	9.00	12	30.75	34.33	32.17	10.20	10.14	20.00	20.67
39	10.00	13	34.50	37.00	35.50	12.20	9.14	18.67	19.33
	11.00	14	37.50	38.67	37.83	12.40	11.00	23.00	26.00
	12.00	15	40.25	40.67	40.50	16.30	14.29	29.17	33.67
	13.00	17	43.25	44.67	43.83	18.90	7.43	24.50	36.00
	14.00	18	46.00	46.67	46.17	19.30	9.57	31.50	38.50
	15.00	20	48.00	48.67	48.17	19.70	11.86	31.67	38.00
	5.00	7	7.67	11.33	9.50	5.70	7.29	13.00	15.00
	6.00	8	14.50	16.00	15.17	6.10	6.71	10.83	12.33
	7.00	10	20.25	24.00	21.67	9.70	8.00	20.33	27.50
	8.00	11	25.50	27.00	26.00	9.50	9.71	19.17	22.17
	9.00	11	30.75	32.00	31.17	9.50	9.71	19.17	22.17
40	10.00	11	33.50	34.00	33.67	9.50	9.71	19.17	22.17
	11.00	12	35.25	37.33	36.00	12.30	9.57	26.00	32.83
	12.00	12	39.00	40.33	39.50	12.30	9.57	26.00	32.83
	13.00	15	40.50	43.00	41.50	13.10	12.86	31.67	37.50
	14.00	15	43.25	43.67	43.83	13.10	12.86	31.67	37.50

	15.00	20	47.50	48.67	47.83	15.70	8.86	33.17	41.50
41	5.00	7	4.00	7.00	5.50	3.50	5.43	8.00	9.00
	6.00	9	10.50	13.00	11.50	4.50	5.43	7.83	9.17
	7.00	11	15.75	17.00	16.17	4.70	7.14	11.00	11.67
	8.00	13	19.75	21.00	20.17	5.10	5.57	9.00	10.17
	9.00	14	22.00	23.00	22.33	9.40	6.57	18.33	23.83
	10.00	17	24.00	25.33	24.50	8.60	5.43	16.17	23.17
	11.00	20	26.25	26.33	26.33	9.90	6.29	17.17	26.50
42	5.00	7	6.00	9.00	7.50	6.10	8.00	12.17	17.67
	6.00	7	11.25	13.33	12.17	6.10	8.00	12.17	17.67
	7.00	9	14.75	17.33	15.83	7.10	7.00	17.67	23.67
	8.00	11	20.50	22.33	21.17	7.70	10.29	24.67	27.67
	9.00	13	22.75	23.33	23.00	9.10	8.57	24.83	30.00
	10.00	15	25.25	26.00	25.50	11.50	9.14	25.67	30.67
	11.00	16	27.75	28.33	28.00	12.90	9.00	28.67	35.00
	12.00	17	29.50	31.67	30.33	13.90	10.14	32.67	39.00
	13.00	20	32.50	34.33	33.33	14.70	13.57	37.00	42.17
43	5.00	7	4.67	7.00	5.83	3.30	6.00	8.67	9.00
	6.00	7	9.75	11.67	10.50	3.30	6.00	8.67	9.00
	7.00	9	13.50	15.33	14.33	4.30	5.86	8.83	9.17
	8.00	11	18.75	20.67	19.50	4.90	6.00	9.33	10.33
	9.00	12	22.00	22.67	22.33	4.50	5.86	10.50	11.67
	10.00	14	22.75	23.67	23.17	9.30	9.14	21.17	24.67
	11.00	16	24.00	24.33	24.17	8.70	7.14	20.00	23.83
	12.00	20	23.25	25.00	23.80	9.50	8.00	21.17	28.67
44	5.00	7	3.00	4.33	3.67	6.90	9.14	16.00	15.50
	6.00	7	6.25	8.00	6.83	6.90	9.14	16.00	15.50
	7.00	8	9.50	11.00	10.00	8.70	10.71	18.67	19.33

