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Original Research Article

Relative Exercise Intensity and Energy Expenditure of a Krav Maga Workout

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Abstract

Introduction: Krav Maga is Hebrew for “close combat” and combines self-defense moves from a variety of disciplines to provide a total body workout. Krav Maga has become increasingly popular as a group fitness class. To our knowledge there is no data documenting the intensity of this type of program. **Purpose:** To determine the relative exercise intensity and energy expenditure of Krav Maga. **Methods:** Six male (age 23.5 ± 3.89 years) and 10 female (age 20.2 ± 1.23 years) subjects performed a graded exercise test on a treadmill. After habituation, subjects also performed a 60-minute Krav Maga workout. Heart rate and VO_2 were monitored every minute throughout the workout and perceived exertion was recorded approximately every 5 minutes throughout the session using the Borg 6-20 RPE scale. **Results:** It was found that subjects exercised at an average of $78 \pm 2.0\%$ of HRmax, $66 \pm 17.0\%$ of VO_{2max} , 8.8 ± 1.97 METs, and an RPE of 12.8 ± 1.15 . Average energy expenditure was 616 ± 216.7 kcal/session (males= 884 ± 141.1 ; females= 492 ± 107.1). **Conclusion:** The Krav Maga workout resulted in a moderate-to-vigorous intensity workout that can provide a viable option for individuals looking for alternatives to traditional aerobic training programs.

Key Words: Energy Expenditure, Krav Maga, Relative Exercise Intensity, Self-defense

Introduction

The benefits of regular exercise are well recognized, yet based on data from the Centers for Disease Control and Prevention (CDC), only 20 percent of Americans are getting sufficient exercise to positively affect their health¹. While traditional forms of

exercise like running and cycling are good sources of aerobic exercise, many people are looking for more enjoyable, alternative modes of activity. Martial arts are an enjoyable alternative to traditional exercise for many and offer unique opportunities to learn self-defense and new skills in a group

setting². New York City-based research firm Simmons Market Research has estimated that over 18.1 million Americans have participated in some form of martial arts in 2015, and these numbers are steadily increasing³. As a result, group fitness classes such as karate, judo, tae-bo, mixed martial arts (MMA), and cardio-kickboxing have become increasingly popular.

A relatively new group exercise class that is being taught at martial arts facilities is called Krav Maga. Krav Maga is Hebrew for “close combat,” and was developed in the mid-1930’s by Imre Lichtenfeld. Krav Maga was used for self-defense in response to the anti-Semitic riots that were threatening Jews, particularly in Czechoslovakia⁴. In 1948, the State of Israel was formed, and the Israeli Defense Force (IDF) was born. During the 20 years Lichtenfeld served in the IDF, he further refined his self-defense techniques, utilizing components of kickboxing, karate, jujitsu, and judo. In 1968, Lichtenfeld's first black belt student, Eli Avikzar, further developed Krav Maga into what it is known as today. The Krav Maga Association was officially started in 1978 and there are 134 recognized Krav Maga Institutes that currently exist globally⁵.

Starting in the early 2000s, Krav Maga training started to become used as an aerobic workout due to the dynamic and full-body nature of the movements. Krav Maga sessions begin with a warm-up and end with a cool-down period, with a variety

of self-defense moves in between. According to Kahn⁶, an aerobic workout is inevitable when long sequences of kicks, punches, and other combatant moves are strung together. Fitness clubs recognized the fast-paced, high intensity nature of Krav Maga, and its popularity has grown.

Based upon previous research, martial arts has been shown to improve aerobic and anaerobic capacity and improve overall fitness². However, to our knowledge, there is no research regarding the potential fitness benefits of Krav Maga. Therefore, the purpose of this study was to determine the relative exercise intensity and energy expenditure (EE) of a Krav Maga workout and determine if it meets American College of Sports Medicine (ACSM) guidelines for exercise prescription⁷.

Methods

Participants

This study included 16 apparently healthy male and female volunteers between 18-29 years of age. All subjects were considered recreationally active (exercising at least 3 times weekly for the past 6 months). The PAR-Q was completed by each subject to screen for cardiovascular or orthopedic contraindications to exercise and written informed consent was obtained from eligible candidates. The study was approved by the University of Wisconsin-La Crosse Institutional Review Board for the Protection of Human Subjects.

