

**Material and Method** : Participants were 20 college rugby football players at Institute of Physical Education, Bangkok Campus. The purposive random sampling was used to recruit 40 volunteers. Simple random sampling was conducted later to select the 20 participants. Then, using  $VO_2$  Max, the participants were divided into four groups. Each group had five participants. Group A received placebo, whereas group B – D received 600, 900 and 1,200 mg of garlic extract, respectively. Five hours after ingestion of the tablet form, subjects underwent an incremental bicycle ergometer test by Astrand and Ryhming protocol for aerobic performance test ( $VO_2$  Max) and Wingate protocol for determination of anaerobic performance. A pilot study was conducted to form a load guideline for subjective exhaustion time. In that study, the work load of 750 kgm./min. was used Before and after receiving garlic extract or placebo, blood pressure was monitored. Data were analyzed using One-Way ANOVA, Honesty Significant Different HSD) and a paired t-test. The significant level was set at 0.05.

**Results**

:  $VO_2$  Max of the four groups were significantly different. HSD was used to test the difference of each pair. Results showed significant difference ( $p = .05$ ). The anaerobic performances including Peak Power Output (PP), Relative Peak Power Output (RPP), and percentage of Fatigue Index (% Fatigue Index) were not different. The blood pressure was not different for the first week, but became different in the second week ( $p = .05$ ). The paired t-test revealed that blood pressure of group B (600 mg of garlic extract) was different ( $t = 4.355$ ;  $p = 0.012$ ), ( $t = 8.552$ ;  $p = 0.001$ ). Moreover, the systolic blood pressure of group C was also significantly different ( $t = 3.773$ ;  $p = 0.020$ ).

**Conclusions** : *VO<sub>2</sub> Max of groups that received garlic extract was higher than that of the placebo group. The anaerobic performances (Peak Power Output (PP), Relative Peak Power Output (RPP), Anaerobic Capacity (AC), the Relative anaerobic capacity (RAC) and percentage of Fatigue Index (% Fatigue Index) and endurance time were not different. However, 600 mg of garlic extract reduced both the systolic and diastolic blood pressure, while the 900 mg of garlic extract reduced only the systolic blood pressure in the second week.*

**Keywords** : *Garlic extract, Anaerobic and aerobic performance, Rugby football, Herbs, Food supplement.*

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นักสวรรถ หนาพวงษอนันท์, ประทุม ม่วงมี, สายวรุฬ ชัยวานิชศิริ. ผลของสารสกัดจากกระเทียมที่มีต่อความสามารถในการทำงานแบบ แอนแอโรบิกและแอโรบิกของนักกีฬา รักบี้ฟุตบอล. จุฬาลงกรณ์เวชสาร 2551 ก.ย.-ต.ค.; 52(5): 343 - 55

**เหตุผลของการทำวิจัย** : รักบี้ฟุตบอลเป็นกีฬาที่มีการปะทะกันอย่างรุนแรงทำให้เกิดการบาดเจ็บได้ตลอดเวลา นักกีฬารักบี้ฟุตบอลจึงต้องมีการทดสอบสมรรถภาพเพื่อความพร้อมของร่างกายทั้งระบบแอโรบิกและแอนแอโรบิก เนื่องจากการเปลี่ยนแปลงแหล่งพลังงานของนักกีฬารักบี้ฟุตบอลที่ระดับความหนักของงานต่ำจะเป็นระบบแอโรบิก ในขณะที่ความหนัก ของงานมาก ยิ่งขึ้นจึงต้องใช้ระบบพลังงานแบบแอนแอโรบิก นอกจากนี้สารอาหาร นับเป็นปัจจัยสำคัญที่ช่วยส่งเสริมสมรรถภาพทางร่างกายโดยเฉพาะมีความเชื่อเกี่ยวกับสมุนไพรว่ามีอิทธิพลต่อประสิทธิภาพของร่างกาย กระเทียมเป็นสมุนไพรที่ใช้กันมานานโดยมีคุณสมบัติเป็นทั้งอาหาร และยา

**เป้าหมาย/ วัตถุประสงค์** : เพื่อศึกษาผลของสารสกัดจากกระเทียมขนาด 600, 900 และ 1200 มิลลิกรัม ที่มีผลต่อความสามารถแบบแอโรบิกและแอนแอโรบิก เวลา ยืนระยะการออกกำลังกาย และความดันโลหิตของนักกีฬารักบี้ฟุตบอล