	8.00	9	12.00	12.67	12.33	10.10	11.57	22.17	23.33
	9.00	9	15.50	18.33	16.67	10.10	11.57	22.17	23.33
	10.00	10	22.75	23.67	23.00	12.70	8.57	21.17	26.83
	11.00	10	25.75	26.67	26.00	12.70	8.57	21.17	26.83
	12.00	11	27.50	29.67	28.33	8.70	10.14	20.00	20.67
	13.00	12	28.75	31.33	29.67	9.90	10.57	19.33	19.33
	14.00	13	32.00	34.33	33.00	12.10	11.00	23.00	26.00
	15.00	15	35.25	37.00	36.00	16.70	11.00	28.17	33.17
	16.00	18	39.00	40.50	39.60	18.90	7.43	24.50	36.00
	17.00	19	42.67	43.33	43.00	20.30	9.57	31.50	38.50
	18.00	20	44.00	46.00	44.80	20.70	13.17	31.67	38.00
45	5.00	7	5.00	6.67	5.83	2.70	8.43	11.33	11.67
	6.00	7	10.50	13.33	11.67	2.70	8.43	11.33	11.67
	7.00	7	15.00	15.67	15.33	2.70	8.43	11.33	11.67
	8.00	8	18.50	20.00	19.17	5.70	9.43	17.17	17.50
	9.00	11	23.25	24.33	23.83	6.90	9.00	22.50	27.17
	10.00	12	25.25	26.00	25.50	10.50	8.00	23.83	33.83
	11.00	13	27.75	28.67	28.00	12.30	8.29	27.00	34.17
	12.00	14	29.50	28.67	29.17	12.10	15.00	34.17	38.17
	13.00	16	31.50	32.00	31.67	12.70	8.00	22.67	34.50
	14.00	20	33.00	34.00	33.33	13.70	11.43	31.83	38.33
46	5.00	7	5.33	7.67	6.50	9.30	11.00	27.83	30.67
	6.00	7	11.75	12.33	12.00	9.30	11.00	27.83	30.67
	7.00	13	14.00	16.33	14.83	12.30	7.43	21.00	32.67
	8.00	13	20.25	21.33	20.67	12.30	7.43	21.00	32.67
	9.00	13	25.25	27.00	26.00	12.30	7.43	21.00	32.67
	10.00	13	29.00	30.33	29.50	12.30	7.43	21.00	32.67
	11.00	15	31.50	32.00	31.67	10.70	10.57	27.50	32.50

	12.00	17	33.25	34.00	33.50	11.70	9.71	26.33	34.33
	13.00	20	34.50	35.00	34.60	11.10	9.57	25.67	33.67
47	5.00	7	5.33	6.00	5.67	4.30	8.43	12.67	13.33
	6.00	8	11.00	12.33	11.67	5.90	9.29	15.00	15.67
	7.00	10	15.50	15.67	15.50	6.90	10.71	19.17	19.67
	8.00	13	22.75	25.67	23.67	10.90	12.57	32.17	38.50
	9.00	13	27.25	29.33	27.83	10.90	12.57	32.17	38.50
	10.00	18	30.25	32.00	30.83	12.30	10.00	31.67	39.83
	11.00	18	34.25	35.67	34.83	12.30	10.00	31.67	39.83
	12.00	20	36.75	38.33	37.50	10.90	11.57	28.33	33.17
48	5.00	7	6.67	8.67	7.67	8.70	7.71	23.50	27.83
	6.00	7	13.00	15.33	13.67	8.70	7.71	23.50	27.83
	7.00	11	15.25	17.00	16.00	8.50	11.29	26.00	27.67
	8.00	11	18.00	20.00	18.83	8.50	11.29	26.00	27.67
	9.00	11	22.50	23.67	23.00	8.50	11.29	26.00	27.67
	10.00	13	25.25	26.00	25.67	10.90	9.43	26.33	31.33
	11.00	17	27.25	28.00	27.50	12.50	9.71	26.83	30.33
	12.00	20	29.25	29.67	29.33	11.70	10.57	24.83	29.33
49	5.00	7	5.00	9.00	7.00	4.70	8.43	11.00	12.50
	6.00	9	12.00	14.67	13.00	5.50	7.29	11.50	13.50
	7.00	11	18.25	21.33	19.50	6.90	7.43	17.00	25.00
	8.00	12	23.50	24.67	24.00	7.10	7.43	18.50	23.33
	9.00	13	26.50	27.33	26.83	8.70	8.14	19.00	28.17
	10.00	13	29.00	30.33	29.50	8.70	8.14	19.00	28.17
	11.00	14	31.00	31.00	31.00	10.10	8.00	22.83	30.67
	12.00	14	34.75	35.33	34.83	10.10	8.00	22.83	30.67
	13.00	16	37.00	38.67	37.67	13.50	10.00	31.33	39.00
	14.00	17	41.25	44.00	42.33	15.70	9.57	31.50	43.17

