# BUKTI KORESPONDENSI ARTIKEL PADA JURNAL

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Kronologi bukti korespondensi terdiri dari 13 aktivitas pada tabel di bawah ini:

| No | Tanggal | Aktivitas |
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| 1 | 10 Juni 2021 | Submit manuskrip pada jurnal melalui online.<br>Mendapat ID: 19924190 |
| 2 | 19 Juni 2021 | Mendapat jawaban dari email dari Reviewer 1 (Dr. Chloe Crawod) |
| 3 | 27 Juni 2021 | Mengirim Revisi ke 1 |
| 4 | 28 Juni 2021 | Mendapat jawaban dari Reviewer 1<br>Hasil peer review akan diberikan oleh Athony Robinson |
| 5 | 27 Juli 2021 | Mendapat email dari Reviewer 2 (Dr. Anthony Robinson ) yang berisi<br>1. Keputusan Peer Review<br>2. Manuskrip yang sudah direview oleh reviewer 2<br>3. Form Publication Agreement |
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| 9 | 1 September 2021 | Menerima LoA |
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| 12 | 18 Oktober 2021 | Notifikasi bahwa artikel akan dipublikasi |
| 13 | 1 November 2021 | Artikel diterbitkan pada Jurnal Vol 9 (6) |

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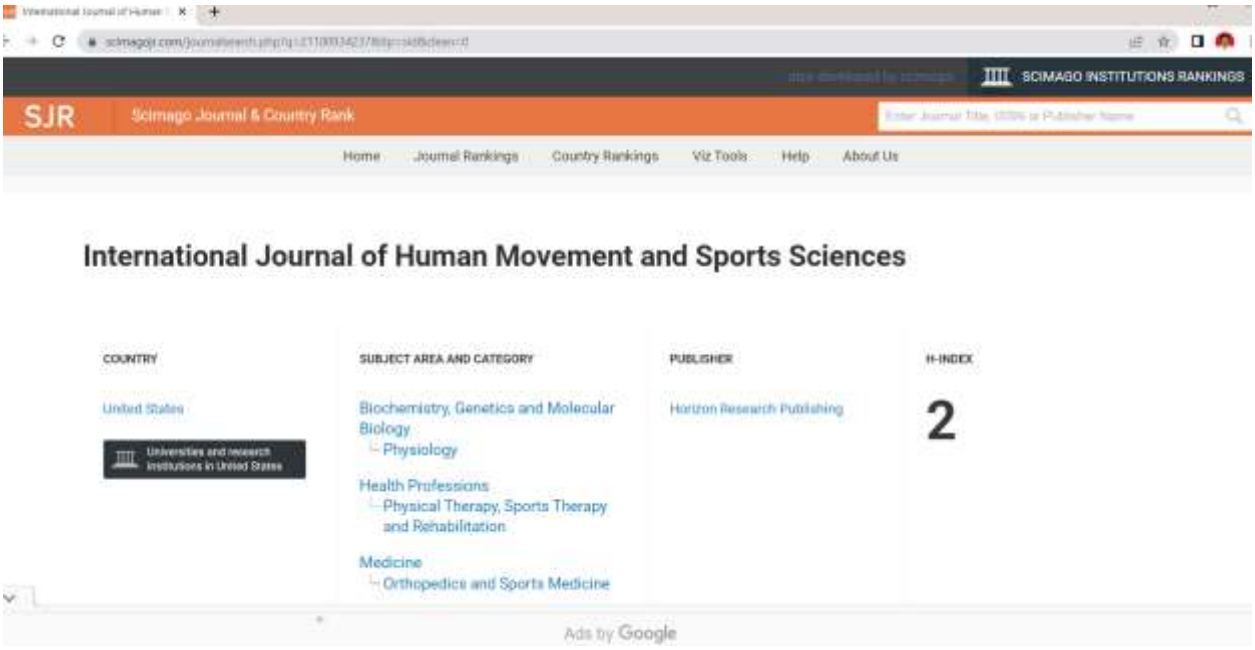


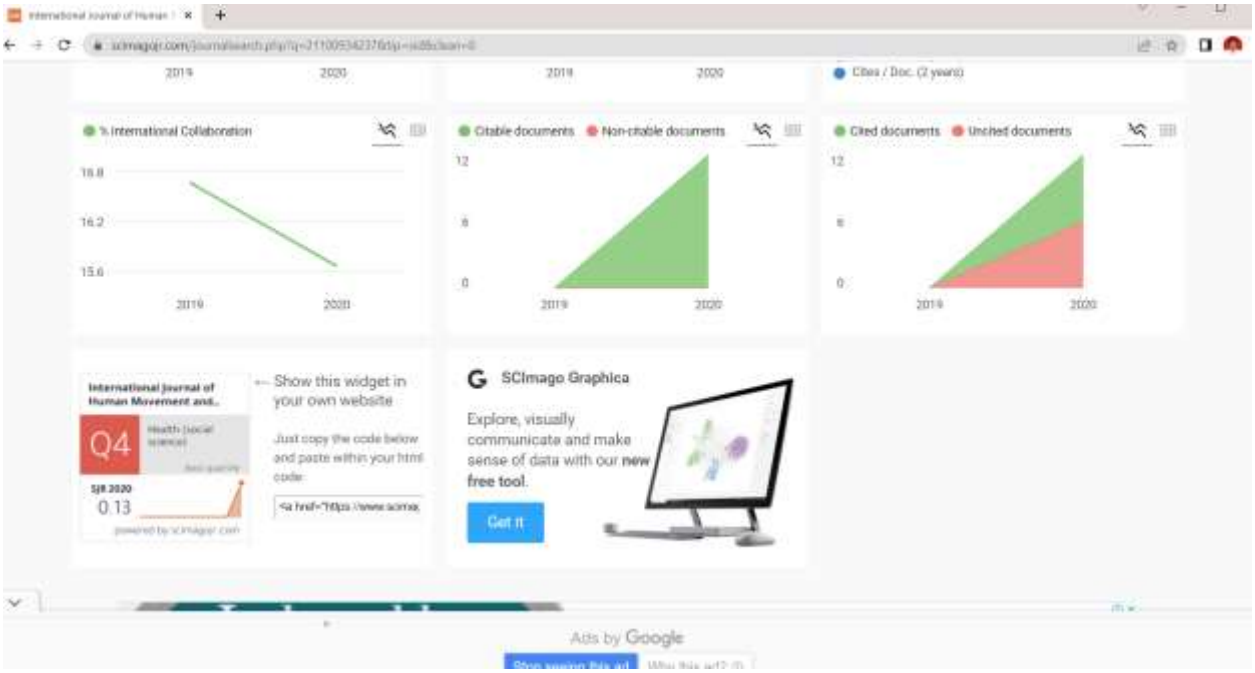
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AKTIVITAS 1. SUBMIT MANUSKRIP MELALUI SISTEM ONLINE

ARTIKEL DISUBMIT

# Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

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## Abstract

High intensity of physical exercise in long period cause muscle damage. Muscle damage in physical exercise can occur due to muscle stretching followed by sarcomere disruption. Muscle damage can be detected by measuring several indicators or markers. Muscle protein efflux during severe physical activities signed by increasing of LDH (lactate dehydrogenase) and CK (creatine Kinase). Many studies explained the effect of high intensity physical exercise in long period to muscle damage, but only few studies investigated the effect of high intensity exercise in short period. The study aims to analyze the blood lactate and creatine kinase serum after high intensity short period physical exercise between elite and non-elite athlete. Seventy-five participants involved in this research, they were elite athletes (37) and non-elite athletes (38). All participants perform Running -based Anaerobic Sprint Test (RAST) as a high-intensity short period. The blood for lactate level and creatine kinase measurement was taken as soon as they finished the RAST. The study showed the minimum power 213 watts (non-elite) and 252 watts (elite). The maximum power were 322 watts (non-elite) and 400 watts (elite). The average of power were 263 watts (non-elite) and 317 watts (elite). The fatigue index was 4.04 watts/sec (non-elite) and 2,80 watts/sec (elite). The blood lactate level was 6.96 (non-elite) and 5.5 (elite). The serum level of creatine kinase was 241 (non-elite) and 198.8 (elite). The differences between elite and non-elite athlete were found in minimum power (p=0.049), maximum power (p=0.015), the average power (p=0.025) and the fatigue index (p=0.015). There was no difference of blood lactate (p=0.063) and serum level of creatine kinase (p=0.241). It can be concluded that the high intensity short period exercise not significantly to cause the muscle damage both of elite and non-elite athletes, although the power was different.