Procedures

Initially, each subject performed a maximal exercise test on a treadmill to determine maximal heart rate (HR_{max}) and maximal oxygen consumption (VO_{2max}). The test started at a self-selected walking or running pace and at 0% grade. Treadmill grade was increased 2.5% every 2 minutes until the subject reached volitional exhaustion. Throughout the test HR rate was recorded each minute using a Polar HR monitor (Polar Electro, Kempele, Finland) and VO₂ was measured continuously using a Parvo Medics metabolic cart (Sandy, UT). Maximal HR was defined as the highest HR observed at any point in the test and VO_{2max} was defined as the highest continuous 30-second value for VO₂ seen during the test. Prior to each test, the metabolic system was calibrated with gases of known concentrations (15.98% O₂, 4.12% CO₂) and with room air (20.94% O₂ and 0.03% CO₂) as per the manufacturer guidelines. Calibration of the pneumotachometer was done via a 3 Liter calibration syringe. Rating of perceived exertion (RPE) was recorded every 2 minutes using the 6-20 Borg scale⁸. Additionally, individual HR/VO₂ regression equations were developed using the HR and VO₂ responses during the last 30 seconds of each stage of the incremental treadmill test. These regression equations were used to predict VO₂ based on the HR responses during the Krav Maga workout. Caloric expenditure was calculated from the predicted VO₂ data assuming a constant of 5 kcal per liter of O₂ consumed.

Each subject performed at least two practice sessions to become familiar with the Krav Maga workout. Once deemed proficient by the primary investigator, each subject completed a 60-minute Krav Maga workout session by following along to a pre-recorded Krav Maga workout DVD⁹. Heart rate was recorded each minute during the workout with a Polar HR monitor and RPE was assessed every 5 minutes during the workout using the 6-20 Borg Scale. The HR values were inserted into the individual HR/VO₂ regression equations to predict VO₂ on a minute-by-minute basis during the Krav Maga session.

Statistical analyses

Standard descriptive statistics were used to summarize the data and characterize the subjects population. All values are represented as mean \pm standard deviation. Comparisons between males and females were made using independent t-tests. Alpha was set at .05 to achieve statistical significance. All analyses were conducted using the SPSS Version 25.0 (Chicago, IL).

Results

Descriptive characteristics of the 16 subjects who participated in the study are presented in Table 1. There were no significant differences in age, weight, or HR_{max} between males and females. Males were significantly taller and had a significantly higher VO_{2max} than females.

Table 1. Descriptive characteristics of the subjects (N= 16).

Characteristic	Males (n=6)	Females (n=10)
Age (yr)	23.5 ± 3.89	20.2 ± 1.23
Height (cm)	179.3 ± 6.92	168.7 ± 5.62*
Weight (kg)	78.5 ± 16.43	66.8 ± 8.23
HRmax (bpm)	191 ± 6.2	194 ± 7.3
VO ₂ max (ml/kg/min)	49.6 ± 3.19	39.3 ± 5.97*

*Significantly different than males, $p < .05$.

The physiological responses to the 60-minute Krav Maga workout are summarized in Table 2. Exercise intensity data are also graphically presented in Figure 1-5, respectively. It was decided to represent the intensity of the workout in terms of %HRmax and %VO₂max, as that is how it is most often reported in the comparative

literature. There were no significant differences in HR, RPE, %HRmax, or %VO₂max between males and females. Males had a significantly higher VO₂ and METs achieved during the workout. Males also expended significantly more calories (kcal/min and kcal/session) than females.

Table 2. Physiological responses during the 60-minute Krav Maga workout.