	15.00	20	44.50	45.67	45.00	17.10	9.43	32.00	45.00
50	5.00	7	5.00	6.00	5.50	3.70	8.00	11.67	12.83
	6.00	9	11.25	14.33	12.33	8.70	9.86	24.00	33.67
	7.00	11	15.00	19.33	16.83	6.50	9.00	15.83	19.50
	8.00	12	23.00	25.33	24.17	7.30	7.57	12.33	17.50
	9.00	12	28.75	32.00	29.83	7.30	7.57	12.33	17.50
	10.00	13	32.50	33.00	32.83	8.90	9.14	20.00	32.50
	11.00	14	35.00	38.00	36.17	9.70	11.14	22.33	34.67
	12.00	14	39.75	40.67	40.00	9.70	11.14	22.33	34.67
	13.00	15	40.25	36.00	38.83	10.00	10.14	23.50	36.00
	14.00	18	37.75	40.67	38.83	17.50	8.71	20.67	45.00
	15.00	20	42.50	46.00	44.33	17.90	10.57	22.33	37.00
51	5.00	7	5.33	7.33	6.33	3.30	7.86	11.33	11.00
	6.00	9	11.00	11.00	11.17	5.50	10.86	16.33	14.33
	7.00	11	13.25	14.33	13.50	6.10	8.14	14.50	16.83
	8.00	13	16.50	17.33	16.83	10.70	8.43	26.50	31.67
	9.00	13	18.50	20.00	19.17	10.70	8.43	26.50	31.67
	10.00	15	23.25	23.67	23.33	12.50	8.86	24.67	34.83
	11.00	15	27.75	28.00	27.83	12.50	8.86	24.67	34.83
	12.00	18	28.25	28.33	28.33	14.70	7.86	23.00	36.83
	13.00	19	32.50	35.00	33.33	12.10	6.86	17.50	31.17
	14.00	20	35.75	36.67	36.17	17.90	8.86	22.50	39.00
52	5.00	7	5.33	9.67	7.50	4.10	8.71	12.33	12.33
	6.00	7	13.50	14.67	14.00	4.10	8.71	12.33	12.33
	7.00	8	16.50	18.67	17.50	4.50	7.14	9.50	11.33
	8.00	8	22.50	23.33	22.83	4.50	7.14	9.50	11.33
	9.00	8	24.50	24.67	24.67	4.50	7.14	9.50	11.33
	10.00	9	26.75	27.00	26.83	5.10	6.86	10.17	12.33

	11.00	9	28.75	29.67	29.00	5.10	6.86	10.17	12.33
	12.00	10	30.50	32.33	31.33	5.30	7.71	12.33	14.17
	13.00	11	33.25	33.00	33.17	6.50	9.71	15.33	17.00
	14.00	13	34.00	34.33	34.00	12.90	13.29	31.33	35.83
	15.00	15	37.50	39.33	38.00	16.30	13.71	34.50	39.17
	16.00	16	40.33	42.50	41.20	16.50	11.00	30.00	34.83
	17.00	20	44.00	45.00	44.40	17.90	12.00	30.83	38.33
53	5.00	8	5.67	11.67	8.67	5.70	9.71	15.17	15.83
	6.00	9	12.50	13.33	12.83	6.50	10.00	18.17	17.67
	7.00	12	14.50	17.33	15.67	8.70	10.57	25.50	27.33
	8.00	14	22.25	23.00	22.33	12.50	11.86	29.83	34.33
	9.00	15	25.25	26.67	25.67	11.50	11.00	30.83	35.50
	10.00	17	27.00	28.67	27.67	12.90	13.71	32.83	38.17
	11.00	19	30.75	30.67	30.67	14.30	10.43	31.67	36.83
	12.00	19	33.50	34.00	33.67	14.30	10.43	31.67	36.83
	13.00	19	34.50	35.67	35.17	14.30	10.43	31.67	36.83
	14.00	20	39.00	40.67	39.67	14.10	15.29	36.00	37.83
54	5.00	7	5.33	9.00	7.17	9.10	4.71	8.00	11.17
	6.00	7	12.50	14.33	13.17	9.10	4.71	8.00	11.17
	7.00	8	15.75	18.33	16.83	7.50	4.71	8.67	13.67
	8.00	9	23.75	27.00	25.00	9.30	16.29	29.83	29.50
	9.00	12	27.25	28.33	27.83	11.10	7.43	21.00	32.50
	10.00	12	29.75	30.67	30.17	11.10	7.43	21.00	32.50
	11.00	15	32.25	32.33	32.33	10.50	8.29	23.00	33.00
	12.00	15	33.50	34.33	34.00	10.50	8.29	23.00	33.00
	13.00	17	34.75	36.00	35.33	10.70	10.57	27.50	32.50
	14.00	20	38.00	38.00	38.00	11.10	9.71	26.33	34.33
55	5.00	7	6.00	11.00	8.50	4.40	13.14	11.83	12.33