**Keywords** Blood Lactate, Creatine Kinase, Elite Athlete, RAST

## 1. Introduction

Prolonged intense physical exercise raised the muscle damage [1]. Previous study suggested muscle breakdown is one of sources of muscle fatigue during a triathlon [2], marathon [3] and resistance exercise [4]. Muscle damage in physical exercise occur due to muscle stretching followed by sarcomere disruption. The damage of cell membranes resulted in impaired function. The muscle damage not only occurs in skeletal muscles, but also in heart muscle. Study in rat consequences that aerobic and anaerobic physical activities performed for 10 days without any rest-day may cause cardiac muscle damage. Physical activity may result in hypoxia and systemic adaptation [5].

There are two mechanism of muscle damage during exercise: mechanical and metabolic stress. The mechanical stress occurs on muscle during exercise induced by stretching of sarcomeres. When the contractile apparatus, muscle cytoskeleton and sarcolemma-associated proteins stretch over the maximal capacity, the sarcomere was disruptions [6]. Muscle extent during eccentric exercise raised muscle damage risk than either isometric and concentric exercise [7]. Loss of sarcolemma integrity followed by increasing of CK activity and loss of muscle function. Abnormality histological muscle structure was found following the elevation of serum CK [8].

Muscle damage can be detected by measuring several indicators or markers [9][10]. Muscle protein efflux during

severe physical activities signed by increasing of LDH (lactate dehydrogenase) and CK (creatine Kinase). Blood lactate level is the common method to predict the aerobic capacity [11]. Muscle damage can also cause an inflammatory reaction which is characterized by infiltration of inflammatory cells such as neutrophils and macrophages. The infiltration of these inflammatory cells has been implicated in producing secondary cytoskeletal disruptions to eccentrically exercised muscle [12].

Athletes is an individual who do the physical activity in the long period. Regular training and competition already do in high intensity. High physical activity caused muscle fatigue, muscle damage and muscle soreness. Many studies suggested the effect of long period high intensity physical activity to the muscle damage, but only a little study suggested the effect of high intensity in a short period. The aim of this study was to compare the power, blood lactate and CK after short period high intensity physical activity between elite and non-elite athletes.

# 2. Materials and Methods

### 2.1. Participants

The participants of this study joined voluntary by the fill the approval questionary. Seventy-five male athletes participated on this study, consist of 37 elite athletes and 38 non-elite athletes. The inclusion criteria of elite athletes were the athlete who had been gold, silver and bronze medal in national or international competition. The non-elite athletes were student of Sport Faculty Universitas Negeri Semarang. They were 16-31 years old elite athlete and 17-22 years of non-elite athletes.

All participants were examined their healthy by physician before test, included blood pressure, rest heart rate, cardiac and lung function. The doctor decided whether the participant can take the exercise or not. The medical team was in standby during the test.

### 2.2. Running-based Anaerobic Sprint Test

Running Anaerobic-based Sprint Test (RAST) is a high intensity exercise which done in short period. RAST was conducted to determine anaerobic capacity of athlete Participants undertakes a 10-15 minutes warm-up session before main exercise. Participants runs at maximum pace completed six 35 meter running track, with 10 seconds rest allowed between each sprint track for turn around. The time spend was measured for each running track. Total time was summary of time spend to finished first -sixth tracks.

RAST was assessed by several parameters. The parameters of RAST included maximum power, minimum power, average of power, fatigue index and velocity. The calculation of parameters was:

Velocity = (distance/time)
Power (P)= (body weight x distance$^2$)/time$^3$
Fatigue Index (FI)= (Pmax - Pmin)/total time

### 2.3. Creatine Kinase and Blood Lactate analysis

The creatine kinase levels were measured from the peripheral blood. The blood was collected from brachial vein in one hour after they finished the run. The blood was placed in plain tube, transported to laboratory in the cool box. The serum level of CK was measured by Elisa.

Blood lactate level is indirect marker fatigue or damage of exercising muscle. Blood lactate was measured as soon as they finish the running test. The blood was taken from peripheral capillary. The determination of lactate used @Accutrend Plus for lactate strips.

### 2.4. Statistical analysis

The data were collected includes the maximum power, minimum power, average of power, fatigue index, velocity, CK and blood lactate level. All data were exam the normality and homogeneity. The difference of average between elite and non-elite athlete was tested by one-way Anova**.**

### 2.5 Ethical Clearance

The investigation was approved by the Universitas Negeri Semarang Ethics Committee. The aim, purpose and exam procedure were explained to give participant understanding. All participants signed their written informed consent to participate in the study. The study was in agreements with the declaration of Helsinki of the World Medical Association.

# 3. Result

The doctor recommended all participants to involved in study by the healthy condition were good. The blood pressure range between 100/60 mmHg – 140/90, while the rest heart rate between 62 – 88 beats per minute. There were not found the heart and lung disorder.

The minimum power, maximum power, average of power and fatigue index were presented in Table 1. The Table 1. showed that the power of elite athletes higher than non-elite athlete, while the fatigue index was opposite.

The velocity was difference between elite athlete and non-elite athlete (Figure 1.). Elite athlete faster than non-elite athlete for all tracks. The peak of velocity was during third track, both elite and non-elite athlete. The decline of velocity was after the third track. The last track was the lowest velocity (Figure,1).

Blood lactate and creatine kinase serum were evaluated after anaerobic sprint test were presented in Table 2. The average of blood lactate and creatine kinase between elite and non-elite athlete were compared by one-way Anova to analyze the difference value. The value of creatine kinase, blood lactate and the difference were presented in Table. 2

