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Relationship between Category of Weight and Threshold of Maximum Oxidation of Lipids in Congolese Judoists

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Abstract

Background: One of the goals for training in judo is to mimic real situations. In subsaharian countries; there is a lack of knowledge considering relation between category of weight and threshold maximum oxidation of lipids. **Objectives:** The main objectives of this study were to analyze the effect of category of weight on $lipox_{max}$ and to identify the zones of target intensities corresponding to $lipox_{max}$. **Materials and Methods:** Twenty four male well-training judoists, divided in two groups according to weight, were evaluated during calorimetry effort' test. For this situation, cardiorespiratory parameters (HR, VO_2, VO_{2max}), blood parameter (lactatemia), anthropometric variables and zones of target corresponding to lipox were evaluated. For statistical analysis, Shapiro-Wilks test was used to compare all the data and differences were confirmed by one-way variance. **Results:** No significant differences were observed among two groups for target intensities to lipox. The judoists of group 1 were aged to 24.1 ± 5.9 years with 1.78 ± 0.07 m *versus* 20.4 ± 1.6 years with 1.86 ± 0.04 m. Primary results indicated higher intensities for $lipox_{max}$. Also, values of power (% LDC) and VO_2 and were significantly higher in the judoists for group 2, with respectively: 45.3 ± 10.2 and 46.4 ± 8.6 ml/min *versus* 38.2 ± 7.2 and 31.3 ± 7.6 ml/min. **Conclusion:** High weight in judoists induces high intensities of $lipox_{max}$ and change oxidation of lipids markers following training.

Keywords

Judo, Oxidation of Lipids, $Lipox_{max}$, Weight Category

1. Introduction

The most important role played by glucides and lipids energy supply for cell functions bias substrates used by aerobic metabolism to provide energy to the muscles at the time of average and long duration exercises [1] [2]. To oxidize maximum of lipids, the literature reveals that intensity's effort ranging between 31% and 63% of oxygen maximum uptake (VO_2 max) must be generally carried out [3] [4] [5]. However, the width of this zone of intensity makes that it is difficult to prescribe the intensity corresponding to the point of maximum oxidation of the lipids ($Lipox_{max}$. This observation can be explained by heterogeneity of studied populations, particularly in terms of level of performance. Indeed, the aerobic drive generally produces an increase in the maximum flow of oxidation of the lipids (DMOL) and a shift towards the line of $Lipox_{max}$ [6]. Consequently, sportsmen must involve themselves with intensities of exercise higher than sedentary subjects, to oxidize a maximum of lipids [7]. However, according to our knowledge, no study studied $Lipox_{max}$ of judoists. This specific combat sport has a combination of rules that confers singular characteristics to judo (e.g., grappling-based techniques or striking-based techniques; scoring system; time duration of round; distribution of gender; organization in weight divisions) [8]. Despite these characteristics, studies have shown that judois regarded as a combat sport on high level intensity and intermittent sport [9] [10]. However, judo is a sport with dominant anaerobic-aerobic way; it is characterized by seven categories of weight: <60 kg; <66 kg; <73 kg; <81 kg; <90 kg; <100 kg; >100 kg according to recommendations of International Federation of Judo (IFJ). Another important characteristic of judo is the long duration of a competitive event. While a professional fight may last up to five 5-minute, judo may perform up to seven matches in the same day. Consequently, if $Lipox_{max}$ is similar in the judoists of less than 66 kg and those of 90 kg, it will be then possible to establish a narrow zone of intensities target common making it possible to prescribe $Lipox_{max}$ precisely.

This study aimed thus to examine the influence of the category of weight on $Lipox_{max}$ of the judoists, like identifying the zones of target intensities corresponding to $Lipox_{max}$. Insofar as the lipids (triglycerides) stored in the organization constitute one of two principal sources of energy during muscular exercise, a better comprehension of the metabolism of fat during the training in the judoists of various categories proves to be necessary.