	6.00	7	13.50	16.00	14.50	4.40	13.14	11.83	12.33
	7.00	9	16.25	17.67	16.83	4.40	7.00	8.83	11.17
	8.00	10	21.50	24.33	22.67	5.20	6.43	9.50	12.00
	9.00	10	28.25	28.33	28.17	5.20	6.43	9.50	12.00
	10.00	11	29.75	30.67	30.00	6.30	9.14	13.33	13.50
	11.00	11	32.00	32.67	32.17	6.30	9.14	13.33	13.50
	12.00	12	34.75	34.67	34.83	6.70	9.71	15.33	17.00
	13.00	12	37.25	38.33	37.50	6.70	9.71	15.33	17.00
	14.00	14	40.50	40.67	40.50	12.90	16.57	32.67	36.00
	15.00	15	43.25	44.33	43.67	15.10	8.86	28.00	34.33
	16.00	17	47.33	48.50	47.80	15.80	8.14	26.00	36.17
	17.00	20	50.00	51.50	50.60	17.70	13.71	34.50	39.17
	5.00	7	5.67	9.00	7.33	3.60	6.71	10.83	11.17
	6.00	7	11.25	13.00	12.00	3.60	6.71	10.83	11.17
	7.00	9	15.25	16.67	15.83	5.40	7.00	16.50	14.33
	8.00	10	18.50	21.67	19.67	6.20	6.57	11.50	15.83
56	9.00	11	23.75	25.67	24.50	12.30	7.57	21.33	34.33
	10.00	12	25.75	27.67	26.50	10.70	6.86	24.00	31.67
	11.00	14	28.75	30.00	29.17	12.30	6.29	14.83	29.50
	12.00	15	31.00	33.33	32.00	14.50	9.29	26.33	37.00
	13.00	20	36.50	36.67	36.67	17.40	6.71	17.17	34.33
	5.00	7	5.00	9.33	7.17	6.30	8.00	12.17	17.67
	6.00	9	11.75	14.00	12.83	7.00	7.00	17.67	23.67
	7.00	11	15.50	17.67	16.33	7.90	7.33	18.33	26.67
57	8.00	13	20.75	22.33	21.33	8.90	7.86	20.83	27.17
	9.00	13	24.25	25.67	24.83	8.90	7.86	20.83	27.17
	10.00	15	28.50	30.33	29.33	12.70	9.00	28.67	35.00
	11.00	16	32.50	34.33	33.33	11.80	7.29	23.67	30.33

	12.00	18	36.00	38.33	37.00	13.60	6.71	26.33	37.67
	13.00	20	40.25	43.00	41.33	14.50	8.57	31.50	41.50
	5.00	7	7.33	10.00	8.67	7.90	8.57	22.00	27.50
	6.00	7	13.00	15.33	13.83	7.90	8.57	22.00	27.50
	7.00	9	17.75	20.33	18.67	6.20	7.57	17.83	21.67
	8.00	10	22.25	25.33	23.50	6.80	8.71	21.33	25.83
58	9.00	10	27.75	28.67	28.00	6.80	8.71	21.33	25.83
	10.00	15	29.25	30.33	29.67	8.50	12.57	21.67	23.33
	11.00	15	32.50	32.00	32.17	8.50	12.57	21.67	23.33
	12.00	18	35.50	34.33	34.67	10.00	13.29	29.67	33.17
	13.00	20	37.50	37.33	37.50	11.80	11.29	31.33	34.67
	5.00	8	4.33	6.00	5.17	5.50	5.57	12.83	19.00
	6.00	11	9.00	11.33	9.67	8.70	6.43	14.17	21.83
	7.00	12	15.25	18.00	16.33	8.30	5.86	15.33	26.50
	8.00	12	19.50	20.67	19.83	8.30	5.86	15.33	26.50
59	9.00	13	22.75	24.33	23.50	11.00	5.71	17.50	29.00
	10.00	13	27.00	26.67	26.83	11.00	5.71	17.50	29.00
	11.00	14	28.25	29.33	28.67	11.40	7.00	21.50	32.00
	12.00	17	31.50	32.67	31.83	12.10	6.43	21.17	30.17
	13.00	20	34.75	35.50	34.80	13.50	12.57	31.33	37.17
	5.00	7	6.67	8.67	7.67	4.50	8.43	11.00	12.50
	6.00	7	16.00	20.33	17.50	4.50	8.43	11.00	12.50
	7.00	9	19.75	20.67	20.33	5.30	8.14	11.83	13.83
	8.00	10	22.25	24.67	23.33	6.80	6.71	14.83	24.67
60	9.00	11	29.00	31.33	30.00	9.50	12.00	26.83	31.83
	10.00	12	32.50	33.33	33.00	8.70	7.14	17.00	27.17
	11.00	13	33.75	34.33	34.17	7.10	10.43	21.00	22.17
	12.00	13	35.50	37.00	36.33	7.10	10.43	21.00	22.17