Parameter	Males (n=6)	Females (n=10)	Overall (N=16)
HR (beats/min)	150 ± 20.1	151 ± 19.2	151 ± 19.5
Range	142-158	147-155	142-158
%HRmax	79 ± 1.1	78 ± 2.5	78 ± 2.0
Range	77-80	75-83	75-83
VO ₂ (ml/kg/min)	34.7 ± 8.06	24.6 ± 7.72*	28.4 ± 9.25
Range	32-40	19-34	19-40
%VO ₂ max	70 ± 15.5	63 ± 17.3	66 ± 17.0
Range	64-75	45-71	45-75
METS	9.9 ± 0.92	7.0 ± 1.41*	8.8 ± 1.97
Range	9-11	5-10	5-11
kcal/min	13.7 ± 4.26	8.2 ± 2.64*	10.2 ± 4.34
Range	9-17	6-11	6-17
Total kcal/session	884 ± 141.1	492 ± 107.1*	616 ± 216.7
Range	658-1027	331-683	331-1027
RPE [#]	13.1 ± 1.42	12.7 ± 0.93	12.8 ± 1.15
Range	11-14	11-13	11-14

*Significantly different from males, $p < 0.05$. [#]Excludes warm-up and cool-down.

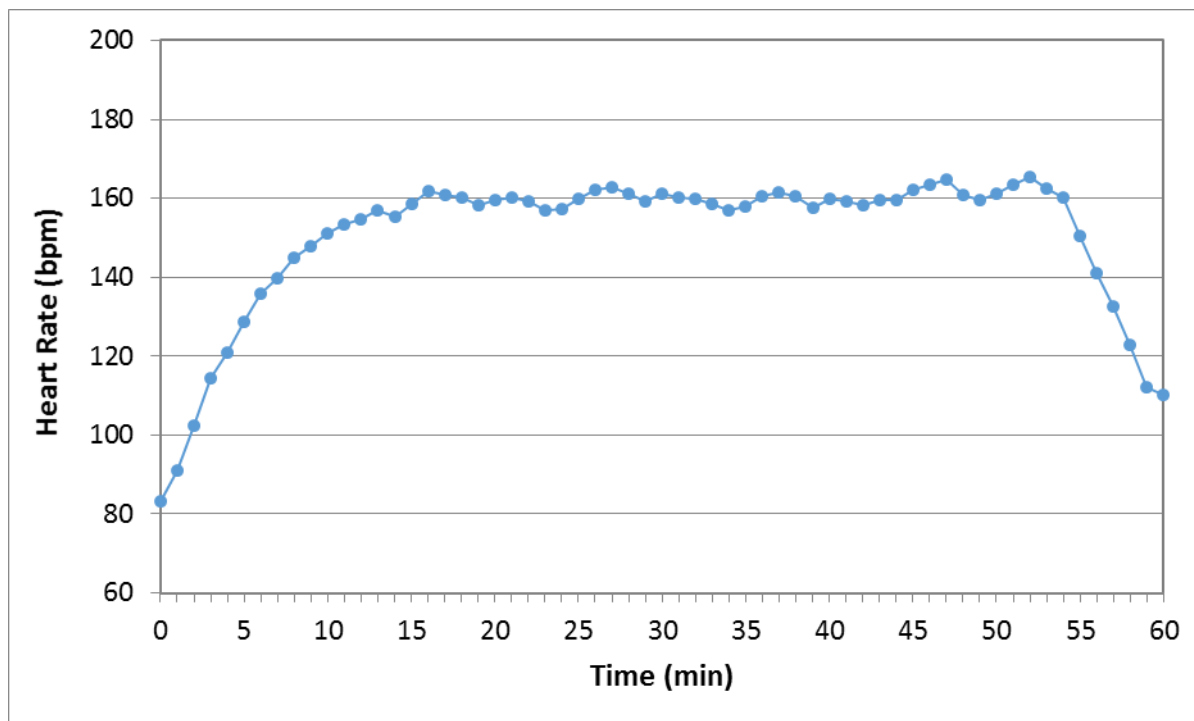


Figure 1. Minute-by-minute HR responses during the Krav Maga workout.