2. Materials and Methods

2.1. Subjects

For this study, 24 judoists, aged from 18 to 35 years, all involved on the high level but of different categories of weight, were recruited (**Table 1** and **Table 2**). These judoists were separate in two groups according to their category of weight (**Table 1** and **Table 2**). Group 1 consisted of 17 judoists of less than 66 kg, group 2 formed of 7 judoists of more than 90 kg.

Table 1. Anthropometric characteristics, physiological and related to the training of the 17 judoists of group 1 and the 24 judoists (group 1 and 2).

	Group 1		Together of the 24 judoists		P
	Mean ± SD	CI 95%	Mean ± SD	CI 95%	
Age (years)	24.1 ± 5.9	2.7	22.2 ± 5.3	2.1	0.03
Height (cm)	178.0 ± 7.0	3.0	182.0 ± 6.0	2.0	0.47
Body mass (kg)	64.2 ± 1.1	2.8	83.8 ± 0.6	2.3	0.001
Lubricate (%)	12.4 ± 1.9	0.9	15.3 ± 1.9	0.7	0.24
Experiment (years)	9.4 ± 5.3	2.4	9.9 ± 4.6	1.8	0.49
Weekly volume of drive (h)	9.9 ± 2.7	1.3	11.4 ± 3.6	1.4	<0.01
LDC (w)	343 ± 25	11	345 ± 24	10	0.92
VO_2 max (ml/min)	4345 ± 430	199	5903.7 ± 727.0	156	0.75
VO_2 max (ml/kg/min)	69.2 ± 2.1	3.1	63.8 ± 2.7	2.5	0.39
RQmax	1.11 ± 0.05	0.02	1.24 ± 0.07	0.03	0.12
FCmax (bpm)	192 ± 8	4	194 ± 8	3	0.26
[La^-] (mmol/l)	12.8 ± 2.6	1.2	13.1 ± 2.7	1.1	0.58
RPEmax	19.1 ± 1.1	0.5	19.1 ± 1.1	0.4	0.48

Abbreviations: p, level of significance; LDC, aerobic maximum power; VO_2 max, maximum consumption of oxygen; QRmax, respiratory quotient maximum; FC max, maximum heart rate; [La^-], maximum lactatemy; RPEmax, maximum perception of the effort.

Table 2. Anthropometric characteristics, physiological and related to the training of the 7 judoists of group 2 and the 24 judoists (group 1 and 2).

	Group 2		Together of the 24 judoists		P
	Mean ± SD	CI 95%	Mean ± SD	CI 95%	
Age (years)	20.4 ± 1.6	1.4	22.2 ± 5.3	2.1	0.03
Height (cm)	186.0 ± 4.2	3.1	178.0 ± 6.0	2.0	0.36
Body mass (kg)	103.4 ± 0.8	1.4	83.8 ± 0.6	2.3	0.001
Lubricate (%)	18.2 ± 0.3	1.0	15.3 ± 1.9	0.7	0.23
Experiment (years)	11.0 ± 2.2	1.6	9.9 ± 4.6	1.8	0.49
Weekly volume of drive (h)	15.0 ± 1.9	2.2	11.4 ± 3.6	1.4	<0.001
LDC (w)	350 ± 25	19	345 ± 24	10	0.92
VO_2 max (ml/min)	6462.5 ± 1024.0	417	5903.7 ± 727.0	156	0.75
VO_2 max (ml/kg/min)	62.5 ± 5.0	3.7	63.8 ± 3.4	2.5	0.39
RQmax	1.38 ± 0.08	0.06	1.24 ± 0.07	0.03	0.32
FCmax (bpm)	199 ± 7	5	194 ± 8	3	0.26
[La^-] (mmol/l)	14.0 ± 3.3	2.4	13.1 ± 2.7	1.1	0.58
RPEmax	19.0 ± 1.2	0.9	19.1 ± 1.1	0.4	0.48

Abbreviations: p, level of significance; LDC, aerobic maximum power; VO_2 max, maximum consumption of oxygen; QRmax, respiratory quotient maximum; FC max, maximum heart rate; [La^-], maximum lactatemy; RPEmax, maximum perception of the effort.