	13.00	13	39.25	40.00	39.67	7.10	10.43	21.00	22.17
	14.00	14	40.75	41.33	41.00	12.70	8.14	28.33	38.17
	15.00	15	42.75	44.00	43.33	15.70	6.71	24.33	40.50
	16.00	20	45.67	47.00	46.20	16.80	6.86	23.00	43.50
61	5.00	7	6.00	8.33	7.17	2.50	7.86	11.17	11.67
	6.00	7	12.00	12.67	12.33	2.50	7.86	11.17	11.67
	7.00	8	16.00	19.00	17.17	5.10	7.29	15.67	17.83
	8.00	10	22.75	23.67	23.17	6.70	9.00	22.50	27.17
	9.00	11	25.00	25.67	25.17	9.90	8.00	23.83	33.83
	10.00	12	26.75	27.33	26.83	11.30	8.29	27.00	34.17
	11.00	15	26.25	27.67	26.83	12.40	8.00	22.67	34.50
	12.00	17	30.25	31.67	30.83	12.10	15.00	34.17	38.17
	13.00	20	32.75	33.33	33.00	13.40	11.43	31.33	38.00
62	5.00	8	6.00	9.67	7.83	6.50	10.00	18.17	17.67
	6.00	8	11.75	14.00	12.50	6.50	10.00	18.17	17.67
	7.00	10	15.25	16.33	15.67	5.40	6.43	10.33	15.17
	8.00	12	18.75	20.67	19.50	12.50	7.29	25.67	33.67
	9.00	14	24.25	26.00	25.00	8.30	10.57	25.50	27.33
	10.00	14	28.00	27.33	27.67	8.30	10.57	25.50	27.33
	11.00	14	28.75	30.33	29.17	8.30	10.57	25.50	27.33
	12.00	15	31.75	33.00	32.17	11.50	18.14	32.50	35.67
	13.00	17	35.25	36.67	35.83	12.70	8.29	29.17	37.00
	14.00	20	37.00	38.67	37.67	14.00	6.57	26.67	35.33
63	5.00	7	5.00	7.33	6.17	5.40	8.43	14.17	17.50
	6.00	9	11.25	12.67	11.83	5.80	7.14	13.33	16.67
	7.00	12	14.50	15.00	14.67	7.90	8.43	19.83	26.17
	8.00	12	16.75	19.00	17.67	7.90	8.43	19.83	26.17
	9.00	14	23.25	25.00	24.00	9.50	9.43	23.33	30.33