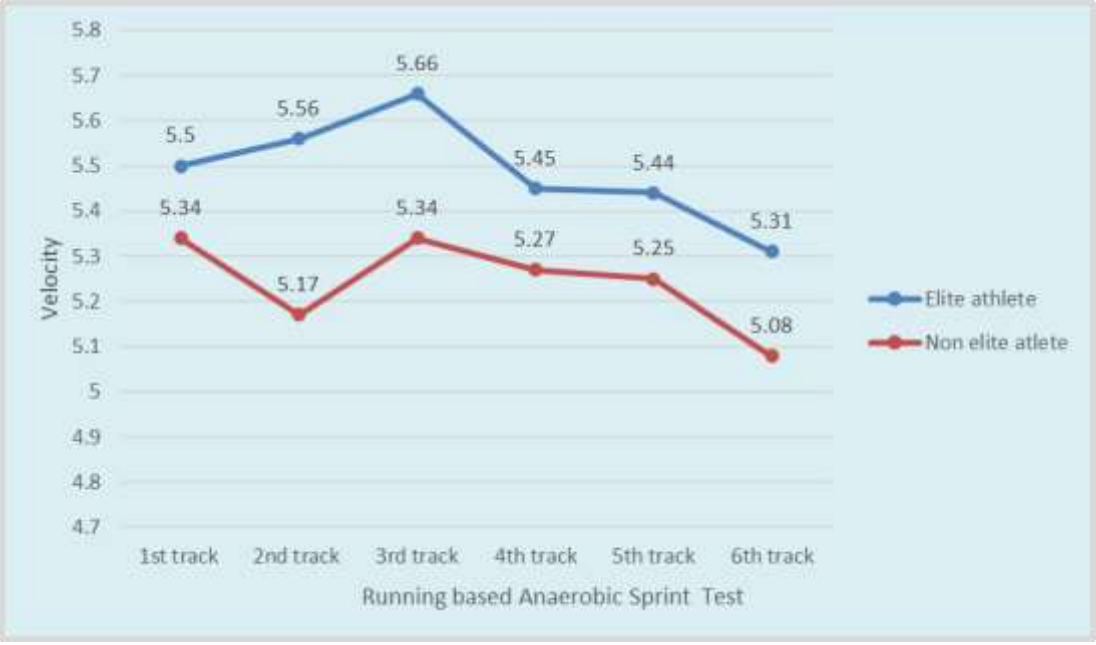


**Figure 1.** The comparison of velocity during RAST

**Table 1**. The comparison RAST between elite and non-elite athlete

| | Elite athlete (n=37) | | | Non-elite athlete (n=38) | | | Difference of average (*p*) |
|---|---|---|---|---|---|---|---|
| | lowest value | highest value | average | lowest value | highest value | average | |
| Minimum Power | 95 | 432 | 252 | 91 | 370 | 213 | 0.049 |
| Maximum Power | 155 | 807 | 400 | 138 | 655 | 322 | 0.015 |
| Average of Power | 117 | 520 | 317 | 112 | 473 | 263 | 0.025 |
| Fatigue Index | 0.70 | 8.88 | 2.80 | 0.90 | 13.42 | 4.04 | 0.015 |

**Table 2**. Blood lactate and Creatine Kinase serum level of elite and non-elite athlete after RAST

| | Elite athlete (n=37) | | | Non-elite athlete(n=38) | | | Difference of average (*p*) |
|---|---|---|---|---|---|---|---|
| | lowest value | highest value | average | lowest value | highest value | average | |
| Creatine Kinase (U/L) | 92 | 523 | 198,8 | 99 | 996 | 241 | 0.067 |
| Blood Lactate | 1 | 11.9 | 5.5 | 2.6 | 15.7 | 6,96 | 0.241 |

## 4. Discusssion

The purposes of this investigation were to examine the effect of high intensity in short period of exercise to muscle damage marker between elite and non-elite athlete. RAST was chosen to examine the athletes because their characteristic, high intensity in short period. RAST is a practicable field test to estimate anaerobic capacity of athlete [13],[14]. RAST is widely used to measure anaerobic capacity in addition to the Wingate test. During the RAST we can know the maximum and minimum power, speed and fatigue index.

Our finding suggested the difference of minimum power, maximum power and fatigue index, but not blood lactate and creatine kinase level. The power and fatigue index of elite-athlete were better than non-elite athlete. The elite athletes get their achievement not only by the exercise factor, but also their talent. The genetic factor role in the determinant of elite athlete like ACTN3 [15], [16], [17].

Lactate is the end products of glycolysis anaerobic. Lactate During intense or strenuous physical exercise blood lactate level can rise to very high. The accumulation lactate increased hydrogen ions concentration and corresponding acidosis. It's well known as a primary factor in muscle fatigue. RAST is a test which finished in several minute. Short activity may not cause accumulation of lactate. The lactate level of elite athlete and non-elite athlete was no difference. It might the elite and non-elite athlete were trained athletes. The trained athlete had well adaptation mechanism to eliminate lactate.

The rest time between the effort may related with CK level. RAST was carried out by taking 6 tracks each 35 meters away, so that only required a short time to finish the test. The interval between tracks was very short, which is 10 seconds. The length of the rest interval affects the increase in CK levels in the blood, shorter rest intervals related to higher CK [4].

The velocity of elite athlete higher than non-elite athlete for all tracks. The peak of velocity reach on third track, and then begin to decline. The last track was the slowest. The velocity was affected on rises the serum creatine kinase. Previous study suggested that fast velocity of eccentric contractions produced higher serum CK activity than slower actions for the same time under tension [18]. The increasing of CK activity during fast velocity might been activated by protein degradation signaling pathways (FOXO1 and FOXO3) and elevate myostatin content in rat skeletal muscle [19]. For concentric muscle actions, in which force and velocity was inversely related, it is likely that a slower movement speed would produce higher elevations in serum CK. [4]. In related with the velocity during RAST, it understandable that the average of CK of elite non-elite athletes was higher than elite athletes.

Many factors influenced the release of CK included gender, age, exercise type, genetic, exercise modality. The degree of CK elevation depends on the type and duration of exercise, i.e aerobic or anaerobic [5], eccentric or concentric [20], [21], chronic or acute [22]. The nutrition influenced the CK serum level related exercise by their antioxidant role and suppressed the inflammatory response [23].

The greater elevation of CK was found in those untrained person [24], [25], [26]. It was understandable that no difference CK and blood lactate level between elite and non-elite athlete. In this study, the non-elite athletes were recruited from student of sport faculty, so they were doing the physical exercise regularly. The trained athlete had the capability adaptation to mechanical and metabolic stress-induced exercise. The muscle fiber proportion may different

between elite athlete and non-elite athletes, but the increasing of CK following exercise-induced muscle damage may not be related to muscle fiber proportions of athletes [27].

However, this research still had some limitation. There was no data about the diet of athlete and the intensity of physical activity before test. In addition, CK serum level only check in once measurement and no follow-up after that. The previous study suggested that the CK serum level was already exist after several days.

## 5. Conclusion

Blood lactate and creatine kinase serum level are indirect marker of muscle damage. Blood lactate and creatine kinase level increased after prolonged high intensity of physical activities. The result of blood lactate and creatine kinase serum level after RAST were not difference between elite and non-elite athletes. It can be concluded that high intensity of anaerobic physical exercise in short period may not cause the muscle damage in athlete, both elite and non-elite.

## Conflicts of interest

There were no conflicts of interest to declare.

## Acknowledgements

This work was supported by Universitas Negeri Semarang Research Program of Indonesian Ministry of Nasional Education.

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AKTIVITAS 2. Mendapat jawaban dari Reviewer 1 (Chloe Crawod) melalui Email



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Dear Dr. Chloe Crawford

Thank you for the review. I have made revisions according to your suggestions and I sent you a revised manuscript.

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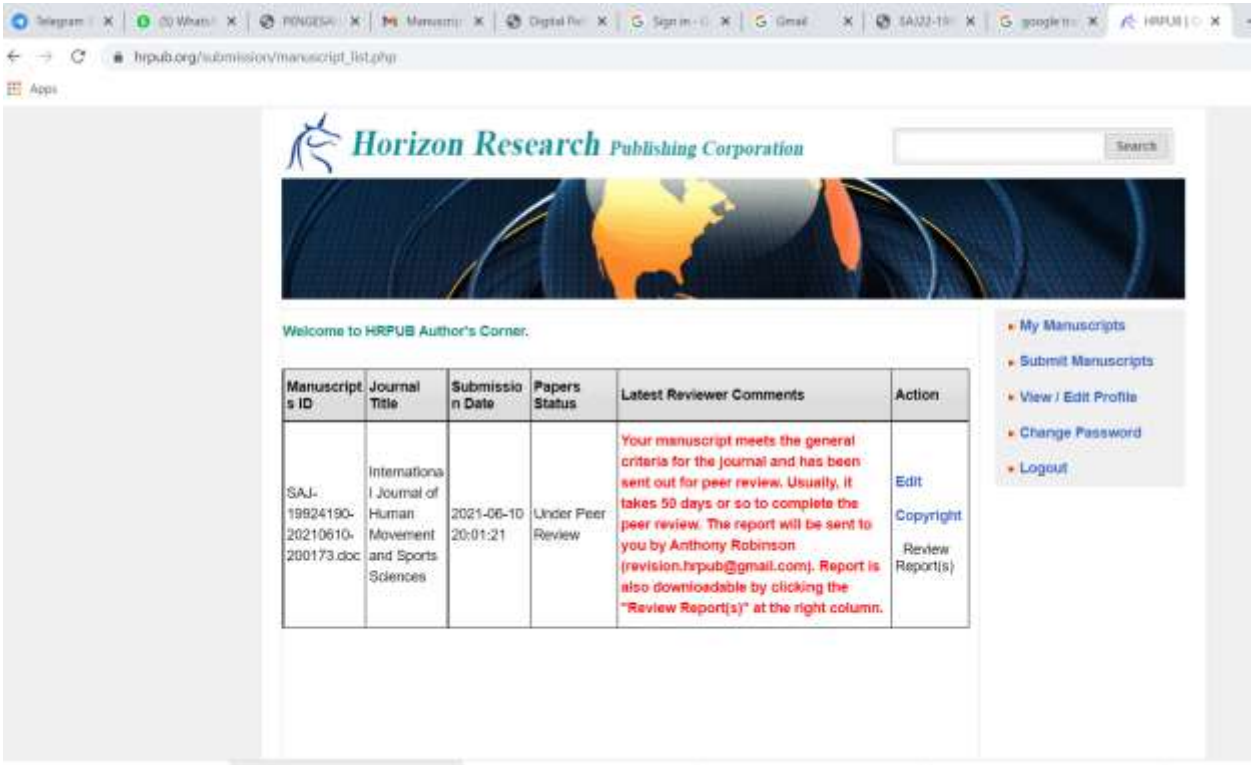