2.2. Material

2.2.1. Cycloergometer

The test of calorimetry of effort was led on a cycloergometer to electromagnetic brake (Ergoline S 300, Medisoft® Dinant, Belgium). This cycloergometer made it possible to the judoists to maintain a power selected by adjustments of resistance according to the cycling frequency.

2.2.2. Cardiorespiratory Parameters

The effort was evaluated by calorimetrytest with an electrocardiogram with 12 ways (Medcard, Medisoft® Sorinnes, Belgium) which was connected to the analyzer of gaseous exchange. The oxygen uptake (VO_2 max), the production of carbon dioxide (VCO_2) and the respiratory quotient (RQ) were measured in cycle with cycle with a measuring equipment in open circuit (Ergocard, Medisoft® Dinant, Belgium). Data-processing software used Exp'air (Medisoft® Dinant, Belgium). This apparatus was gauged according to recommendations' of the manufacturer. A syringe of 3l (Calibration pump, Medisoft® Dinant, Belgium) was used for the calibration of volumes, while the calibration of gases was carried out thanks to the ambient air (*i.e.*, environmental temperature and atmospheric pressure) and to a gas standard, whose concentrations were known (16% of oxygen and 4% of CO_2).

2.2.3. Blood Parameters

The blood concentration in lactates [La^-] was determined by a system of analysis ABL800Flox (Radiometer medical® Copenhagen, Denmark).

2.2.4. Rating of Perceived Exertion [RPE]

The RPE was measured using the French translation of scale RPE of Borg (1970) [11].

2.2.5. Height, Body Mass and Fat

The size, the body mass and the thickness of the cutaneous folds were measured with a mural measuring apparatus (model 220, Seca® Hamburg, Germany), a gauged balance (TBF 543, Tanita® Tokyo, Japan) and anadipometer (HSK-B 1 Body Care® Warwickshire, England), respectively. Methods of Durnin and Wormersley (1974) [12] were used for evaluate thickness of the cutaneous folds.

2.3. Method

Before the realization of the calorimetry test, the judoists signed a note of information and a form of assent their retailer the goal and the procedure of the investigation. This study was approved by the National Council of Ethics of Biomedical Research of Congo.

Test of Calorimetry of Effort

The test was preceded by one period by rest by at least three minutes in order to measure the cardiorespiratory parameters in a basal state. Then, an eight minutes heating with 100 w, followed by one period of five minutes passive recov-

ery on the cycloergometer was carried out. Following the latter, the judoists began the calorimetrytest.

During this test, the initial power was fixed at 150 w (during four minutes) and the increment was of 50 w every four minutes until 300 w. Of the four minute old stages were selected because it was already reported that one three minutes duration is valid to determine $Lipox_{max}$ of the high level judoists [13]. Moreover, obtaining a stable state of the gaseous exchange (VO_2 and VCO_2) during the last minute of each stage was controlled. Once the load of 300 w reached, the increment of power was of 25 w every two minutes, and this until exhaustion (incapacity of the judoist to maintain a cycling frequency above 70 revolutions per minute (rpm) during more than five seconds. The judoists were to develop the greatest possible power. The latter corresponded to the aerobic maximum power (LDC). To reach the LDC, verbal encouragements were given to judoists at the time of the intensities higher than 300 w.

During the test, the heart rate (FC), the VO_2, the VCO_2 and the RQ were measured continuously, then realised during the 30 last seconds of each stage. Then, the share of oxidation of the lipids was given starting from the formula (which was applied to the first four stages):

[Lipids] (mg/min) = −1.7012 VCO_2 (ml/min) + 1.6946 VO_2 (ml/min).

The climax of the relation between the power and oxidation of lipids (bell-shaped curve) corresponded to $Lipox_{max}$.