	10.00	14	25.75	27.00	26.17	9.50	9.43	23.33	30.33
	11.00	15	27.25	28.33	27.67	10.40	7.43	13.17	20.33
	12.00	17	30.25	31.00	30.50	11.90	11.43	28.83	35.17
	13.00	17	32.00	33.33	32.67	11.90	11.43	28.83	35.17
	14.00	20	35.50	37.33	36.33	12.00	10.43	26.83	35.33
64	5.00	7	4.00	6.33	5.17	3.90	9.71	13.67	13.17
	6.00	10	11.00	13.33	11.83	4.30	8.00	12.83	13.00
	7.00	12	15.25	16.67	15.83	4.10	9.29	14.00	13.83
	8.00	14	19.50	21.00	20.00	4.50	8.14	14.17	14.67
	9.00	17	21.50	22.33	21.83	5.90	6.71	15.83	20.33
	10.00	18	23.50	24.00	23.67	6.10	10.29	18.83	20.17
	11.00	20	25.00	26.00	25.50	7.70	11.00	21.00	22.17
65	5.00	7	5.33	6.33	5.83	5.30	6.71	9.67	10.50
	6.00	7	8.00	8.67	8.17	5.30	6.71	9.67	10.50
	7.00	9	11.00	12.00	11.33	5.80	6.86	14.83	17.67
	8.00	13	14.50	16.67	15.33	7.50	5.86	9.17	15.33
	9.00	13	17.50	18.67	18.00	7.50	5.86	9.17	15.33
	10.00	17	20.50	22.33	21.17	10.20	7.00	19.50	24.83
	11.00	20	22.75	24.33	23.50	11.10	7.57	19.67	27.83
66	5.00	7	7.33	11.67	9.50	5.50	6.86	9.33	10.00
	6.00	10	14.25	15.67	14.83	7.00	6.71	9.33	11.00
	7.00	13	18.75	20.67	19.50	7.40	6.57	12.83	14.00
	8.00	15	21.75	22.33	22.00	10.20	7.43	14.17	17.33
	9.00	17	23.25	24.00	23.50	11.50	6.43	17.67	24.83
	10.00	20	25.25	26.00	25.50	12.40	9.14	24.00	28.83
67	5.00	9	5.00	8.33	6.67	4.00	8.00	14.17	16.83
	6.00	11	12.25	13.00	12.50	4.50	8.43	19.83	26.17
	7.00	13	13.25	14.00	13.50	4.90	11.00	25.17	31.17

	8.00	14	16.00	16.67	16.33	5.10	11.00	24.33	30.33
	9.00	16	21.25	23.00	21.83	9.50	10.57	24.17	33.17
	10.00	20	25.50	27.00	26.17	11.20	13.43	29.50	33.83

APPENDIX B - CONSENT TERM CEP

UNIVERSIDADE FEDERAL DE PERNAMBUCO

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO
(PARA MAIORES DE 18 ANOS OU EMANCIPADOS - Resolução 466/12)

Convidamos o(a) Sr.(a) para participar como voluntário(a) da pesquisa "**VALIDADE DA ESCALA DE BORG 6-20 PARA A PRESCRIÇÃO DE EXERCÍCIO AERÓBICO EM ESTEIRA**", que está sob a responsabilidade do pesquisador Prof. Danilo Edson de Souza, com endereço Rua Candido Ferreira, 709, Piedade, CEP: 54400-100 – Jaboatão dos Guararapes – PE /(81)996554246 / e-mail: daniloeds@gmail.com. Também participam desta pesquisa: Prof. Dr. Vinicius Oliveira Damasceno, Telefone: (81) 981751068.

Este Termo de Consentimento pode conter alguns tópicos que o(a) senhor(a) não entenda. Caso haja alguma dúvida, pergunte à pessoa a quem está lhe entrevistando, para que o(a) senhor(a) esteja totalmente esclarecido(a) sobre tudo que está respondendo. Após os esclarecimentos, caso aceite em fazer parte do estudo, rubrique as folhas e assine ao final deste documento, que está em duas vias. Uma delas é sua e a outra é do pesquisador responsável que está lhe entrevistando. Em caso de recusa o(a) Sr.(a) não será penalizado(a) de forma alguma. Também garantimos que o(a) Senhor(a) tem o direito de retirar o consentimento da sua participação em qualquer fase da pesquisa, sem qualquer penalidade.

INFORMAÇÕES SOBRE A PESQUISA:

