THE ACUTE METABOLIC RESPONSES DURING CROSSFIT-BASED AND TABATA-BASED WORKOUT PROTOCOL AMONG HEALTHY INDIVIDUALS

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UNIVERSITI PENDIDIKAN SULTAN IDRIS

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ABSTRACT

The objective of the study was to investigate and compare the acute metabolic response (energy expenditure (kcal), maximum volume of oxygen consumption (VO_2max), respiratory exchange ratio (RER)) on Crossfit-based workout protocol and Tabata-based protocol. The study used a quasi-experimental method. 20 healthy and gym goer's men aged 19-24 years old were involved in this study. Participants were assigned to perform Crossfit-based workout ("WOD" 17.1) and Tabata-based protocol with the same "WOD" with 80% 1RM dumbbell snatch and burpees box jump-over with 24 inch depth box equated based on total activity time for 14 minutes each within 90%-95% of maximum heart rate. The orders were randomize counterbalanced among the participants to avoid order effects. Paired sample t-test was conducted to compare the energy expenditure (kcal), VO_2max, RER) between both protocol workouts. There was significant differences between energy expenditure per minute for both workout-based protocols, the analysis revealed that the Crossfit-based protocol workout burn more caloric expenditure (per minute) (m = 13.96, s = 1.37) compare to Tabata-based workout protocol (m = 13.29, s = 1.45), t (19) = 3.78, p $\leq$0.05. There was also a significant difference between VO_2max for Crossfit-based workout and VO_2max for Tabata-based workout. The Crossfit-based protocol workout consumed more oxygen intake (ml.kg-1.min) (m = 45.33, s = 5.33) compare to Tabata-based workout protocol (m = 44.11, s = 5.28), t (19) = 6.75, p $\leq$ .05. RER result also was significant difference between both workout-based protocols that the Crossfit-based protocol RER is higher (m = 1.27, s = 0.05) compare to Tabata-based protocol (m = 1.25, s = 0.04), t (19) = 3.380, p $\leq$ 0.05. To conclude, the different workout protocols used did affect the acute metabolic responses. The implication of this study highlights that the Crossfit-based protocol is more beneficial in acute response of energy expenditure, VO_2max, and RER.

TINDAK BALAS AKUT METABOLIC KETIKA PROTOKOL SENAMAN CROSSFIT-BASED DAN TABATA-BASED DALAM KALANGAN INDIVIDU SIHAT

ABSTRAK

Objektif kajian ini adalah untuk membandingkan tindak balas akut metabolik (penggunaan tenaga (*kcal*), kuantiti maksima penggunaan oksigen (*VO_2max*) dan nisbah pertukaran pernafasan (*RER*) terhadap protokol senaman *Crossfit-based* dan protokol senaman *Tabata-based*. Kajian ini menggunakan kaedah kuasi-eksperimen. 20 lelaki sihat dan kerap ke gim (umur lingkungan 19-24 tahun) terlibat dalam kajian ini. Para peserta ditugaskan untuk melakukan protokol senaman *Crossfit-based* ("*WOD*" 17.1) dan protokol senaman *Tabata-based* dengan "*WOD*" yang sama dengan 80% daripada nilai satu ulangan maksimum *dumbbell snatch* dan lompatan *burpees* melepasi kotak yang berketinggian 24 inci yang disamaratakan jumlah masa senaman keseluruhan selama 14 minit dengan kadar degupan jantung diantara 90%-95% kadar maksima. Turutan senaman diseimbangkan secara rawak dalam kalangan peserta bagi mengelakkan kesan turutan. Ujian-t sampel berpasangan dijalankan bagi membandingkan *kcal, VO_2max,* dan *RER* bagi kedua-dua protokol senaman. Perbezaan yang signifikan ditunjukkan bagi penggunaan tenaga per minit bagi kedua-dua protokol senaman. Analisa menunjukkan protokol senaman *Crossfit-based* menggunakan lebih tenaga (per minit) (m = 13.96, s = 1.37) berbanding protokol senaman *Tabata-based* (m = 13.29, s = 1.45), *t* (19) = 3.78, p ≤0 .05. Perbezaan yang signifikan juga ditunjukkan bagi *VO^2max* dalam protokol senaman *Crossfit-based* dan *VO_2max* dalam protokol senaman *Tabata-based*. Protokol senaman *Crossfit-based* menggunakan oksigen yang lebih tinggi (ml.kg-1.min) (m = 45.33, s = 5.33) berbanding protokol senaman *Tabata-based* (m = 44.11, s = 5.28), *t* (19) = 6.75, p ≤ .05. Keputusan *RER* juga menunjukkan perbezaan yang signifikan diantara protocol senaman dimana *RER* bagi protokol senaman *Crossfit-based* lebih tinggi berbanding protokol senaman *Tabata-based* (m = 1.27, s = 0.05), (m = 1.25, s = 0.04), t (19) = 3.380, p ≤ 0.05. Kesimpulannya, perbezaan protokol senaman yang digunakan memberi kesan terhadap tindak balas akut metabolik. Implikasi kajian menunjukkan protokol senaman *Crossfit-based* lebih memberi impak dari segi tindak balas akut penggunaan tenaga, *VO_2max*, dan *RER*.