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**Chloe Crawford** <preview.hrpub@gmail.com> Mon, Jun 28, 2021 at 8:55 AM
To: Nasuka Nasuka <nasuka@mail.unnes.ac.id>

Dear Dr. Nasuka, M. Kes,

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## Revision after Peer Review (ID:19924190)-Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

5 messages

**Anthony Robinson** <revision.hrpub@gmail.com> Tue, Jul 27, 2021 at 2:49 PM
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ARTIKEL YANG DIREVIEW OLEH REVIEWER 2 (ANTHONY ROBINSON)

**WHICH TEST IS CONSIDER FOR THE MINIMUM POWER AND MAXIMUM POWER –NOT MENTION –AND WHAT IS THE PURPOSE OF THIS TEST.**

**FOR EXAMPLE**
**EXPLOSIVE POWER: STANDING BROAD JUMP TEST**

# Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

**RED –TO BE DELETED**

**BLUE: TO WRITE / RE-WRITE**

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**Abstract** High intensity of physical exercise in long period cause muscle damage. Muscle damage in physical exercise can occur due to muscle stretching followed by sarcomere disruption. Muscle damage can be detected by measuring several indicators or markers. Muscle protein efflux during severe physical activities signed by increasing of LDH (lactate dehydrogenase) and CK (creatine Kinase).

The study aims to analyze the blood lactate and creatine kinase serum after high intensity short period physical exercise between elite and non-elite athlete. Seventy-five participants involved in this research, they were elite athletes (37) and non-elite athletes (38). **MEAN AGES OF THE PARTICIPANTS XXXXXX.**
All participants perform Running -based Anaerobic Sprint Test (RAST) as a high-intensity short period. The blood for lactate level and creatine kinase measurement was taken as soon as they finished the RAST. The study showed the minimum power 213 watts (non-elite) and 252 watts (elite). The maximum power were 322 watts (non-elite) and 400 watts (elite). The average of power were 263 watts (non-elite) and 317 watts (elite). The fatigue index was 4.04

watts/sec (non-elite) and 2,80 watts/sec (elite). The blood lactate level was 6.96 (non-elite) and 5.5 (elite). The serum level of creatine kinase was 241 (non-elite) and 198.8 (elite). The differences between elite and non-elite athlete were found in minimum power (p=0.049), maximum power (p=0.015), the average power (p=0.025) and the fatigue index (p=0.015). There was no difference of blood lactate (p=0.063) and serum level of creatine kinase (p=0.241).

**It can be concluded** that the high intensity short period exercise not significantly to cause the muscle damage both of elite and non-elite athletes, although the power was different.

It is concluded that the high intensity short period exercise not significantly cause the muscle damage elite and non-elite athletes groups, (**although the power was different- kindly re-write the sentence –not clear).**

**Keywords** Blood Lactate, Creatine Kinase, Elite Athlete, RAST

(Many **earlier** studies **had** explained the effect of high intensity physical exercise in long period to muscle damage, but only few studies investigated the effect of high intensity exercise in short period – **should be included in INTRODUCTION PART)**

---

## 1. Introduction

Prolonged intense physical exercise raised the muscle damage [1]. Previous study suggested muscle breakdown is one of sources of muscle fatigue during a triathlon [2], marathon [3] and resistance exercise [4]. Muscle damage in physical exercise occur due to muscle stretching followed by sarcomere disruption. The damage of cell membranes resulted in impaired function. The muscle damage not only occurs in skeletal muscles, but also in heart muscle. Study in rat consequences that aerobic and anaerobic physical activities performed for 10 days without any rest-day may cause cardiac muscle damage. Physical activity may result in hypoxia and systemic adaptation [5].

There are two mechanism of muscle damage during exercise: mechanical and metabolic stress. The mechanical stress occurs on muscle during exercise induced by stretching of sarcomeres. When the contractile apparatus, muscle cytoskeleton and sarcolemma-associated proteins stretch over the maximal capacity, the sarcomere was disruptions [6]. Muscle extent during eccentric exercise raised muscle damage risk than either isometric and concentric exercise [7]. Loss of sarcolemma integrity followed by increasing of CK activity and loss of muscle function. Abnormality histological muscle structure was found following the elevation of serum CK [8].

Muscle damage can be detected by measuring several indicators or markers [9][10]. Muscle protein efflux during severe physical activities signed by increasing of LDH (lactate dehydrogenase) and CK (creatine Kinase). Blood lactate level is the common method to predict the aerobic capacity [11]. Muscle damage can also cause an inflammatory reaction which is characterized by infiltration of inflammatory cells such as neutrophils and macrophages. The infiltration of these inflammatory cells has been implicated in producing secondary cytoskeletal disruptions to eccentrically exercised muscle [12].

Athletes is an individual who do the physical activity in the long period. Regular training and competition already do in high intensity. High physical activity caused muscle fatigue, muscle damage and muscle soreness. Many studies suggested the effect of long period high intensity physical activity to the muscle damage, but only a little study suggested the effect of high intensity in a short period. The aim of this study was to compare the power, blood lactate and CK after short period high intensity physical activity between elite and non-elite athletes.

## 2. Materials and Methods

### 2.1. Participants

The participants of this study joined voluntary by the fill the approval questionary. Seventy-five male athletes participated on this study, consist of 37 elite athletes and 38 non-elite athletes. The inclusion criteria of elite athletes were the athlete who had been gold, silver and bronze medal in national or international competition. The non-elite athletes were student of Sport Faculty Universitas Negeri Semarang. They were 16-31 years old elite athlete and 17-22 years of non-elite athletes.

All participants were examined their healthy by physician before test, included blood pressure, rest heart rate, cardiac and lung function. The doctor decided whether the participant can take the exercise or not. The medical team was in standby during the test.

### 2.2. Running-based Anaerobic Sprint Test

Running Anaerobic-based Sprint Test (RAST) is a high intensity exercise which done in short period. RAST was conducted to determine anaerobic capacity of athlete Participants undertakes a 10-15 minutes warm-up session before main exercise. Participants runs at maximum pace completed six 35 meter running track, with 10 seconds rest allowed between each sprint track for turn around. The time spend was measured for each running track. Total time was summary of time spend to finished first -sixth tracks.

RAST was assessed by several parameters. The parameters of RAST included maximum power, minimum power, average of power, fatigue index and velocity. The calculation of parameters was:

Velocity = (distance/time)

Power (P)= (body weight x distance$^2$)/time$^3$

Fatigue Index (FI)= (Pmax - Pmin)/total time

### 2.3. Creatine Kinase and Blood Lactate analysis

The creatine kinase levels were measured from the peripheral blood. The blood was collected from brachial vein in one hour after they finished the run. The blood was placed in plain tube, transported to laboratory in the cool box. The serum level of CK was measured by Elisa.