In complement of these measurements, the general RPE were raised at the end of each stage. A sample of blood was taken with the stop of the test. Exhaustiveness was checked by the attack from at least three of the five following criteria:

- A plate in VO_2 max;
- An increase in the VO_2 lower than 150 ml/min in spite of a rise in the power;
- A QR higher than 1.1;
- A FC max measured to 90% of the FC max predicted;
- One [La^-] higher than 8 mmol/l with the stop of the exercise;
- A value of RPE from at least 18 at the time of the last entirely supplemented stage.

2.4. Experimental Methods

At a preliminary session, size, body mass and percentage of fat were given [9]. During this meeting, the judoists were familiarized on scale RPE. Moreover, one recommendation of this one and of its recommendations was provided to the judoists, so that they use them at the time of their drives. During this meeting, it was specified with the judoists that they were to avoid the physical activities exhausting during the 48 hours preceding the test.

The recommendations of scale RPE were read and explained to the judoists, right before the test to help the judoists to bind their stimuli to the values of RPE. The period pretest was also used to regulate the heights of saddle and guide.

During the test, the judoists were to maintain a cycling frequency continuously

ranging between 70 and 100 rpm. The air of the room was air-conditioned and the temperature maintained between 20˚C and 24˚C. The test was always carried out under medical control (cardiologist and lung specialist).

2.5. Statistical Analysis

The results are expressed in the average form standard deviation (SD) and of confidence interval (CI) at 95% (IC95%). The normality of the distribution of the data was checked by the test of Shapiro-Wilks, while the homogeneity of the variance was confirmed by the Levene'stest. An analysis of variance (ANOVA) to a factor (G1 *versus* G2) was used to compare all the data. The threshold of significativity was fixed at 0.05 for all the analyses. The statistical data processing was carried out with software Statview 5.

3. Results

The anthropometric and physiological characteristics of the judoists are presented in Table 1 and Table 2. The judoists of group 2 were significantly younger (20.4 ± 1.6 years *versus* 24.1 ± 5.9 years; $p < 0.03$) and significantly spent ($p < 0.01$) more time being involved in training (15.0 ± 1.9 days against 9.9 ± 2.7 days) weekly than judoists of group 1. The RQ recorded before the stop of the test of the judoists of G2 was significantly higher than that of the judoists of G1 (1.38 ± 0.08 *versus* 1.11 ± 0.05; $p < 0.12$).

Table 3 and Table 4 bring back the target intensities corresponding to $Lipox_{max}$ in the two groups of judoists. These intensities were not significantly different, except for the zones of FC and percentage of FCmax. For these last, the judoists of G2 had zones significantly higher in comparison with the judoists of G1 (112 ± 11 bpm *versus* 129 ± 13 bpm and 58.6% ± 6.1% *versus* 65.0% ± 6.5% FC max $p < 0.05$).

Table 3. Zones of target intensities corresponding to $Lipox_{max}$ of the 17 judoists of group 1.

	Group 1				Groups 1 et 2				P
	Mean ± SD	CI 95%	Xmin	Xmax	Mean ± SD	CI 95%	Xmin	Xmax	
Flow (mg/min/kg)	5.6 ± 2.5	1.1	4.5	6.8	5.9 ± 2.7	1.1	4.8	7.0	0.40
Power (w)	132 ± 31	14	117	146	139 ± 33	13	126	152	0.50
Power (% LDC)	38.2 ± 7.2	3.3	34.9	41.6	40.3 ± 8.6	3.4	37	44	0.70
VO_2 (ml/min)	27.6 ± 5.5	2.5	25.1	30.1	28.7 ± 6.2	2.5	26	31	0.30
VO_2 (%VO_2 max)	42.4 ± 7.1	3.3	39.1	45.7	43.6 ± 7.6	3.0	41	47	0.25
VO_2 (%VO_2 réserve)	37.7 ± 8.2	3.8	33.9	41.4	38.9 ± 8.6	3.4	35	42	0.29
FC (bpm)	112 ± 11	5	107	117	119 ± 34	14	105	133	<0.01
FC (%FC max)	58.6 ± 6.1	2.8	55.8	61.4	60.6 ± 6.8	2.7	5.8	63	0.03
FC (%FC holds)	47.5 ± 18.6	8.6	39.0	56.1	51.4 ± 19.1	7.6	44	59	0.17
RPE	9.9 ± 3.3	2.5	7.5	12.4	9.2 ± 2.7	1.1	8	10	0.38