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LIST OF ABBREVIATIONS

1RM	One - repetition maximum
AMRAP	As Many Repetitions As Possible
BIA	Bioelectrical Impedance Analysis
CP	Creatine Phosphate
HIIT	High Intensity Interval Training
HIPT	High Intensity Power Training
HR	Heart Rate
HRmax	Maximum Heart Rate
KCAL	Kilocalorie
LA	Lactic Acid
LT	lactate threshold
PAR-Q	Physical Activity Readiness Questionnaire
POmax	Maximum Power Output
RER	Respiratory Exchange Ratio
SPSS	Statistical Package of Social Science
VO_2max	Maximum Rate of Oxygen Consumption
WOD	Workout of The Day

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

For the last 10 years fitness industry has been bombarded with fitness regimes such as Crossfit, Tabata, Fartlek and many more, with each if the regimes or protocols developed aiming at improving overall fitness, mainly cardiovascular and muscular endurance capability of it users.

Two most prominent or highly popular within the fitness fraternity are the crossfit and tabata protocol. Both have been used by many trainers in the commercial and high performance industry. Both can be considered as a training protocol which used high intensity approach. However, tabata can be said as having more precise and refine approach with clear work and rest period ratio compared to crossfit, which looks more as a high intensity continuous training program.

Crossfit can be known from typical features across its entire workout, which normally constantly varied, involved functional movement that aims to improve fitness (Glassman, 2006a). The founder Greg Glassman has designed this Crossfit in order to enhance a large array of bodily characteristics concurrently with respect to cardiovascular patience, power, flexibility, speed, agility and balance (Glassman, 2013). Besides, Crossfit describe as the recreation of health when crossfit also comprises competitive aspect into each workout that inspired an individuals to strive past their preliminary targets and expectation (Hak, 2013).

The main combination method to form a Crossfit workout are consists of the combination between circuit weight training (CWT) and High-intensity interval training (HITT). As mentioned by Gibala and McGee (2008), this HITT involves the performing of repetition bouts of all out exercises together with a short rest periods between the bouts. Whereas, the segments of high-intensity are performed approximately close to maximal oxygen consumption (VO_2max).

Crossfit is as a result cardio and anaerobic in its nature, since it involves each extended and extreme and brief events of big muscle group (Paine, Uptgraft & Wylie, 2010). The Crossfit workouts are ordinarily based on a “Workout of the Day" (WOD). Glassman (2006) stated that during the performing of WOD, each participants are timed even as they perform the given exercise at near maximum exertion stages. Moreover, each of the WOD session also would requires training in all three energy system which are the creatine phosphate (CP) system, anaerobic glycolysis, and oxidative phosphorylation (Beilke et al., 2012).

In addition, this Crossfit training are significantly increase work capability and was recommended for the Army soldier of United States (Paine.et al., 2013). In previous research, crossfit based high intensity vigor coaching greatly improved maximum cardio capability and helps in minimize the physique fat percent in a ten week experimental be trained (Smith et al., 2013). The current study, general lengthy-time period Crossfit pastime is concerning higher stages of body awareness, physique picture delight, body competence and global self- esteem (Koteles et al., 2016). In a further, eight-week study, crossfit training drastically expand work potential and used to be recommended for U.S.A.Navy infantrymen (Paine et al., 2010).

By the same token, the Crossfit exercises are design to stressed each and every metabolic procedure by means of connecting numerous activity motion, intensities, resistance, sets and leisure interval to widen training advantages (Arias et al., 2016)(Brown et al., 2010). Even though crossfit emphasizes the skills of regularly assorted challenge, criticism has derive as regards to the lacking of individualization WODs as excellent defense issues for the excessive depth along with aggressive nature of the certain workout routines (Manninen, 2004).