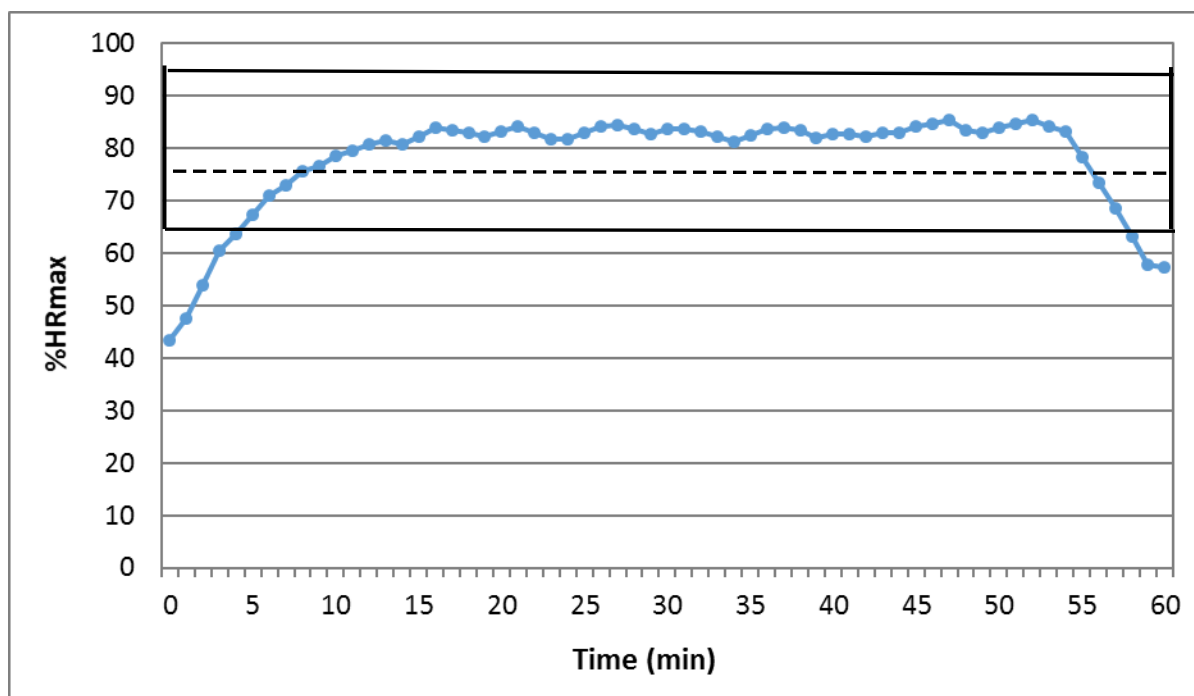


Figure 2. Relative HR responses (% HRmax) during the Krav Maga workout. The boxed region indicates the ACSM guidelines for improving cardiorespiratory endurance (64-76% of HRmax corresponds to moderate intensity and 77-95% of HRmax corresponds to vigorous intensity).