**รูปแบบการวิจัย** : การศึกษาแบบ Completely Randomized Design (CRD)

**วิธีการทำวิจัย** : กลุ่มตัวอย่างเป็นอาสาสมัครจำนวน 40 คน จากสถาบันการพลศึกษา วิทยาเขตกรุงเทพ โดยสุ่มกลุ่มตัวอย่างแบบง่ายจำนวน 20 คน จากนั้น แบ่งเป็น 4 กลุ่ม ๆ ละ 5 คน โดยที่กลุ่มที่ 1 ได้รับสารเลียนแบบ กลุ่มที่ 2 - 4 ได้รับสารสกัดจากกระเทียมขนาด 600, 900 และ 1,200 มิลลิกรัม ตามลำดับ หลังจากได้รับสารสกัดจากกระเทียม หรือสารเลียนแบบ เป็นเวลา 5 ชั่วโมง นักกีฬาทุกคนได้รับการทดสอบ ความสามารถในการทำงานแบบแอโรบิก ( $VO_2$  Max) ตามวิธีของ Astrand and Ryhming ความสามารถในการทำงานแบบแอนแอโรบิก ตามวิธีของ Wingate และเวลายืนระยะการออกกำลังกายตามการศึกษานำร่อง (Pilot Study) โดยใช้ความหนักของงานที่ 750 kgm./min นอกจากนั้นมีการวัดความดันโลหิตก่อนและหลังจากการได้รับสารสกัดจากกระเทียม และ สารเลียนแบบข้อมูลที่ได้ถูกนำมาวิเคราะห์ โดยใช้สถิติการทดสอบ ความแปรปรวนทางเดียว (One-Way ANOVA) เปรียบเทียบความแตกต่างรายคู่ โดยใช้ค่าสถิติ HSD (Honestly Significant Difference) และทดสอบความแตกต่างระหว่างค่าเฉลี่ย โดยใช้การวิเคราะห์สถิติ Paired Samples t - Test ระดับนัยสำคัญทางสถิติ กำหนดไว้ที่ .05

- ผลการศึกษา** : ความสามารถในการทำงานแบบแอโรบิก ( $VO_2 \text{ max}$ ) ระหว่างกลุ่มตัวอย่างที่ได้รับสารสกัดจากกระเทียมเมื่อเปรียบเทียบกับสารเลียนแบบมีความแตกต่างกัน ( $p = .05$ ) ไม่พบความแตกต่างสำหรับการทดสอบแบบแอนแอโรบิก (การทดสอบค่ากำลังงานที่ทำได้สูงสุด ค่าสัมพันธ์ของกำลังงานที่ทำได้สูงสุดต่อมวลของค่าสมรรถภาพการใช้พลังงานแบบไม่ใช้ออกซิเจน ค่าสัมพันธ์ของสมรรถภาพการใช้พลังงานแบบไม่ใช้ออกซิเจนต่อมวลของร่างกาย และร้อยละดัชนีป้องกันความเหนื่อย) พบความแตกต่างของความดันโลหิตใน สัปดาห์แรก แต่ไม่พบความแตกต่างในสัปดาห์ที่สอง ( $p = .05$ ) โดยกลุ่มตัวอย่างที่ได้รับสารสกัดจากกระเทียม ขนาด 600 มิลลิกรัม มีความดันโลหิตช่วงบนและช่วงล่างลดลงอย่างมีนัยสำคัญทางสถิติ ( $p = 0.012, 0.001$ ) และกลุ่มที่ได้รับสารสกัดจากกระเทียมขนาด 900 มิลลิกรัมพบว่าความดันโลหิตช่วงบนลดลงอย่างมีนัยสำคัญทางสถิติ  $p = .020$ )
- สรุป** : ความสามารถในการทำงานแบบแอโรบิก ( $VO_2 \text{ max}$ ) ของกลุ่มที่ได้รับสารสกัดจากกระเทียมสูงกว่ากลุ่มที่ได้รับสารเลียนแบบ ไม่พบความแตกต่างของความสามารถในการทำงานแบบแอนแอโรบิก (ค่ากำลังงานที่ทำได้สูงสุด ค่ากำลังงานที่ทำได้สูงสุดต่อมวลของร่างกาย ค่าการใช้พลังงานแบบไม่ใช้ออกซิเจน ค่าการใช้พลังงานแบบไม่ใช้ออกซิเจนต่อมวลของร่างกายและร้อยละดัชนีป้องกันความเหนื่อย) และเวลาขึ้นระยะการออกกำลังกายของกลุ่มที่ได้รับสารสกัดจากกระเทียมและสารเลียนแบบ อย่างไรก็ตามสารสกัดจากกระเทียมขนาด 600 มิลลิกรัม สามารถ ลดความดันโลหิตเลขตัวบนและความดันโลหิตเลขตัวล่าง และสารสกัดจากกระเทียมขนาด 900 มิลลิกรัม สามารถลดความดันโลหิตเลขตัวบนในสัปดาห์ที่ 2
- คำสำคัญ** : สารสกัดจากกระเทียม, ความสามารถในการทำงานแบบแอนโรบิกและแอโรบิก, รักบี้ฟุตบอล, สมุนไพรร, ผลิตภัณฑ์เสริมอาหาร.