Blood lactate level is indirect marker fatigue or damage of exercising muscle. Blood lactate was measured as soon as they finish the running test. The blood was taken from peripheral capillary. The determination of lactate used @Accutrend Plus for lactate strips.

### 2.4. Statistical analysis

The data were collected includes the maximum power, minimum power, average of power, fatigue index, velocity, CK and blood lactate level. All data were exam the normality and homogeneity. The difference of average between elite and non-elite athlete was tested by one-way Anova**.**

### 2.5 Ethical Clearance

The investigation was approved by the Universitas Negeri Semarang Ethics Committee. The aim, purpose and exam procedure were explained to give participant understanding. All participants signed their written informed consent to participate in the study. The study was in agreements with the declaration of Helsinki of the World Medical Association.

## 3. Result

The doctor recommended all participants to involved in study by the healthy condition were good. The blood pressure range between 100/60 mmHg – 140/90, while the rest heart rate between 62 – 88 beats per minute. There were not found the heart and lung disorder.

The minimum power, maximum power, average of power and fatigue index were presented in Table 1. The Table 1. showed that the power of elite athletes higher than non-elite athlete, while the fatigue index was opposite.

The velocity was difference between elite athlete and non-elite athlete (Figure 1.). Elite athlete faster than non-elite athlete for all tracks. The peak of velocity was during third track, both elite and non-elite athlete. The decline of velocity was after the third track. The last track was the lowest velocity (Figure,1).

Blood lactate and creatine kinase serum were evaluated after anaerobic sprint test were presented in Table 2. The average of blood lactate and creatine kinase between elite and non-elite athlete were compared by one-way Anova to analyze the difference value. The value of creatine kinase, blood lactate and the difference were presented in Table. 2

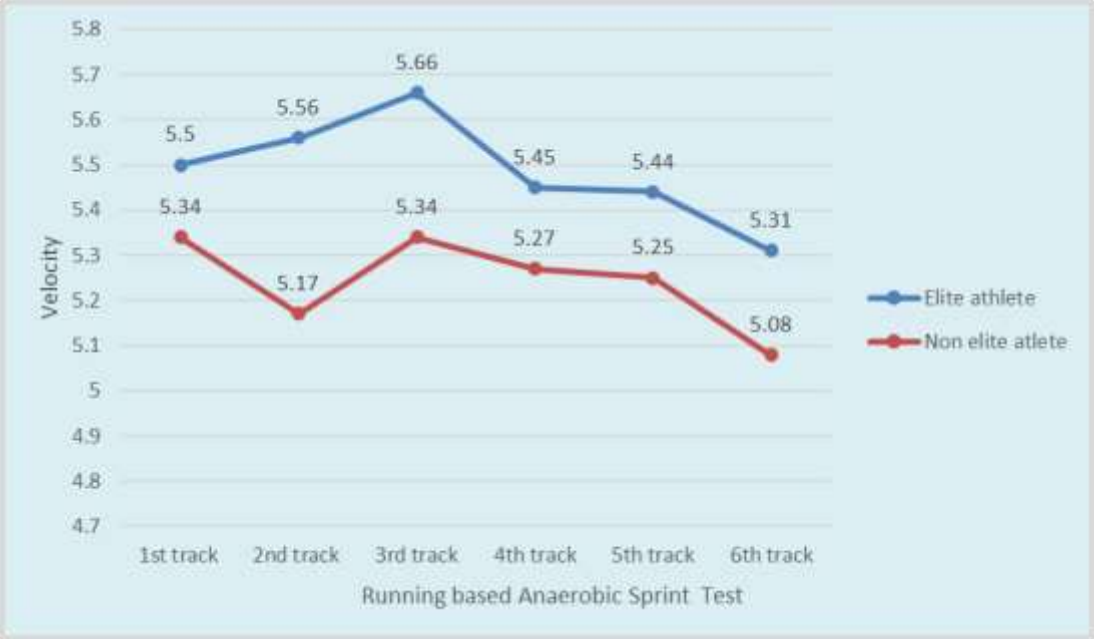


**Figure 1.** The comparison of velocity during RAST

**Table 1**. The comparison RAST between elite and non-elite athlete

| | Elite athlete (n=37) | | | Non-elite athlete (n=38) | | | Difference of average (*p*) |
|---|---|---|---|---|---|---|---|
| | lowest value | highest value | average | lowest value | highest value | average | |
| Minimum Power | 95 | 432 | 252 | 91 | 370 | 213 | 0.049 |
| Maximum Power | 155 | 807 | 400 | 138 | 655 | 322 | 0.015 |
| Average of Power | 117 | 520 | 317 | 112 | 473 | 263 | 0.025 |
| Fatigue Index | 0.70 | 8.88 | 2.80 | 0.90 | 13.42 | 4.04 | 0.015 |

**Table 2**. Blood lactate and Creatine Kinase serum level of elite and non-elite athlete after RAST

| | Elite athlete (n=37) | | | Non-elite athlete(n=38) | | | Difference of average (*p*) |
|---|---|---|---|---|---|---|---|
| | lowest value | highest value | average | lowest value | highest value | average | |
| Creatine Kinase (U/L) | 92 | 523 | 198,8 | 99 | 996 | 241 | 0.067 |
| Blood Lactate | 1 | 11.9 | 5.5 | 2.6 | 15.7 | 6,96 | 0.241 |

## 4. Discussion

The purposes of this investigation were to examine the effect of high intensity in short period of exercise to muscle damage marker between elite and non-elite athlete. RAST was chosen to examine the athletes because their characteristic, high intensity in short period. RAST is a practicable field test to estimate anaerobic capacity of athlete [13],[14]. RAST is widely used to measure anaerobic capacity in addition to the Wingate test. During the RAST we can know the maximum and minimum power, speed and fatigue index.

Our finding suggested the difference of minimum power, maximum power and fatigue index, but not blood lactate and creatine kinase level. The power and fatigue index of elite-athlete were better than non-elite athlete. The elite athletes get their achievement not only by the exercise factor, but also their talent. The genetic factor role in the determinant of elite athlete like ACTN3 [15], [16], [17].

Lactate is the end products of glycolysis anaerobic. Lactate During intense or strenuous physical exercise blood lactate level can rise to very high. The accumulation lactate increased hydrogen ions concentration and corresponding acidosis. It's well known as a primary factor in muscle fatigue. RAST is a test which finished in several minute. Short activity may not cause accumulation of lactate. The lactate level of elite athlete and non-elite athlete was no difference. It might the elite and non-elite athlete were trained athletes. The trained athlete had well adaptation mechanism to eliminate lactate.

The rest time between the effort may related with CK level. RAST was carried out by taking 6 tracks each 35 meters away, so that only required a short time to finish the test. The interval between tracks was very short, which is 10 seconds. The length of the rest interval affects the increase in CK levels in the blood, shorter rest intervals related to higher CK [4].

The velocity of elite athlete higher than non-elite athlete for all tracks. The peak of velocity reach on third track, and then begin to decline. The last track was the slowest. The velocity was affected on rises the serum creatine kinase. Previous study suggested that fast velocity of eccentric contractions produced higher serum CK activity than slower actions for the same time under tension [18]. The increasing of CK activity during fast velocity might been activated by protein degradation signaling pathways (FOXO1 and FOXO3) and elevate myostatin content in rat skeletal muscle [19]. For concentric muscle actions, in which force and velocity was inversely related, it is likely that a slower movement speed would produce higher elevations in serum CK. [4]. In related with the velocity during RAST, it understandable that the average of CK of elite non-elite athletes was higher than elite athletes.