O objetivo deste estudo consiste em validar a escala Borg 6-20 para prescrição de exercício aeróbico em esteira. A escala de Borg 6-20 é um instrumento formado por 15 categorias numeradas de 6 a 20, convencionalmente usada para quantificar a intensidade do exercício de forma subjetiva, baseada na percepção do indivíduo durante ou após a realização da atividade. Esta pesquisa terá duração total de 6 meses, incluso as 12 semanas das intervenções e as três semanas para avaliação. Contaremos com sua participação durante 6 visitas, nessas 15 semanas, seguindo os protocolos deste estudo. Todas as rotinas e procedimentos realizados serão explicados pelo pesquisador. Durante os testes e nas intervenções certificaremos, que mesmo remota, existe a possibilidade de risco para dor muscular, sensação de fadiga e lesão osteomioarticular (lesões nos ossos, músculos e articulações do corpo) porém de caráter remoto. Será aplicado o questionário de Screening pré-exercício (AHA/ACSM, 2014) que é um instrumento usado para identificar os riscos a saúde relacionado a doenças pré-existentes, com o intuito de direcionar a conduta adequada para prescrição de exercício. Como o teste aeróbio lhe levará o máximo do esforço, este terá acompanhamento de dois profissionais para sua segurança. Em caso de intercorrência os indivíduos serão socorridos para UPA na Av. Joaquim Ribeiro, s/n - Iputinga, Recife - PE, 50980-000. Sendo de total responsabilidade do pesquisador responsável o suporte a intercorrências, socorro imediato e suporte financeiro a eventuais despesas. Ao término do estudo, o senhor receberá os seus resultados obtidos em cada teste para uso particular, visto que, essas informações podem trazer benefício para futuras prescrições de exercício feitas por profissionais de educação física de sua confiança.

As informações desta pesquisa serão confidencias e serão divulgadas apenas em eventos ou publicações científicas, não havendo identificação dos voluntários, a não ser entre os responsáveis pelo estudo, sendo assegurado o sigilo sobre a sua participação. Os dados

coletados nesta pesquisa (estratificação de risco (AHA/ACSM, 2014), antropometria, composição corporal, teste de exercício incremental máximo), ficarão armazenados em pastas e no computador pessoal, sob a responsabilidade do pesquisador Prof. Dr. Vinicius de Oliveira Damasceno, no endereço acima informado acima, pelo período de mínimo de cinco anos. No endereço Av. Jornalista Anibal Fernandes, s/n, CDU, CEP: 50670-901 – Recife – PE/ (81) 2126-8506 (inclusive ligações a cobrar).

O (a) senhor (a) não pagará nada para participar desta pesquisa. Se houver necessidade, as despesas para a sua participação serão assumidos pelos pesquisadores (ressarcimento de transporte e alimentação). Fica também garantida indenização em casos de danos, comprovadamente decorrentes da participação na pesquisa, conforme decisão judicial ou extrajudicial.

Em caso de dúvidas relacionadas aos aspectos éticos deste estudo, você poderá consultar o Comitê de Ética em Pesquisa Envolvendo Seres Humanos da UFPE no endereço: **(Avenida da Engenharia s/n – 1º Andar, sala 4 - Cidade Universitária, Recife-PE, CEP: 50740-600, Tel.: (81) 2126.8588 – e-mail: cepccs@ufpe.br).**

Pesquisador Responsável: _____
(Prof. Danilo Edson de Souza)

CONSENTIMENTO DA PARTICIPAÇÃO DA PESSOA COMO VOLUNTÁRIO(A)

Eu, _____, CPF _____, abaixo assinado, após a leitura (ou a escuta da leitura) deste documento e de ter tido a oportunidade de conversar e ter esclarecido as minhas dúvidas com o pesquisador responsável, concordo em participar do estudo "**VALIDADE DA ESCALA DE BORG 6-20 PARA A PRESCRIÇÃO DE EXERCÍCIO AERÓBICO EM ESTEIRA**", como voluntário (a). Fui devidamente informado (a) e esclarecido (a) pelo(a) pesquisador (a) sobre a pesquisa, os procedimentos nela envolvidos, assim como os possíveis riscos e benefícios decorrentes de minha participação. Foi-me garantido que posso retirar o meu consentimento a qualquer momento, sem que isto leve a qualquer penalidade ou interrupção de meu acompanhamento.

Local e data _____

Assinatura do participante: _____

Presenciamos a solicitação de consentimento, esclarecimentos sobre a pesquisa e o aceite do voluntário em participar. (02 testemunhas não ligadas à equipe de pesquisadores):

Nome:	Nome:
Assinatura:	Assinatura:

ATTACHMENT A - RESEARCH ETHICS COMMITTEE

UNIVERSIDADE FEDERAL DE PERNAMBUCO CENTRO DE CIÊNCIAS DA SAÚDE / UFPE-

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: VALIDADE DA ESCALA DE BORG 6-20 PARA PRESCRIÇÃO DO EXERCÍCIO AERÓBICO EM ESTEIRA

Pesquisador: Danilo Edson de Souza

Área Temática:

Versão: 3

CAAE: 83453418.7.0000.5208

Instituição Proponente: Pós-Graduação em Educação Física

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.707.294

AUTHORIZATIONTTACHMENT B - QUESTIONNAIRE FOR PRE-PARTICIPATION STRATIFICATION IN PHYSICAL ACTIVITY PROGRAMS AHA/ACSM

Questionário do AHA/ACSM para Estratificação Pré-participação em Programas de Atividades Físicas

Para avaliar a sua condição de saúde, assinale todas as afirmativas que são verdadeiras:

Histórico

Você tem ou já teve:
___ Um ataque cardíaco.
___ Uma cirurgia cardíaca.
___ Uma cateterização cardíaca.
___ Uma angioplastia coronária.
___ Um implante de marcapasso.
___ Uma desfibrilação ou distúrbio de ritmo cardíaco.
___ Uma doença da válvula cardíaca.
___ Um colapso cardíaco.
___ Um transplante cardíaco.
___ Uma doença cardíaca congênita.

Sintomas

___ Você já experimentou desconforto no peito com o esforço.
___ Você já experimentou uma falta de ar súbita.
___ Você já experimentou tonturas, desmaios ou perda de sentidos.
___ Você usa ou já usou medicações para o coração.

Outras Questões de Saúde

___ Você tem diabetes.
___ Você possui asma ou outra doença pulmonar.
___ Você já sentiu queimação ou câimbras em seus membros inferiores ao caminhar distâncias curtas.
___ Você tem algum problema músculo-esquelético que limite sua prática de atividade física.
___ Você tem preocupações quanto a segurança de se exercitar.
___ Você tem alguma prescrição para medicação(ões).
___ Se do sexo feminino, você está grávida.
___ Você possui alguma doença da tireóide, dos rins ou do fígado.

CONCLUSÃO 1

Se você marcou qualquer um dos itens nesta seção, consulte o seu médico ou outro profissional de saúde antes de se engajar em um programa de exercícios. Você pode necessitar de uma estrutura que disponha de supervisão médica especializada.

Fatores de Risco Cardiovasculares

Se homem:
___ Você tem 45 anos ou mais.
Se mulher:
___ Você tem 55 anos ou mais ou já fez histerectomia ou está em pós-menopausa.
Para todos:
___ Você fuma ou parou de fumar há menos de 6 meses.
___ Sua **pressão**:
- **sistólica** é maior ou igual a 140 mmHg e/ou **diastólica** é maior ou igual a 90 mmHg, ou;
- é controlada por alguma medicação, ou;
- é desconhecida por você.

___ Seu **colesterol** sangüíneo:
- **total** é maior que 200 mg/dL, ou;
- **LDL** é maior do que 130 mg/dL, ou;
- **HDL** é menor do 40 mg/dL, ou;
- é desconhecido por você.

___ O seu pai ou irmão (antes dos 55 anos) ou mãe e irmã (antes dos 65 anos), teve/tiveram um ataque cardíaco ou fez/fizeram uma cirurgia cardíaca.
___ Seu **açúcar sangüíneo**:
- apresenta níveis acima de 100 mg/dL, ou;
- é desconhecido por você.

___ Você faz menos que 120 min por semana de atividades físicas moderadas (que levem a um discreto aumento da respiração).
___ Você está mais que 9 kg acima do seu peso.

CONCLUSÃO 2

Se você marcou mais do que um item nesta seção, consulte o seu médico ou outro profissional de saúde antes de se engajar em um programa de exercícios. Você pode se beneficiar pela utilização de uma estrutura de atividades físicas que disponibilize supervisão profissional qualificada para orientar seu programa de exercícios.

Outros

___ Nenhuma das afirmativas nos itens **Histórico**, **Sintomas** ou **Outras Questões de Saúde** e no máximo um item em **Fatores de Risco Cardiovasculares**.

CONCLUSÃO 3

Você está apto a iniciar seu programa de exercícios sem consultar o seu médico ou outro profissional de saúde em um programa auto-orientado ou em quase todos os centros de atividades físicas que atendam às suas necessidades para um programa de exercícios.

Adaptado por Tony Meireles dos Santos (2008) de ACSM (1998). Recommendations for Cardiovascular Staffing, and Emergency Policies at Health/Fitness Facilities. MSSE 30(6): 1009-1018 com base no ACSM (2006). ACSM Guidelines for exercise testing and prescription. Baltimore: Lyppincott Williams & Wilkins.

ATTACHMENT C – BORG 6-20 Scale