Rugby football is a heavy and full contact sport in which injuries frequently occur. Thus, both aerobic and anaerobic fitness are required for the athletes. As a result, the athletes usually take intensive fitness training. Nutrients are an essential factor for improvement of the physical performance. Moreover, it is believed that herbs have an influence on physical performance. Garlic is an ancient herb that can be used as food as well as medicine. The ancient Egyptians were said to eat garlic to enhance physical functions during the pyramid construction or playing heavy sports such as weightlifting and swimming.<sup>(1-3)</sup> It is recorded that Greek athletes ate garlic to enhance their physical strength before competing in the first Olympic Games.<sup>(4)</sup> Previous studies have indicated that garlic lowers cholesterol and blood pressure which is consistent with Madre's study. Madre found that garlic increases blood circulation in arteries and capillaries and decreases blood viscosity.<sup>(5)</sup> The reduction in blood viscosity and increased blood circulation may enhance oxygen transportation and improve the function of muscle fibers.<sup>(6)</sup> Jung et al. (1991) indicated that, after eating garlic for five hours, blood vessels are dilated and the correlated tissue functions are facilitated. This is consistent with Wolf et al. (1990)<sup>(7)</sup> that five hours after eating 900 mg of garlic, the conjunctival vessels (arterioles & venules) were dilated. The vasodilatation can reduce risks of thrombosis in important organs such as the brain and heart. Inal, et al. (2000)<sup>(8)</sup> found that garlic extract increases  $VO_2$ Max and physical endurance. In Thailand, utilization of garlic to improve athletic performance is limited. Most of the studies are related to general health issues. This study aims to

investigate the effects of garlic extract on athlete anaerobic and aerobic performance. The findings impact on the development of athlete training and utilization of Thai herbs for sports.

## Material and Method

Participants were 20 college rugby football players. The purposive random sampling was used to recruit 40 volunteers. Simple random sampling was conducted later to select 20 participants. Then, using  $VO_2$ Max, the participants were divided into four groups. Each group has five participants. Group A received placebo, whereas group B - D received 600, 900 and 1,200 mg of garlic extract, respectively.

## Variables

**Independent variables** were 600, 900 and 1,200 mg of garlic extract.

**Dependent variables** were  $VO_2$ Max, endurance time, anaerobic performance and blood pressure.

## Basic assumptions

1. The Wingate protocol for determination of anaerobic performance was used to evaluate anaerobic performance.  $VO_2$ Max was measured by Astrand and Ryhming protocol for aerobic performance test. Tests were conducted using an incremental bicycle which is a reliable and widely used method for measurement of aerobic and anaerobic power.
2. Regarding endurance time, the authors had conducted a pilot study in five male college students of the Institute of Physical Education, Bangkok, to identify a load guideline for subjective exhaustion time. In this study, a load of 750 Kgm/min was used during the testing period.

3. The participants underwent a medical check-up, to ensure that their health was good. The check-up was performed by a registered doctor. A medical record signed by the doctor was used to confirm the participants' health status. Additionally, all of the participants had never before used garlic extract, Warfarin, or any other anticoagulants. Moreover, the participants agreed to perform the test at full strength.