Many factors influenced the release of CK included gender, age, exercise type, genetic, exercise modality. The degree of CK elevation depends on the type and duration of exercise, i.e aerobic or anaerobic [5], eccentric or concentric [20], [21], chronic or acute [22]. The nutrition influenced the CK serum level related exercise by their antioxidant role and suppressed the inflammatory response [23].

The greater elevation of CK was found in those untrained person [24], [25], [26]. It was understandable that no difference CK and blood lactate level between elite and non-elite athlete. In this study, the non-elite athletes were recruited from student of sport faculty, so they were doing the physical exercise regularly. The trained athlete had the capability adaptation to mechanical and metabolic stress-induced exercise. The muscle fiber proportion may different between elite athlete and non-elite athletes, but the increasing of CK following exercise-induced muscle damage may not be related to muscle fiber proportions of athletes [27].

However, this research still had some limitation. There was no data about the diet of athlete and the intensity of physical activity before test. In addition, CK serum level only check in once measurement and no follow-up after that. The previous study suggested that the CK serum level was already exist after several days.

## 5. Conclusions

Blood lactate and creatine kinase serum level are indirect marker of muscle damage. Blood lactate and creatine kinase level increased after prolonged high intensity of physical activities. The result of blood lactate and creatine kinase serum level after RAST were not difference between elite and non-elite athletes. It can be concluded that high intensity of anaerobic physical exercise in short period may not cause the muscle damage in athlete, both elite and non-elite.

**NOTE:** YOU HAD NOT MENTIONED THAT THE HIGH

INTENSITY OF ANAEROBIC PHYSICAL EXERCISE IN SHORT PERIOD MAY NOT CAUSE THE MUSCLE DAMAGE IN ELITE AND NON –ELITE.

YOU HAD NOT MENTIONED OR EXPLAINED THE TRAINING PROTOCOL EMPLOYED ON ELITE AND NON-ELITE GROUPS.

IF YOU ADMINTER THE TRAINING PROTOCOL YOU HAVE TO SEE THE DIFFERENCE FROM PRE TO POST TEST.

YOU HAD JUST COMPARE THE STATUS BETWEEN ELITE AND NON-ELITE

KINDLY RE-WRITE THE CONCLUSIONS CAREFULLY.

---

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2/21/22, 3:20 PM UNNES Mail - Revision after Peer Review (ID:19924190)-Creatine Kinase and Blood Lactate on High Intensity Short Period ...

**Nasuka Nasuka** <nasuka@mail.unnes.ac.id> Sat, Jul 31, 2021 at 10:16 PM
To: Anthony Robinson <revision.hrpub@gmail.com>

Dear Dr. Anthony Robinson

Thank you for the review. I have made revisions according to your suggestions and I sent you a revised manuscript.

Thank you

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--

Regards,
Dr.Nasuka, M.Kes
( ORCID http://orcid.org/0000-0003-3818-4987 , Scopus ID 57205025296 ) Associate Professor of Sport Coaching
Department, Sport Sciences Faculty (+62)24 - 8508007 Universitas Negeri Semarang, Indonesia


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**Anthony Robinson** <revision.hrpub@gmail.com> Mon, Aug 2, 2021 at 8:40 AM
To: Nasuka Nasuka <nasuka@mail.unnes.ac.id>

Dear Nasuka,

Thank you for your reply.
Please send the revised paper and cover letter to us via email after you finish it.

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AKTIVITAS 9. MENERIMA LETTER OF ACCEPTANCE



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**Nasuka Nasuka <nasuka@mail.unnes.ac.id>**

## Acceptance Letter & Advice of Payment (ID:19924190)-Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

3 messages

**Anthony Robinson** <revision.hrpub@gmail.com> Wed, Sep 1, 2021 at 10:14 AM
To: Nasuka Nasuka <nasuka@mail.unnes.ac.id>

Dear Nasuka,

Your paper has been accepted for publication. Herewith attached is the Acceptance Letter.

The publication fee is $480. Below are Wire Transfer instructions.

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Once the payment is finished, please inform us or send the remittance bill to us.

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**Nasuka Nasuka** <nasuka@mail.unnes.ac.id> Thu, Sep 2, 2021 at 1:41 PM
To: Anthony Robinson <revision.hrpub@gmail.com>

Dear Dr. Anthony Robinson,
I have received the Letter of Acceptance and have made the APC payment. Here I attach proof of transfer from BNI to Cathay Bank.

Thank you

Horizon Research Publishing Corporation, USA

Date: 08/31/2021

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# Acceptance Letter

Dear Nasuka,

Congratulations! As a result of the reviews and revisions, we are pleased to inform you that your following paper has been accepted for publication.

Paper Title: Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

Paper ID: 19924190

Contributor (s): Nasuka, Anies Setiowati, Fitri Indrawati

It is scheduled for publication on International Journal of Human Movement and Sports Sciences, Vol 9, No 6.

The publication fee $ 480 should be paid within 2 weeks.

Should you have any questions, please feel free to let us know by quoting your **Paper ID** in any future inquiries.

Best wishes,

John Thompson

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## Proof Reading before Publication (ID:19924190)-Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

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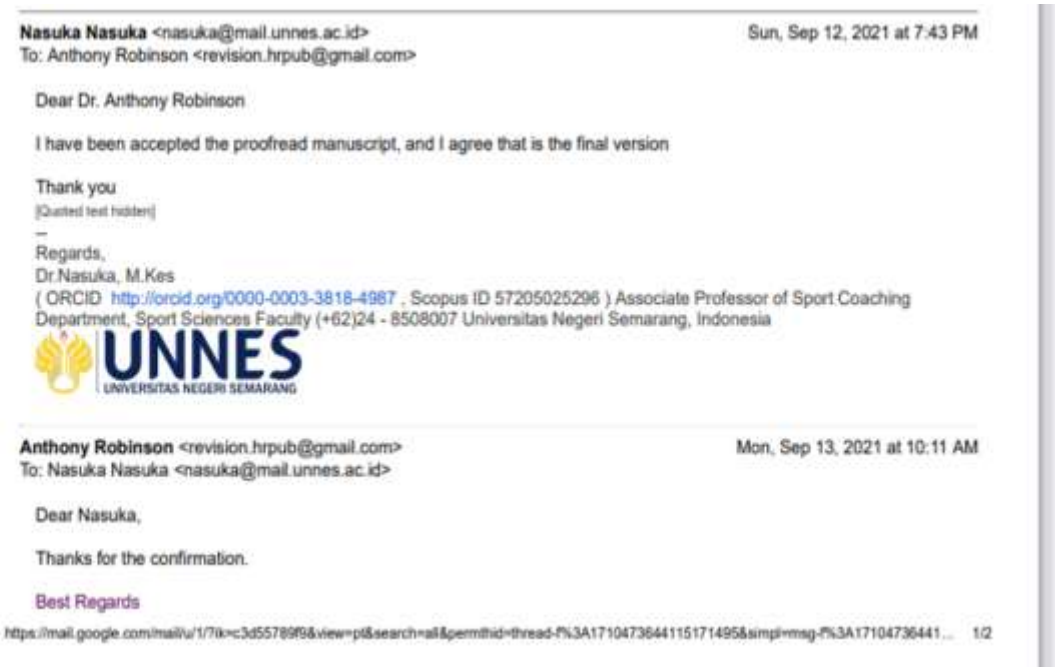

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Dear Dr. Anthony Robinson

I have been accepted the proofread manuscript, and I agree that is the final version

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Regards,
Dr.Nasuka, M.Kes
( ORCID http://orcid.org/0000-0003-3818-4987 , Scopus ID 57205025296 ) Associate Professor of Sport Coaching
Department, Sport Sciences Faculty (+62)24 - 8508007 Universitas Negeri Semarang, Indonesia

**Anthony Robinson** <revision.hrpub@gmail.com> Mon, Sep 13, 2021 at 10:11 AM
To: Nasuka Nasuka <nasuka@mail.unnes.ac.id>

Dear Nasuka,

Thanks for the confirmation.