The Tabata system includes a 20 seconds quick bouts of high intensity exercise interspersed with 10 seconds brief rest periods. The proof recommends Tabata training is robust for inducing physiological advantages (Tabata et al., 1996). Tabata training was named for its developer Dr. Izumi Tabata at the National Institute of Fitness and Sport in Tokyo with this form of conditioning. In year 1996, Tabata and his colleagues has conducted a study to compare the moderate depth continuous training at 70% of maximal oxygen consumption (VO_2max) for 60 minutes, with high depth interval training (HIIT) at 170% of VO_2max where it is involves a movement or

modality or motion such as squat jumps, stair running or cycling that need to be done for 20 seconds at a maximum effort with 10 seconds rest for 8 total cycles by Olson. Emberts et al., (2013) claimed that the HIIT includes of eight, 20 second all-out exercise bouts adopted with the aid of 10 seconds of rest for a complete of four minutes of exercise. The findings of his research confirmed that HIIT had a better relationship with reorganized aerobic capability than moderate steady coaching and composed and carry of 28 percent in anaerobic potential, which aerobic training did not preform.

Findings via Tabata and his colleagues also brief, intensive interval training isactually a time powerful approach in improving both cardio vigor and capacity of anaerobic (Miller et al., 2015). Besides, Tabata is the title of a certain style of recreation program that supplies an identical wellbeing advantage to that of cardio exercise however tabata has bit extra spice and may also be whole in 4 minutes (Mishra, 2016). Tabata sort training is an effective alternate to more natural cardio centered training regimens in the face of a considerable shortened time commitment and lessen training volume (Burgomaster et al., 2007). Meanwhile, Olson (2014) stated that Tabata kind training routines have emerged wherein period differ between 8 and 20 minutes entailing more than 4 minutes bouts performance at 74% to 95% VO_2max along a minute recuperation subsequent every 4 minutes bout. Long-established findings shows that HIIT has highly used of VO_2max (Bayati et al., (2011).

In view of the fact that VO_2max is a standard and powerful size of an overall fitness level, it is important. Furthermore, HIIT has been found to boost insulin

sensitivity (Babraj et al., 2009; Nybo et al., 2010; Whyte et al., 2010), HDL levels (Tjonna et al., 2009), and blood pressure (Gibala & McGee, 2008; Whyte et al., 2010) thus reducing body fat percentage (Gibala & McGee, 2008; Whyte et al., 2010) (Trembley, Simoneau, Bouchard., 1994). This study is design because of their benefit to improve the individual performance either for health or sports improvement. Dr. Izumi Tabata performed an interval trial and reported the findings of an experiment in Medicine in Sports Journal and Exercise, in which he resulted in achieving outstanding gains of both anaerobic and aerobic conditioning in a group of experienced athletes with a four-minute period (3:50) regimen of 20 seconds in all work accompanied by 10 seconds of rest. Consequently, the 4-minute high intensity group of Dr. Tabata obtained stronger VO_2max enhancement than the control group, who adopted a modest intensity regimen of 60 minutes. On the other side, the clincher was Crossfit athletes have demonstrated improved endurance performance without endurance training, and amazingly, in clinical trials of high intensity regimen Crossfits has produced improvements in endurance measures that revealed those achieved through programs comprised largely of endurance efforts.

1.2 Statement of Problem

Having a correct exercise regimn and proper technique will help the practitioners to hit the specific aim of the exercise objective. Thus, when choosing the exercise or workout to do, the practitioner or the trainer need to know the best workout to help them to develop their health and skill related components. Both Crossfit workout and Tabata workout protocol claimed that the training can able improve metabolic

capacity of it users. While so many types of training introduced, this two training are a part of them that accepted by the trainers to use this method for the athletes. However, questions arise which of them is the best method when compared, which one burn more calories, which one produce higher oxygen consumption capability and which of the workout have better respiratory exchange ratio (RER). If all of above are unknown, it will be difficult for trainers and clients alike to choose the right and appropriate program which can serve their training goal.

1.3 Purpose of the study

The purpose of this study is to investigate the acute metabolic responses (energy expenditure (kcal), volume of oxygen consumption (VO_2max), and respiratory exchange ratio (RER) on Crossfit-based workout protocol and Tabata-based workout protocol among healthy male KPTM students.