### Definitions

1. Garlic extract is a tablet of garlic powder coated with enteric film. Therefore, the tablet will be dissolved in the intestine. The optimal pH in the intestine will maximize the alliinase functions. As a result, the garlic powder will be digested into allicin and then will be absorbed through the intestine.
2. Placebo is a dummy of the garlic extract. It is edible, made of flour, and has no harmful effect.
3. Athletes are college rugby football players from the Institute of Physical Education Bangkok, aged 18-22 years, in good health, who had not previously used garlic extract, Warfarin or any other anticoagulants.
4. Anaerobic performance consists of Peak Power Output (PP), Relative Peak Power Output (RPP), percentage of Fatigue Index (% Fatigue Index), Anaerobic Capacity, and the relative anaerobic capacity. In this study, the Wingate protocol was used to measure the anaerobic performance.
5. Aerobic Performance is  $VO_2$  Max, measured by the Astrand and Ryhming protocol for aerobic performance tests.
6. Endurance time is the period of time that the participants can ride the bicycle with the load of 750 Kgm/ min (125 Watts).

### Instruments

The instruments included a height measure, a stopwatch, a computer, a blood pressure monitor, interview records, a rhythm synthesizer (Yamaha, Japan), a digital scale (Transmate, Taiwan), a ergo-metric bicycle (Monark: model Ergo Medic 894 E, Sweden), the Monark Anaerobic Test Software (Sweden), and a ergo-metric bicycle (Monark Aerobic test: model Ergo Medic 828 E, Sweden).

### Procedures

The study was conducted as follows:

1. Review of literature and gathering research setting information.
 

The information consists of primary and secondary information. The primary information was gathered by interviewing personnel from the board of administration, coaches, and staff of the sport sciences center of the Institute of Physical Education Bangkok. The information includes details of the athletes, instruments, research setting and research assistants. The secondary information reviews aerobic and anaerobic performance tests regarding procedures and criteria for interpretation and garlic extracts.
2. Contact with garlic extract and placebo manufacturers.
3. Development of records for the aerobic-anaerobic performance and endurance time, information sheets and consent forms for the athletes, medical records and testing schedules.
4. Submission of forms to supervisor and co-supervisor for review and contact with the graduate school regarding the research procedure.
5. Conduct of a pilot study in five male college students of the Institute of Physical Education Bangkok

in order to identify a load guideline for subjective exhaustion time.

6. Approval obtained for the research proposal from the ethics committee, and formal contacts made with the Institute of Physical Education, Bangkok, the garlic extract and placebo manufacturers. Potential participants were approached, using the information sheets and consent form and the research assistants to be trained.

7. Contacts were made with specialist doctors for the athletes' medical check-up. The medical records were also used to select participants.

### Data collection

1. Twenty college rugby football players of the Institute of Physical Education, Bangkok, were recruited. Then, they were divided into 4 groups, each group had five participants. The  $VO_2$  Max and medical check-up results were used for dividing criteria. Participants who had similar performance were assigned to the same group. There were four testing groups and two tests.

2. Research assistants were trained. All tests were conducted by the same researcher and research assistants at the same place with the same set of instruments.

3. Testing procedures were explained verbally. Information sheets were also provided.

4. The tests were conducted as follows:

1. Test I:

The participants in group A-D received placebo, 600, 900 and 1,200 mg of garlic extract, respectively. The research assistants and the participants did not know whether the tablets received were placebo or garlic extract. All participants registered at 6.00 am on the testing day. Their blood

pressure was monitored. The tablets were taken after breakfast. After that they attended classes as usual for five hours. Then, they met again at 12.00 pm. The blood pressure,  $VO_2$  Max, endurance time and anaerobic performance were evaluated. Each group was tested twice a week for two consecutive weeks.

2. Test II:

Group B was selected for this test. The procedure was the same as Test I, except only blood pressure and  $VO_2$  Max were measured in the afternoon. The test was conducted four times at two day intervals.

5. After taking the tablets (placebo or garlic extract), the participants were interviewed regarding general information and the effects of the tablets.

6. The average blood pressure,  $VO_2$  Max, endurance time, and anaerobic performance were calculated.

7. Statistic analysis, discussion and conclusion were performed.

### Results

The SPSS for Windows Version 12 (Statistical Package for the Social Science Personal Computer) was used for data analysis.

1. Mean ( $\bar{X}$ ) and standard deviation (SD) were calculated for each of the variables and demographic data of the participants.