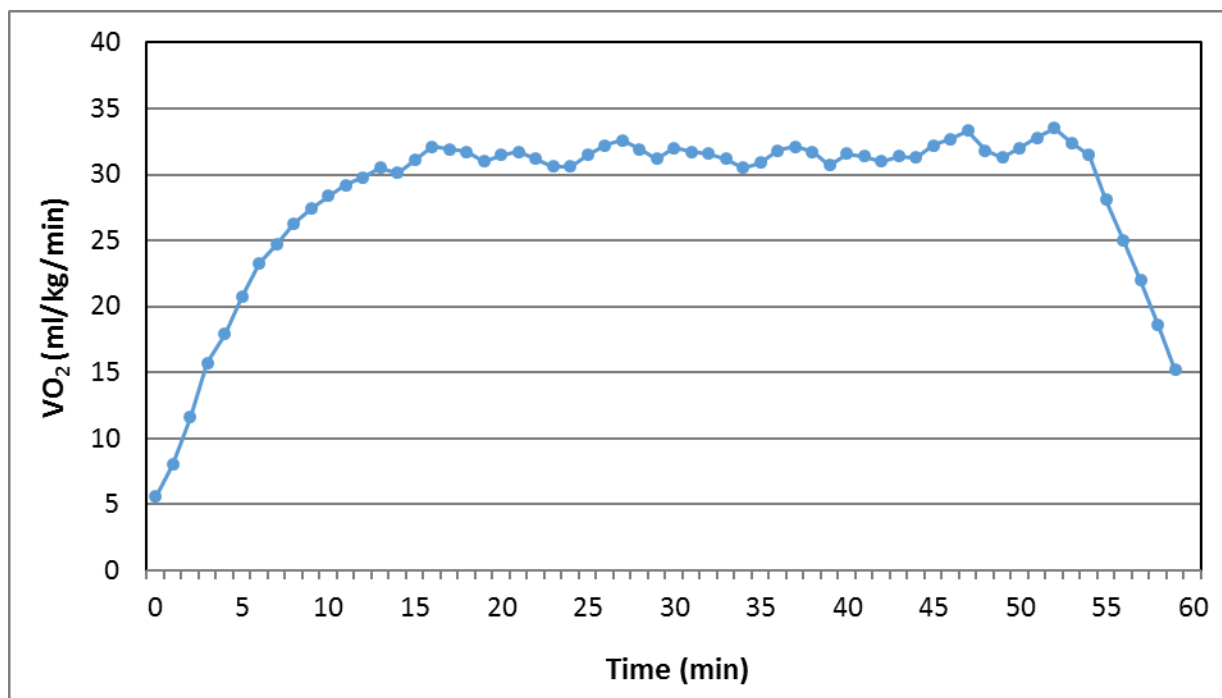


Figure 3. Predicted oxygen consumption (VO₂) during the Krav Maga workout.

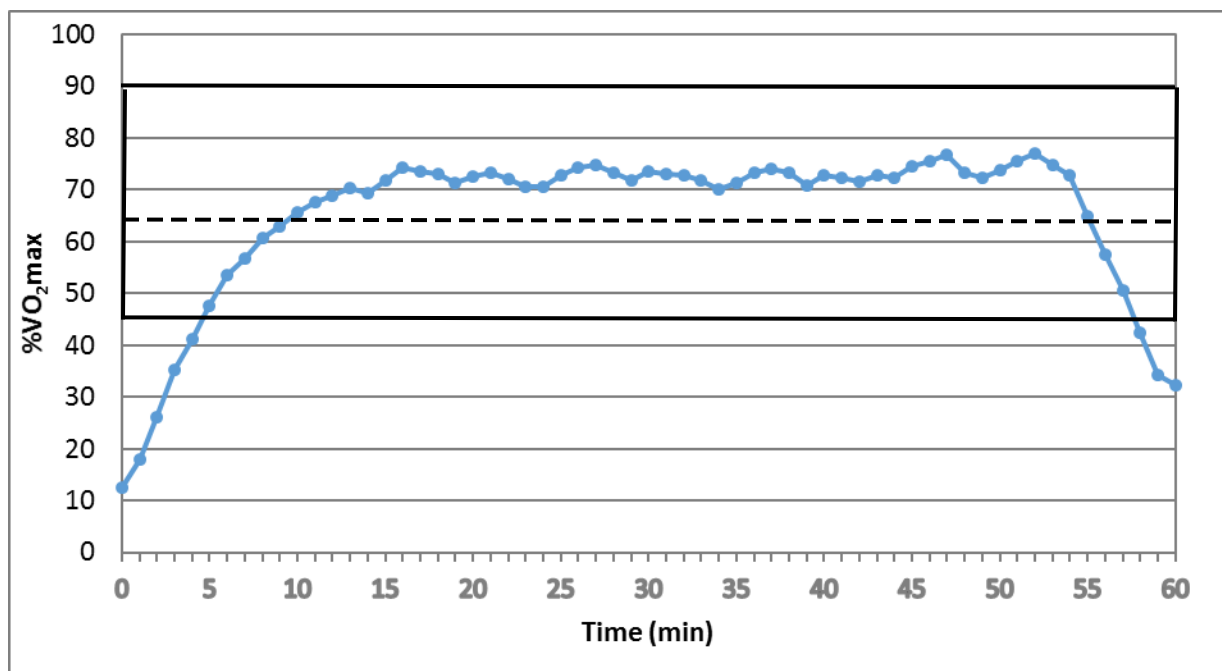


Figure 4. Relative oxygen consumption responses (%VO₂max) during the Krav Maga workout. The boxed region indicates the ACSM guidelines for improving cardiorespiratory endurance (46-63% of VO₂max corresponds to moderate intensity and 65-90% of VO₂max corresponds to vigorous intensity).