1.4 Objectives of the study

To answer the question that been arisen, the objectives of the study are carried out as the following:

i. To determine acute metabolic responses (energy expenditure, oxygen consumption, and respiratory exchange ratio) during Crossfit-based workout protocol among healthy individuals.

ii. To determine acute metabolic responses (energy expenditure, oxygen consumption, and respiratory exchange ratio) during Tabata-based protocol among healthy individuals.

iii. To compare acute metabolic responses (energy expenditure, oxygen consumption, and respiratory exchange ratio) during Crossfit-based workout protocol and Tabata-based protocol among healthy individuals.

1.5 Research Questions

The research questions that arise within this study are as follows:

i. What are the acute metabolic responses (energy expenditure, oxygen consumption, respiratory gas exchange ratio) during Crossfit-based workout protocol among healthy individuals?

ii. What are the acute metabolic responses (energy expenditure, oxygen consumption, respiratory gas exchange ratio) during Tabata-based protocol among healthy individuals?

ii. Will there be any significant differences of acute metabolic responses (energy expenditure, oxygen consumption, respiratory gas exchange ratio) with Crossfit-based workout protocol and Tabata-based protocol among healthy individuals?

1.6 Research Hypothesis

1.6.1 H_0: There is no significant difference of metabolic responses (caloric expenditure) between both Crossfit-based workout and Tabata-based workout.

1.6.2 H_0: There is no significant difference of metabolic responses (VO_2max) between both Crossfit-based workout and Tabata-based workout.

1.6.3 H_0: There is no significant difference of metabolic responses (respiratory gas exchange ratio (RER)) between both Crossfit-based workout and Tabata-based workout.

1.7 Significance of the Study

Training is an important part of preparing an individual for improves the performance in a competition as well as in their life. The time and the effectiveness level to improve the performance is an important thing for an athlete. Hence, this study aim to investigate the acute metabolic responses during both Crossfit-based workout and Tabata-based workout. Outcomes of the study will give information which of the training that will give more impact. It is also provide evidence to trainers or individual for the training they are choosing. Furthermore, it will become a benefit to future researcher to explore the exercise training area to improve their performance in specific period of time.

1.8 Limitations of the Study

There are several factors that exceed the limitation of the researcher to control. The limitation factors that were figured out by the researcher during study as the follows:

i. The participants recruited were recreationally male gym goers from Kolej Poly-Tech MARA (KPTM) Bangi.

ii. Motivation is one of the psychological factors that indirectly contributed within this study. The maximal effort of the participants were needed to complete the task given during the session could affect the outcome of the research since this study was conducted in three different sessions including the familiarization and test session. Beside, in order to perform the workout, the maximal load of 80% of the participants' 1 repetition maximum was used. The participant need to snatch the load until they failed to perform the proper execution of dumbbell snatch exercise hence, the level of motivation to complete the task within this study was beyond the researcher's capability. Besides, the participants were asked to used the self-pace lift in order to make sure the proper dumbbell snatch execution instead of prevent from feel burden during the session was conducted.

iii. The study assumed that the participants had performed the workout with 80% or their 1 Repetition Maximum repeatedly within 90% - 95% of HRmax until the end of the workout time. However, the competency of the coach or assistance on honesty during the testing is not within the capability of the researcher to control. This is because during the session, coach or assistant was required to observe and correcting the movement

error during the familiarization and test session. Testing environment could lead an increase of anxiety level of the participant. However, it is out of the researcher's capability to handle.

iv. Since the load used was 80% of 1 Repetition Maximum of dumbbell snatch and burpees jump over box of 24 inch box within 90% - 95% of HRmax, the participants were asked to perform the workout protocol with self-pace to make sure the participant able to complete the workout protocol properly. Thus the pace was not within the control.

1.9 Delimitations of the Study

This study was delimited as following the criteria during the investigation:

i. The inclusion criterion for the study was only recreationally resistance trained male participants who aged of 19-23 (20±1.65) years old from Kolej Poly-Tech MARA (KPTM) Bangi was selected to be a part of this study.

ii. The weight range of the participants was between 55 to 72 kg (63.33±7.37) with the height range of 164 to 177 cm (169±3.76) was delimited.

iii. The participants abled to perform dumbelle snatch exercise with 1-Repetition Maximum of at least 1.5 times of their bodyweight was recruited for this study.

iv. The participants were free from any musculoskeletal injuries for the past year and during this study were conducted. The participants were excluded if they were injured.

v. To avoid any discrepancies of gender, only male participant were selected to involve in this study as male had a greater muscle composition compared to female.

vi. The number of repetition only counted when the participant performed the dumbbell snatch and burpees jump over exercise with proper execution.

vii. The data collection of the study was held at gymnasium at Kolej Poly-Tech MARA (KPTM) Bangi.

viii. The instruments used in this study were in a good condition before the study started.

ix. The load use was submaximal load with 80% of 1 Repetition Maximum, 24 inch box depth for burpees jump over box and Maximum Heart Rate within 90% - 95%.