2. One-Way ANOVA was used to test the differences between the groups. When the differences were identified, the Honest Significant Difference (HSD) was utilised to test the difference of each pair. The p value was set at .05.

3. The blood pressure difference between pre- and post-test was analysed using paired t-test,  $p = .05$ .

Data analysis revealed that Group C that received 900 mg of garlic extract had the highest average VO<sub>2</sub> Max (Table 1). VO<sub>2</sub> Max of the four groups were significantly different (Table 2). Thus, HSD was used to test the difference of each pair. The results showed significant difference (p = .05). The anaerobic performances including Peak Power Output (PP), Relative Peak Power Output (RPP), and percentage

of Fatigue Index (% Fatigue Index) were not different (Table 3). The blood pressure was not different for the first week, but different in the second week (p = .05) (Table 4). Paired t-test revealed that blood pressure of group B (600 mg of garlic extract) was different (t = 4.355; p = 0.012), (t = 8.552; p = 0.001). Moreover, the systolic blood pressure of group C was also significantly different (t = 3.773; p = 0.020).

**Table 1.** VO<sub>2</sub> Max. of the treatment groups.

Test group	VO <sub>2</sub> Max (ml./ kg./ min.)	
	$\bar{X}$	SD
Placebo	51.59	3.96
600 mg.	51.61	3.96
900 mg.	53.20	2.13
1200 mg.	35.83	2.97

**Table 2.** Differences of VO<sub>2</sub> Max.

Source of variation	SS	df	MS	F	p
VO <sub>2</sub> Max between group	1005.840	3	335.280	29.857	.000 *
Within group	179.673	16	11.230		
Total	1185.513	19			
Endurance Time	116.186	3	38.729	.746	.540
Within group	830.886	16	51.930		
Total	947.072	19			

\* p < .05

**Table 3.** The Honesty Significant Difference (HSD) of VO<sub>2</sub> Max.

Test Group	$\bar{X}$	Placebo	600 mg	900 mg	1200 mg
		( $\bar{X} = 51.59$ )	( $\bar{X} = 51.61$ )	( $\bar{X} = 53.20$ )	( $\bar{X} = 35.83$ )
Placebo	51.59	-	.000 *	.000 *	.000 *
600 mg of garlic extract	51.61		-	.000 *	.000 *
900 mg of garlic extract	53.20			-	.000 *
1,200 mg of garlic extract	35.83				-

\* significant different at p = .05



**Table 4.** Comparison of the Peak Power Output (PP), Relative Peak Power Output (RPP), Anaerobic Capacity (AC), the Relative anaerobic Capacity (RAC) and percentage of Fatigue Index (% Fatigue Index).

Source of variation	SS	df	MS	F	p
PP between group	58,592.888	3	19,530.963	1.994	.156
Within group	156,750.500	16	9,796.907		
Total	215,343.400	19			
RPP between group	5.167	3	1.722	.961	.435
Within group	28.674	16	1.792		
Total	33.841	19			
AC between group	16,006.580	3	5,335.520	.987	.424
Within group	86,491.490	16	5,405.718		
Total	102,498.100	19			
RAC between group	5.411	3	1.804	3.249	.050
Within group	8.883	16	.555		
Total	14.294	19			
% Fatigue Index	700.495	3	233.498	1.741	.199
Within group	2,145.996	16	134.125		
Total	2,846.491	19			

\* p < .05

**Table 5.** Comparison of week 2 blood pressure (mm Hg) before and after receiving the tablets.

Group	$\bar{X}$	S		
Placebo n = 5	Pre/ Post	Pre/ Post		
Systolic	122.60/ 122.20	3.286/ .837	0.293	0.784
Diastolic	82.00/ 80.60	2.121/ 1.140	1.723	0.160
600 mg. n = 5	Pre/ Post	Pre/ Post		
Systolic	123.80/ 120.60	2.490/ .894	4.355	0.012 *
Diastolic	84.60/ 81.40	1.517/ .894	8.552	0.001*
900 mg. n = 5	Pre/ Post	Pre/ Post		
Systolic	122.60/ 120.40	1.817/ .548	3.773	0.020*
Diastolic	81.20/ 80.40	2.588/ .548	0.825	0.456
1200 mg. n = 5	Pre/ Post	Pre/ Post		
Systolic	128.40/ 126.40	7.603/ 6.731	2.000	0.116
Diastolic	78.40/ 75.60	5.814/ 3.130	1.411	0.231