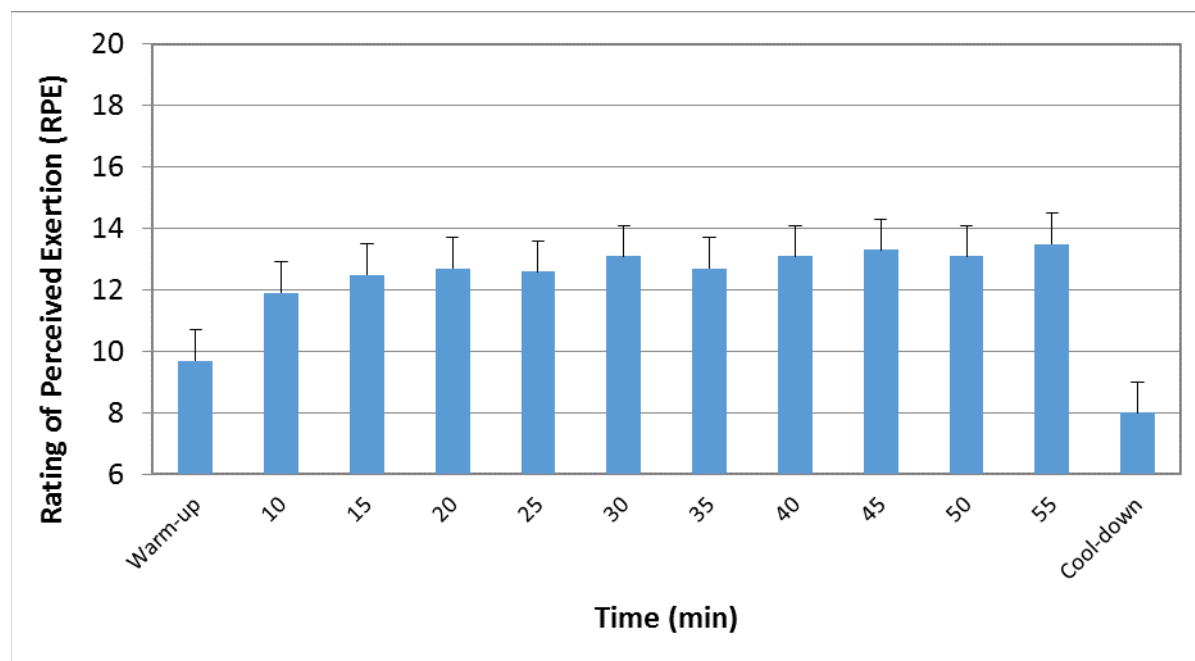


Figure 5. Rating of perceived exertion (RPE) response during the Krav Maga workout.

Discussion

The purpose of this study was to determine the relative exercise intensity and EE of a Krav Maga workout and to compare those values to ACSM¹ guidelines for improving cardiorespiratory endurance and for weight management. ACSM¹ recommends that individuals exercise between 64-95% of HRmax or 46-90% of VO₂max in order to improve cardiorespiratory endurance. In the current study, exercise intensity averaged 78±2.0% of HRmax and 66±17.0% of VO₂max for the 60-minute Krav Maga workout, which places it on the borderline of the moderate to vigorous intensity ranges. It should be noted that these averages included a 5-minute warm-up and 5-minute cool-down. As can be seen from Figures 2 and 4, subjects were exercising in the vigorous intensity range

for the majority of the workout portion of the Krav Maga session. These data are consistent with the findings of a study on taekwondo which reported that subjects were exercising between 65-81% of HRmax¹⁰. Similarly, Milanez et al.¹¹ reported that HR during a 90-minute karate session averaged 73% of HRmax. In terms of percentage of VO₂max, Francescato, Talon, and di Prampero¹² found that subjects were working between 55-94% of VO₂max during a karate routine, depending upon the specific movements being performed. Similarly, it was found that subjects were working at an average of 73% of VO₂max during karate¹³ and taekwondo¹⁴ workouts, respectively¹⁶.