Best Regards

AKTIVITAS 12. Menerima Notifikasi Untuk Publikasi



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Nasuka Nasuka <nasuka@mail.unnes.ac.id>

## Notification of Final Publication

1 message

**editor@hrpub.org** <editor@hrpub.org> Mon, Oct 18, 2021 at 8:12 PM
To: nasuka@mail.unnes.ac.id

Dear Nasuka,

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Best regards,

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AKTIVITAS 13. Artikel di publikasi pada Vol 9 no. 6



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International Journal of Human Movement and Sports Sciences Vol. 9(6), pp. 1081 - 1086
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# Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

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**ABSTRACT**

High intensity of physical exercise in long period causes muscle damage. Muscle damage in physical exercise can occur due to muscle stretching followed by sarcomere disruption. Muscle damage can be detected by measuring several indicators or markers. Muscle protein efflux during severe physical activities signed by the increase of LDH (lactate dehydrogenase) and CK (Creatine Kinase). Many studies explained the effect of high intensity physical exercise in long period on muscle damage, but only few studies investigated the effect of high intensity exercise in short period. The purpose of research is to analyze the high intensity short period exercise on blood lactate and creatine kinase serum between elite and non-elite athlete. The post test only group design study was conducted to reach the aims of research. Seventy-five participants involved in this research and they were elite athletes (n=37) and non-elite athletes (n=38). The elite athletes were 24.71 ± 4.753 years old, while the non-elite athletes were 20.19 ± 1.619 years old. All participants perform Running -based Anaerobic Sprint Test (RAST) as a high-intensity short period exercise. The velocity of athletes was calculated for each running track. The blood for lactate level and creatine kinase (CK) measurement was taken as soon as they finished the RAST. The blood lactate level was 6.96 mmol/L (non-elite) and 5.5 mmol/L (elite). The serum level of CK was 241 (non-elite) and 198.8 (elite). Both of elite and non-elite CK level were higher than normal value. There was no difference in blood lactate (p=0.063) and serum level of CK (p=0.241) between elite and non-elite athlete. The conclusion was the blood lactate and CK serum level after high intensity short period increased higher than the normal value. There was not difference between elite and non-elite athletes, suggesting that the elite and non-elite athletes put in the same effort in performing and running the test. The recommendation of this research is that the high intensity short period exercise should be alternatively implemented to avoid muscle damage to athlete.


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# Creatine Kinase and Blood Lactate on High Intensity Short Period Exercise

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**Abstract** High intensity of physical exercise in long period causes muscle damage. Muscle damage in physical exercise can occur due to muscle stretching followed by sarcomere disruption. Muscle damage can be detected by measuring several indicators or markers. Muscle protein efflux during severe physical activities signed by the increase of LDH (lactate dehydrogenase) and CK (Creatine Kinase). Many studies explained the effect of high intensity physical exercise in long period on muscle damage, but only few studies investigated the effect of high intensity exercise in short period. The purpose of research is to analyze the high intensity short period exercise on blood lactate and creatine kinase serum between elite and non-elite athlete. The post test only group design study was conducted to reach the aims of research. Seventy-five participants involved in this research and they were elite athletes (n=37) and non-elite athletes (n=38). The elite athletes were 24.71 ± 4.753 years old, while the non-elite athletes were 20.19 ± 1.619 years old. All participants perform Running -based Anaerobic Sprint Test (RAST) as a high-intensity short period exercise. The velocity of athletes was calculated for each running track. The blood for lactate level and creatine kinase (CK) measurement was taken as soon as they finished the RAST. The blood lactate level was 6.96 mmol/L (non-elite) and 5.5 mmol/L (elite). The serum level of CK was 241 (non-elite) and 198.8 (elite). Both of elite and non-elite CK level were higher than normal value. There was no difference in blood lactate (p=0.063) and serum level of CK (p=0.241) between elite and non-elite athlete. The conclusion was the blood lactate and CK serum level after high intensity short period increased higher than the normal value. There was not difference between elite and non-elite athletes, suggesting that the elite and non-elite athletes put in the same effort in performing and running the test. The recommendation of this research is that the high intensity short period exercise should be alternatively implemented to avoid muscle damage to athlete.

**Keywords** Blood Lactate, Creatine Kinase, High Intensity Exercise

## 1. Introduction

Prolonged intense physical exercise raised the muscle damage [1]. Previous study suggested muscle breakdown is one of the sources of muscle fatigue during a triathlon [2], marathon [3] and resistance exercise [4]. Muscle damage in physical exercise occurs due to muscle stretching followed by sarcomere disruption. The damage of cell membranes resulted in impaired function. The muscle damage not only occurs in skeletal muscles, but also in heart muscle. Study in rat consequences that aerobic and anaerobic physical activities performed for 10 days without any rest-day may cause cardiac muscle damage. Physical activity may result in hypoxia and

systemic adaptation [5].

There are two mechanism of muscle damage during exercise: mechanical and metabolic stress. The mechanical stress occurs on muscle during exercise induced by stretching of sarcomeres. When the contractile apparatus, muscle cytoskeleton and sarcolemma-associated proteins stretch over the maximal capacity, the sarcomere was disruptions [6]. Muscle extent during eccentric exercise raised muscle damage risk than either isometric or concentric exercise [7]. Loss of sarcolemma integrity followed by increasing of CK activity and loss of muscle function. Abnormality histological muscle structure was found following the elevation of serum CK [8].

Muscle damage can be detected by measuring several indicators or markers [9][10]. Muscle protein efflux during severe physical activities signed by the increase of LDH (lactate dehydrogenase) and CK (Creatine Kinase). Blood lactate level is a common method for predicting the aerobic capacity [11]. Muscle damage can also cause an inflammatory reaction which is characterized by infiltration of inflammatory cells such as neutrophils and macrophages. The infiltration of these inflammatory cells has been implicated in producing secondary cytoskeletal disruptions to eccentrically exercised muscle [12].

Several studies on the effect of high-intensity exercise over a long period, i.e., all our running, long distances swimming, marathon, have been performed to observed the metabolic change. The metabolic changes in exercise markers such as oxygen consumption, blood lactate, and creatine kinase were analyzed in swimmers [13], runners [14] and endurance athletes [15].

Athlete is an individual who do physical activity in the long period. Regular training and competition have already been done in high intensity. High physical activity caused muscle fatigue, muscle damage and muscle soreness. Many studies suggested the effect of long period high intensity physical activity on the muscle damage, but only a little study suggested the effect of high intensity in a short period. The aim of this study was to compare the power, blood lactate and CK after short period high intensity physical activity.

## 2. Materials and Methods

### 2.1. Participants

The participants of this study joined voluntarily by the fill the approval questionary. Seventy-five male athletes participated in this study, consist of 37 elite athletes and 38 non-elite athletes. The inclusion criteria of elite athletes were the athlete who had been gold, silver and bronze medal in national or international competition. The non-elite athletes were students of Sport Faculty Universitas Negeri Semarang. They were 16-31 years old of elite athlete and 17-22 years of non-elite athletes.

All participants were examined by physician before tested, included blood pressure, rest heart rate, cardiac and lung function. The doctor decided whether the participant can take the exercise or not. The medical team was in standby during the test.

### 2.2. Exercise Protocol

Running Anaerobic-based Sprint Test (RAST) is a high intensity exercise which is done in short period. RAST was conducted to determine anaerobic capacity of athlete. The exam begin with 10-15 minutes warm-up session before main exercise. Participants take a starting position behind the start line. Participant runs at maximum pace completed six 35 meter running tracks, with 10 seconds rest allowed between each sprint track for turn around. The time spend was measured for each running track. Total time was summary of time spend to finished first-sixth tracks. Velocity was calculated for each track, which was the distance (35 meter) divided by the track's travel time.