\* p < 0.05

## Discussion

The results showed that the group that received 900 mg of garlic extract had the highest average  $VO_2$  Max (53.20 mg/kg/min). This might be involved with anti-clotting properties of the garlic extract which improve blood circulation. The improvement of blood circulation would increase the oxygen carrying capacity. This is supported by Mader's study (1990).<sup>(5)</sup> The study indicated that garlic extracts have an impact on the blood vessels, blood circulation and plasma viscosity. This may enhance oxygen carrying capacity and muscle-fibers functions.<sup>(6)</sup> This agrees with Inal's study (1995) that examined the effects of 900 mg of garlic extract in 10 athletes.<sup>(9)</sup> It has been found that the group using 900 mg of garlic extract had higher  $VO_2$ Max than the placebo group. Moreover, Letcher et al. (1981) suggested that decreasing plasma viscosity improves oxygen carrying capacity to the muscles.<sup>(10)</sup> In addition, Selenium enriched in garlic can prevent heart and vessels diseases.<sup>(11)</sup> Therefore, it may improve motor functions. Furthermore, the athlete training routine may affect  $VO_2$  Max. As the American Academy of Orthopaedic Surgeons (1991) indicated that training programs are the most important factor for increasing strength, power, and endurance.<sup>(12)</sup> In this study, coaches indicated that the rugby football players undertake for 2-hour training sessions a week. The training programs are determined by the position of the players. For example, the forwards require strength, endurance and balance training. Thus, they perform weight-training, ball passing and ball drills and sprint training. The backs require speed, agility and flexibility. Therefore, their training is short distance running, fast-short distance running, avoiding

obstructions and ball passing training. This suggests that training programs may have an effect on  $VO_2$  Max. Regarding the endurance time, there was no statistical difference. Furthermore, the group that received 900 mg of garlic extract had the lowest endurance time ( $X = 11.81$  min). Generally, there are many factors related to effectiveness of the muscle functions. Nutrients which are the energy source are one of the most important factors. Pratoon<sup>(13)</sup> reports that when the energy sources, such as reduce muscle contraction and strength decreases. Forty percent of the participants reported that they did not have breakfast. Moreover, having three meals a day does not guarantee that the athletes have all essential nutrients. Furthermore, the participants might have insufficient water. Twenty-five percent reported that they did not drink water before training and 60% did not drink during training. Ratanawadee<sup>(14)</sup> emphasized the importance of water to enhance cellular functions, especially biochemical reactions and metabolism. Water plays an important role in nutrient and oxygen transportation, reducing heat and blood circulation. Therefore, inadequate food and water may have an effect on the endurance time. The anaerobic performance was also not different. This might be because of inadequate nutrients. Moreover, the physique of rugby football players differs by their position. The different compositions and muscle sizes might affect the anaerobic performance. This agrees with Cooper et al. (1984)<sup>(15)</sup> who reported that those who have large muscles can reach the peak power output before changing to use anaerobic metabolism. Regarding blood pressure, 600 mg and 900 mg of garlic extracts showed significant differences (both systolic and diastolic for the 600 mg and only systolic for the 900

mg groups). This may be because of scordinin in garlic extract which is also found in ginsengs.<sup>(16)</sup> Scordinin's properties are similar to male and female hormones which may facilitate bodily functions. Furthermore, garlic extracts also contain disulfide that can reduce cholesterol and blood pressure.<sup>(17)</sup> These may reduce the athletes' blood pressure.

### Conclusion

VO<sub>2</sub> Max of the groups that received garlic extract was higher than the placebo group. The anaerobic performances (Peak Power Output (PP), Relative Peak Power Output (RPP), Anaerobic Capacity (AC), the Relative Anaerobic Capacity (RAC) and percentage of Fatigue Index (% Fatigue Index)) and endurance time were not different. However, 600 mg of garlic extract reduced both the systolic and diastolic blood pressures, while 900 mg of garlic extract reduced only the systolic blood pressure in the second week.

### Suggestions for future research

1. Should include aerobic performance evaluation using gas analyzer. The breath by breath record should be included to measure athletes' physiological performances

2. Should include various performances tests such as static and dynamic muscle strength tests, cardiovascular tests, respiratory tests and maximum breathing capacity.

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