Because individuals have different VO₂max values, calculated relative exercise intensity can vary tremendously for the same activity

(e.g., in the present study relative % of VO_2max varied from 45-75%). As a result, exercise intensity is often classified based on absolute metabolic units (METs)⁷. Light-intensity physical activity is defined as being 2.0-2.9 METs, moderate-intensity ranges from 3.0-5.9 METs, and activities requiring ≥ 6.0 METs are considered vigorous¹. In the present study, the average MET requirement for Krav Maga was 8.8 ± 1.97 METs, which falls into the vigorous-intensity range. In the most recent Compendium of Physical Activities, the intensity of martial arts training was estimated to be 5.3 METs in novice participants and up to 10.3 METs in experienced and advanced participants¹⁵. For comparative purposes, running at 5.0 mph (12 min/mile pace) is equivalent to 8.6 METs and bicycling at 13 mph is equivalent to 8.5 METs¹⁵. Previous studies in our laboratory found that a Boot Camp workout had an average intensity of 8.4 METs (unpublished data), QiDance averaged 8.4 METs¹⁶, and Zumba averaged 8.8 METs¹⁷, which are all very similar in intensity to Krav Maga.

Many exercisers choose their workouts based on how many calories they are going to burn, in order to achieve or maintain weight loss. In regard to EE, it is recommended that individuals expend 1,200-2,000 kcal per week (240-400 kcal per exercise session) in order to positively affect body composition¹⁸. The subjects in this study expended an average of 10.2 kcal/min (range of 6-17 kcal/min) during the Krav Maga workout. This equated to an

average of 616 ± 216.7 kcal for the entire Krav Maga session. Several other studies have examined the EE of martial arts activities. Rixon et al.¹⁹ determined that participants in body combat classes were expending an average of 9.7 kcal/min and karate training was found to burn an average of 8 kcal/min¹⁰. Another study found that various karate katas expended between 15-24 kcal for 90-second bursts of activity, however these levels were not sustained²⁰.

The difficulty of a certain physical activity is often something people look at when choosing an exercise routine. How hard a person is working is a subjective description, but nonetheless is an important indicator of exercise intensity. Exercise intensity can be prescribed using the 6-20 Borg RPE scale, with values of 12-14 correlating to moderate-intensity exercise⁸. Excluding the warm-up and cool-down, the average RPE of the Krav Maga workout was 12.8 ± 1.15 (range of 11-14), which would classify Krav Maga as a moderate-intensity activity. In a similar study, RPE ranged between 12-14 during a 90-minute karate session¹¹, which was similar to the Krav Maga workout used in the current study. Limitations to the study included the inability of the subjects to wear portable VO_2 monitors while performing the Krav Maga workout. It was felt that wearing a portable VO_2 analyzer would have prevented the subjects from properly performing some of the large range of motion movements incorporated into the

workout. Therefore, only HRs were recorded during the workouts. These HRs were subsequently inserted into the individual HR/ VO_2 regression equations to predict oxygen consumption. It is possible that VO_2 and subsequent EE values could have been overestimated if HRs were artificially high due to the high muscular effort required for some of the movements; a phenomenon called the pressor response. Previous research on the pressor response suggests that these types of movements can increase HR and blood pressure disproportionately relative to VO_2 ²¹. Another possible limitation was the skill level of the participants. Although all subjects were deemed proficient in the Krav Maga workout prior to being tested, some subjects had prior experience with martial arts, and were therefore more advanced than others. This could have impacted HR responses as well as the predicted EE of the workout.

The results of this study provide direction for future studies on Krav Maga. Future research may want to evaluate subjects over a longer period of time to see how regular Krav Maga training impacts cardiorespiratory endurance and body composition. Additionally, studies may want to evaluate responses in individuals who are more proficient in Krav Maga, such as military personnel who are specifically trained in Krav Maga.

Conclusions

The results of this study indicate that the Krav Maga workout used in the current

study met ACSM guidelines for improving cardiorespiratory fitness, as well as managing body weight. Exercisers can expect a moderate-to-vigorous intensity workout based on the combined HR, VO_2 , and RPE measurements. Thus, Krav Maga offers participants an alternative form of exercise that teaches self-defense techniques, while simultaneously providing a full body workout.

Disclosures

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