Abbreviations: p, level of significance; LDC, aerobic maximum power; $Lipox_{max}$ threshold of maximum oxidation of the lipids; VO_2 oxygen uptake; VO_2 max, consumption maximum of oxygen; VO_2 oxygen uptake VO_2 réserve consumption holds of oxygen; FC max, maximum heart rate; RPE, perception of the effort.

Table 4. Zones of target intensities corresponding to $Lipox_{max}$ of the 7 judoists of group 2.

	Group 1				Groups 1 et 2				P
	Mean ± SD	CI 95%	Xmin	Xmax	Mean ± SD	CI 95%	Xmin	Xmax	
Flow (mg/min/kg)	6.7 ± 3.4	2.5	4.2	9.2	5.9 ± 2.7	1.1	4.8	7.0	0.40
Power (w)	158 ± 34	25	132	183	139 ± 33	13	126	152	0.50
Power (% LDC)	45.3 ± 10.2	7.6	37.7	52.8	40.3 ± 8.6	3.4	37	44	0.70
VO_2 (ml/min)	31.3 ± 7.6	5.7	25.7	37.0	28.7 ± 6.2	2.5	26	31	0.30
VO_2 (%VO_2 max)	46.4 ± 8.6	6.3	40.1	52.7	43.6 ± 7.6	3.0	41	47	0.25
VO_2 (%VO_2 réserve)	41.8 ± 9.4	6.9	34.9	48.4	38.9 ± 8.6	3.4	35	42	0.29
FC (bpm)	129 ± 13	10	120	139	119 ± 34	14	105	133	<0.01
FC (% FC max)	65.0 ± 6.5	4.8	60.2	69.9	60.6 ± 6.8	2.7	5.8	63	0.03
FC (%FC holds)	60.4 ± 18.9	14.0	46.3	74.4	51.4 ± 19.1	7.6	44	59	0.17
RPE	8.8 ± 1.1	1.1	7.7	10.0	9.2 ± 2.7	1.1	8	10	0.38

Abbreviations: p, level of significance; LDC, aerobic maximum power; $Lipox_{max}$ threshold of maximum oxidation of the lipids; VO_2 oxygen uptake; VO_2 max, maximum consumption of oxygen; VO_2 oxygen uptake VO_2 réserve consumption holds of oxygen; FC max, maximum heart rate; RPE, perception of the effort.

4. Discussion

This study shows that $Lipox_{max}$ is not significantly influenced by the category of weight (<66 kg *vs* >90 kg) of the involved judoists, except when $Lipox_{max}$ is expressed in the form of a FC (bpm) or a percentage of FC max. Consequently, independently of the category of weight, the target intensities corresponding to $Lipox_{max}$ in involved judoists are: 37% - 44% LDC, 41% - 47% VO_2 max, 35% - 42% VO_2 reserve, 44% - 59% FC hold and RPE, 8 - 10. However, a distinction must be made when one expresses $Lipox_{max}$ in the form of FC absolute (107 - 110 and 120 - 139 bpm for judoists of less than 66 kg and judoists of more than 90 kg, respectively) or of a percentage of FC max (56% - 61% and 60% - 70% FC max for the judoists of less than 66 kg and those of more than 90 kg, respectively). In theory, zones of intensities target common could be used (E G, for the land period) to prescribe an intensity of exercise allowing to oxidize maximum of lipids, and thus to decrease the superfluous fatty mass of judoists of more than 90 kg [14] [15] and to turn over more quickly to "the weight of form" (particularly after the interseason), without with the precondition duty carrying out an effort test of calorimetry. However, individual analysis of our results reveals that only 29% of judoists of group 1 have $Lipox_{max}$ in the target zones of intensities suggested against 24% in group 2, with regard to the %VO_2 max. These results are in agreement with literature [2]. Indeed, these authors had already noticed that the significant dispersion of the values of $Lipox_{max}$ (from 43% to 59% VO_2 max) was comparable with those found in the literature among the boxers and fighters (from 33% to 75% VO_2 max). The significant inter individual variance of $Lipox_{max}$ makes that the target zones of intensities suggested in the present study do not seem to be used on the ground for the regulation of exercises in $Lipox_{max}$