### 2.3. Creatine Kinase and Blood Lactate Analysis

The CK levels were measured from the peripheral blood. The blood was collected from brachial vein in one hour after they finished the run. The blood was placed in plain tube without EDTA, transported to laboratory in the cool box. The serum level of CK was measured by Elisa.

Blood lactate level is indirect marker fatigue or damage of exercising muscle. Blood lactate was measured as soon as athlete finished the running test. The blood was taken from peripheral capillary. The determination of lactate used @Accutrend Plus for lactate strips.

### 2.4. Statistical Analysis

The data were collected, including the velocity, CK and blood lactate level. The value was presented as mean ± SD. All data were exam by the normality and homogeneity test. By the normal and homogenous data, the difference of average between elite and non-elite athlete was tested by one-way Anova.

### 2.5. Ethical Clearance

The investigation was approved by the Universitas Negeri Semarang Ethics Committee. The aim, purpose and exam procedure were explained to help participant understanding. All participants signed their written informed consent to participate in the study. The study was in agreements with the declaration of Helsinki of the World Medical Association.

## 3. Result

The medical doctor recommended that all participants

be involved in study if they are in good health. The blood pressure range between 100/60 mmHg – 140/90 mmHg. No one was not found to have heart and lung disorder. Age, body height, body weight, body mass index and rest heart rate of participants are presented in Table 1.

The velocity was different between elite athlete and non-elite athlete (Figure 1). Elite athlete are faster than non-elite athlete for all tracks. The peak of velocity was during third track, both elite and non-elite athlete. The decline of velocity was after the third track. The last track was the lowest velocity.

Blood lactate and CK serum were evaluated after anaerobic sprint test were presented in Table 2. The average of blood lactate and CK between elite and non-elite athlete were compared by one-way Anova to analyze the difference value. The value of creatine kinase, blood lactate and the difference were presented in Table 2.

**Table 1.** The Characteristic of Participant

| | Elite athlete (n=37) | Non-elite athlete (n=38) |
|---|---|---|
| **Age (year)** | 24.71 ± 4.753 | 20.19 ± 1.619 |
| **Body Weight (kg)** | 67.38 ± 12.656 | 62.63 ± 8.286 |
| **Body Height (cm)** | 171.4 ± 8.56 | 172.9 ± 7.85 |
| **Body mass Index ($kg/m^2$)** | 22.94 ± 4.10 | 21.21 ± 3.08 |
| **Rest heart rate (bpm)** | 74.7 ± 8.06 | 75.1 ± 7.54 |


**Figure 1.** The velocity of 1st - 6th track during Running-based Anaerobic Sprint Test between elite and non-elite athlete

**Table 2.** The Blood lactate and Creatine Kinase serum level of elite and non-elite athlete

| | Elite athlete (n=37) | | | Non-elite athlete(n=38) | | | Difference of average (p) |
|---|---|---|---|---|---|---|---|
| | lowest value | highest value | average | lowest value | highest value | average | |
| **Creatine Kinase (U/L)** | 92 | 523 | 198.8 | 99 | 996 | 241 | 0.067 |
| **Blood Lactate (mmol/L)** | 1 | 11.9 | 5.5 | 2.6 | 15.7 | 6.96 | 0.241 |

## 4. Discussion

A kind of sport had a characteristic motor skill, i.e., sprint for soccer, vertical jump for volleyball and basketball player, power of arm for badminton player, etc. The motor skills can be trained by various training models, for example, 4 weeks sprint training enhanced vertical jump height of volleyball players [16]. Sprint training was conducted in high intensity but only in several seconds. The purposes of this investigation were to examine the effect of high intensity in short period of exercise on muscle damage marker between elite and non-elite athlete. RAST was chosen to examine the athletes because of the high intensity in short period. RAST is a practicable field test to estimate anaerobic capacity of athlete [17],[18]. RAST is widely used to measure anaerobic capacity in addition to the Wingate test. During the RAST we can know the maximum and minimum power, velocity and fatigue index.

The elite athletes get their achievement not only by the exercise factor, but also their talent. The genetic factor role in the determinant of elite athlete like ACTN3 [19], [20], [21]. The elite athlete and non-elite athlete differ in terms of level of competition. The difference in the level of competition is the implication of the difference in the frequency of training per week [22]. Gene, training and strong competitive mentality factors simultaneously form an elite athlete.

Lactate is the end products of glycolysis anaerobic. Blood lactate commonly increased after intensive exercise [14]. During intense or strenuous physical exercise blood lactate level can rise to very high. The accumulation lactate increased hydrogen ions concentration and corresponding acidosis. It is well known as a primary factor in muscle fatigue. RAST is a test which finished in several minute. Short activity may not cause accumulation of lactate. The lactate level of elite athlete and non-elite athlete was no difference. The elite and non-elite athlete were trained athletes. The trained athlete had well adaptation mechanism to eliminate lactate.

In comparison with the normal value, the level of CK was higher, both elite and non-elite athlete. Normal CK levels range from 55-170 U/L [23]. High CK levels during exercise are intended to ensure the availability of energy for muscle contraction. The high CK serum levels, without the other markers, do not necessarily indicate muscle damage. In strenuous exercise, serum CK may increase two or three times higher than normal in the resting condition [15].

The rest time between the effort may related with CK level. RAST was carried out by taking 6 tracks each 35 meters away, so that only required a short time to finish the test. The interval between tracks was very short, which is 10 seconds. The length of the rest interval affects the increase in CK levels in the blood, shorter rest intervals related to higher CK [4].

The velocity of elite athlete is higher than non-elite athlete for all tracks. The peak of velocity reaches on third track, and then begins to decline. The last track was the slowest. The velocity was affected on rises the serum creatine kinase. Previous study suggested that fast velocity of eccentric contractions produced higher serum CK activity than slower actions for the same time under tension [24]. The increase of CK activity during fast velocity might be activated by protein degradation signaling pathways (FOXO1 and FOXO3) and elevate myostatin content in rat skeletal muscle [25]. For concentric muscle actions, in which force and velocity was inversely related, it is likely that a slower movement speed would produce higher elevations in serum CK. [4]. In relation to the velocity during RAST, it is understandable that the average of CK of elite non-elite athletes was higher than elite athletes.

Many factors influenced the release of CK included gender, age, exercise type, genetic, exercise modality. The degree of CK elevation depends on the type and duration of exercise, i.e. aerobic or anaerobic [5], eccentric or concentric [26], [27], chronic or acute [28]. The nutrition influenced the CK serum level related exercise by their antioxidant role and suppressed the inflammatory response [29].

The greater elevation of CK was found in those untrained person [30], [31], [32]. It was understandable that there is no difference in CK and blood lactate level between elite and non-elite athlete. In this study, the non-elite athletes were recruited from student of sport faculty, so they did physical exercise regularly. The trained athlete had the capability adaptation to mechanical and metabolic stress-induced exercise. The muscle fiber proportion may be different between elite athlete and non-elite athletes, but the increase of CK following exercise-induced muscle damage may not be related to muscle fiber proportions of athletes [33].

However, this research still had some limitation. There was no data about the diet of athlete and the intensity of physical activity before test. In addition, CK serum level only check in once measurement and no follow-up after that. The previous study suggested that the CK serum level was already exist after several days.

## 5. Conclusions

Blood lactate and CK serum level are indirect marker of muscle damage. Established study appear that blood lactate and CK level increased after prolonged high intensity of physical activities. The high intensity short period physical exercise increased blood lactate and CK serum level higher than the normal value. There was not difference between elite and non-elite athletes, suggesting that the elite and non-elite athletes put in the same effort in performing and running protocol. From the results of

this study, we recommend implementing high-intensity exercise in a short time to improve motor skills without fear of muscle damage.

## Conflicts of Interest

There were no conflicts of interest to declare.

## Acknowledgements

This research was supported by Department of Research and Community Service of Universitas Negeri Semarang, Indonesian Ministry of National Education.

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