1.10 Operational Definitions

Those are definition the term that had been used and observed within this study:

i. Crossfit-based workout: The Crossfit workouts are normally incorporated into high-intensity (e.g. self-selected) exercises conducted with little to no turnaround time in rapid, successive succession (Glassman, 2011; Heinrich, Patel, O'Neal, & Heinrich, 2014). Smith et al. (2013) wrote that

some of the exercises are actually done for the best time, while others are performed in "as many rounds as possible," also known as the AMRAP style, which varies from 10 to 20 minutes using time-varying domains.

ii. Tabata Protocol: Tabata et al., (1996) mentioned that one of High Intensity Interval Taining (HIIT) originated from Japanese scientist 'Izumi Tabata' that consist minimal time during rest duration. Tabata training protocol that consist of work ratio 20 second exercise, 10 second rest that consist of eight exercise bouts, for total duration four minutes. According to Izumi et al., (1996), the number of repetition during tabata training was as many repetition that athlete can perform with their maximal effort during 20 second of exercise duration.

iii. Acute metabolic response: A prompt and efficient energy system capability fo sustaining either high intensity or maintaining prolonged physical activity.

iv. Respiratory exchange ratio (RER): Respiratory Exchange Ratio can be defined as the ratio of the net output of carbon dioxide to the simultaneous net uptake of oxygen at a given site, both expressed as moles or STPD volumes per unit of time. (Medical Dictionary, 2020)

v. VO_2max: A point where the plateaus of oxygen intake are assessed by gradual workouts, an experiment that has been carried out to the point of fatigue, as well as the full ability of the body to transport and use oxygen for energy output.

vi. Caloric expenditure: The quantity of kilocalories used during an operation or during a particular time span.

vii. High Intensity Interval Training: Method of training that increases the volume of high intensity physical work through the control of work-to-rest ratios, while reducing exercise duration and fatigue, in order to increase performance during individual exercise bouts (Baechle & Earle, 2008).

viii. 1 Repetition Maximum: The heaviest load that able to be lifted by performer in only one repetition of exercise with the proper execution (Clayton et al., 2015). It is an appropriate method to determine the resistance used in training (Boone et al., 2017)(Baker, 2016). The procedure to measure 1 Repetition Maximum was by adding the load gradually when the performer can lift the load of the exercise repeatedly until they can only perform the exercise with one repetition with the proper execution. 1 Repetition Maximum is used as the guideline to determine the intensity or load used in training to trigger the muscle activation (Ruf, Chery, & Taylor, 2018).

ix. Healthy and gym goers: The participant who involved in this investigation was healthy without any musculoskeletal injuries and cronic desease for past years and as any person who involving the resistance training at least twice in a week (Khamoui et al., 2009). This study comprised of male participants aged 19 to 23 years old from Kolej Poly-Tech MARA (KPTM) Bangi who had experience in gym training.

x. Heart Rate (HR): Heart was a specialised pump that operates entirely in the body through constant and continuous contraction for delivery blood (Boudoula et al., 2014). HR may also be defined as the pumping action directly induced by the flow of electricity through the heart that repeats the cycle itself, also known as the heart rate (HR). The number of heartbeats

per unit of time generally determined per minute, on the basis of the number of ventricular contractions. During rehearsal or preparation, HR was used to assess the level of strength of the training participants.

1.11 Summary

There are many workout or exercise protocols nowadays commonly used by the practitioner to develop their performance. In order to develop the performance accordingly the target area of individual physiology, the proper and correct exercise protocol have to be chosen. Out of many exercise applied, HIIT, body weight exercise, and functional exercise that including in the Crossfit-based protocol and Tabata-based protocol is the most commonly perform by community and practitioners (Batrakoulis et al., 2020). Thus, the study aimed to determine and compare the acute metabolic response on Crossfit-based protocol and Tabata-based protocol. Furthermore, the outcome may provide informations to the coaches as well as practitioners about the differences of metabolic response on difference workout protocols.