in judoists of more than 90 kg. So in agreement with Brown and *al.* (2009) [7], it seems difficult to predict $Lipox_{max}$ without realizing with the precondition of effort test of calorimetry, even when one takes account of the sex and the sporting speciality. A future work could be to identify the factors which influence $Lipox_{max}$ in judoists, fighters and boxers.

In addition, it is wise to recall that the length of the stages of the effort tests of calorimetry remains discussed [7] [16]. Indeed, some authors showed that one 6 minutes duration (by stage) is preferable at one three minutes duration if one does not want to underestimate $Lipox_{max}$ [17]. However, this undervaluation seems to be proven at the sedentary subjects [17], but "non-existent" statistically among involved fighters [13]. Indeed, Achtenandal., 2002, showed that one duration of three minute old stages would not significantly involve a difference on $Lipox_{max}$ of seven fighters involved (VO_2 max = 64.2 ± 1.6 ml/kg/min) in comparison at one duration of five minute old stages ($Lipox_{max}$ = 5.02 ± 0.10 l/min) *versus* 4.92 ± 0.13 l/min, respectively) [13]. Similarly, we did not find a difference between the gaseous exchange (VO_2 and VCO_2 during the last minute of each stage. Consequently, although should be used stages prolonged (one six minutes duration) for judoists of less than 66 kg, the one four minutes duration old stages proposed in the present study seem sufficient since all judoists were high level and the four minutes duration borders that of a fight of judo.

In our study, $Lipox_{max}$ (44% ± 8% VO_2 max) was comparable with that of other authors [18] [19] [20]. Indeed, Venablesandal. (2005) found already mean $Lipox_{max}$ to 48% ± 1% VO_2 max among 300 fighters [20]. More recently, Chenevièreandal. (2014) noted that $Lipox_{max}$ was located at the neighbourhoods of 44% ± 10% VO_2 max in 32 French judoists (17 women and 15 men) [18]. In the same way, Stisenandal. (2006) reported mean $Lipox_{max}$ to 56% ± 3% VO_2 maxamong eight sporting women involved in endurance brought back [1]. This result is higher than that of this study; however, Jeukendrup and Wallis (2005) made state that the women had their $Lipox_{max}$ with a percentage of VO_2 max higher of 10% than that of the men [21]. Consequently, this difference can be explained by the effect related to the sex (men *versus* women).

5. Conclusion

This study shows that the level of category of weight in the Congolese judoists does not influence $Lipox_{max}$ (except when this last is expressed in % FCmax). However, we note a broad interindividual variance of $Lipox_{max}$ since only one quarter of the studied judoists have their $Lipox_{max}$ in the target zones of intensities suggested. Moreover, when one expresses as a percentage $Lipox_{max}$, FC max and category of weight must be taken into account (56% - 61% FC max for less than 66 kg and 60% - 70% FC max for the most 90 kg). Consequently, intensities target common cannot be used for the regulations of exercises in $Lipox_{max}$ in the Congolese judoists involved in this study. Therefore, endurance training in judo leads to a better coordination between lipid mobilization and oxidation, which could contribute to reducing the metabolic consequences of high weight.

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Footnote

MJGA conceived the original idea of the article. MA worked out the procedure of experimentation, analyzed and treated the data obtained statistically, wrote the handwritten version of the article. IOJ and MKFN worked out the procedure experimentation. PTB read again the final version of the article, inliaisonwith MJGA and MA.

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