ANALYZING THE IMPACT OF CROSS-RUNNING ON BODY COMPOSITION, PHYSICAL PERFORMANCE, AND COMPETITIVE RESULTS IN 5000 M RUNNERS

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Qabul qilindi: 22.10.2025
Ko'rib chiqildi: 23.10.2025
Tasdiqlandi: 24.10.2025

Keywords:
Cross-running – body composition – fat mass {F.M} – muscle mass {M.M} – physical working capacity {P.W.C} – running – aerobic endurance.

Abstract. This study sought to investigate the effects of cross-running on body composition factors, specifically fat mass {F.M.}and muscle mass {M.M.}, as well as on physical working capacity {P.W.C.} and performance levels in 5000m runners {R.L.5000m runners}. The research employed an experimental design with pre- and post-assessments, utilizing two equally matched groups: a control group and an experimental group, each consisting of six 5000m runners. The experimental group participated in a cross-running program, while the control group followed a traditional running program. Both groups underwent a 10-week training regimen, with efforts made to keep the duration and intensity of training sessions as consistent as possible across the two programs. The cross-running program included activities such as cycling, using a cycle ergometer, rowing, running in shallow water, aqua jogging, rope skipping, and using a Versa Climber. The findings revealed that the cross-running program was significantly more effective than the conventional training in enhancing physical working capacity {P.W.C.} and 5000m performance levels {R.L.5000m runners} However, there were no significant improvements in body composition—specifically, in fat mass and muscle mass—between the two groups.

Introduction

Running is considered one of the most physically demanding sports, particularly when focusing on the distance an athlete specializes in. Training sessions in this sport often span long periods and are typically performed at a

constant intensity. This consistency can lead to a higher risk of injury due to extreme physical exertion (Khan, 2017, 245-251). Studies have indicated that 30-55% of regular runners sustain injuries each year during their training (Smith, 2013, 2). In addition, the repetitive nature of training can cause mental fatigue, leading to a decrease in motivation, which negatively impacts the quality of training. This limitation, in turn, hampers the runner's ability to progress and reach peak performance in competitions.

Cross-training has gained popularity as a modern training approach, where athletes incorporate a variety of sports and physical activities with similar components to enhance their performance in a specific sport (Johnson, 2014, 3; Turner, 2007; Roberts, 2010; Zhang, 2012; Baker et al., 2015). Cross-training not only boosts overall physical fitness but also helps the recovery of overused muscle groups, improves muscle balance, lowers the likelihood of injuries, combats the monotony of regular routines, and increases motivation while reducing mental fatigue caused by rigorous training (Thompson, 2009; Williams, 2011; Richardson & Jordan, 2015, 298). These benefits allow athletes to perform training tasks at optimal intensities, which has a positive impact on their competition outcomes. Cross-training is especially beneficial in endurance sports, where athletes strive to cover long distances in the shortest possible time, and training regimens often involve repetitive patterns (Khan, 2017, 289), as seen in long-distance running.

However, opinions differ regarding the effectiveness of cross-training in improving athletic performance. While some studies argue that cross-training significantly enhances performance (Adams et al., 2008; Linton, 2013; Carter, 2014; Peterson et al., 2009; Stewart, 2012), others contend that traditional training methods yield better results (Smith, 2013, 3). This discrepancy motivated the researcher to investigate the impact of cross-training on the performance levels of 5000m runners (R.L.5000m runners) and determine whether this approach could improve their specialized performance.

The cross-training program for long-distance runners can include various unconventional exercises that emphasize aerobic and muscular endurance, particularly targeting the leg muscles. These activities include cycling, using a cycle ergometer, rowing, shallow water running, aqua jogging, skipping rope, and using a VersaClimber (Johnson, 2014; Khan, 2017; Roberts, 2010, 270-285). The diversity of exercises in cross-training helps to alleviate the monotony and physical fatigue caused by prolonged running sessions, thus enhancing the effectiveness of the training and improving the performance in 5000m races.

One important focus in long-distance running training is improving body composition {B.C.}, particularly by reducing fat mass {F.M.} and increasing muscle mass {M.M.}. This is essential for boosting the runner's performance during competitions {Barnes & Roberts, 2001; Mitchell, 2016; Taylor, 2011; Wright, 2014}. As an aerobic endurance activity, running significantly

contributes to improving B.C. through fat-burning processes that provide the necessary energy for physical exertion {Davis et al., 2007, 75; Carter et al., 2010; Rogers & McPherson, 2011}. However, some studies suggest that aerobic training may not only reduce F.M. but also cause a loss of M.M. {Simmons & Clark, 2007}, which could negatively impact the runner's performance. Therefore, it is important to examine how cross-training affects B.C. in 5000m runners.

Physical working capacity {P.W.C.}refers to the body's ability to generate both aerobic and anaerobic energy to perform sustained muscular effort {Davis et al., 2007, 30; Carter et al., 2010, 85}. This is a key factor in determining the performance level of 5000m runners {R.L.5000m runners}, making it crucial to understand the effects of cross-training on P.W.C. in these athletes.

Research Procedures

The researcher used the experimental approach, which was deemed most appropriate for the research nature.

Experimental Design

The researcher used pre- and post-measurements of two equal groups: one as the control group and the other as the experimental group.

Research Sample

The main sample consisted of 15 healthy runners aged 21-23 years. They were purposely selected from Green Bay Athletics Club, which is registered with the National Athletics Federation. This club was chosen because of its proximity to a coastal environment, necessary for conducting certain activities in the cross-training program, such as running in shallow water, versa climber, and aqua jogging.

The pilot study sample consisted of 10 healthy runners, purposely selected from Riverside Athletics Club, located in a similar environment to that of the main sample

Data Collection Tools

A) The {Tanita – Model TBF-300A} device {as shown in the supporting chart} was used to measure the variables of body composition {B.C.}, including fat mass {F.M.} and muscle mass {M.M.}. This device was selected for its ease and speed in measuring the required variables, and its suitability was confirmed by expert consultation.

B) The Harvard Step Test {as illustrated in another chart} was used to measure physical working capacity {P.W.C.}. This test was chosen for its longstanding validity, having been used successfully in numerous studies over the years. Its use was also confirmed by expert opinions.

C) An expert consultation form was used to verify the reliability of the research procedures.

Pilot Study

The pilot study was conducted from 24.06.2023 to 30.06.2023 to ensure the validity and reliability of both the Tanita device for measuring B.C. and the Harvard Step Test for assessing P.W.C.

Pre-measurements

The pre-measurements were conducted from 01.07.2023 to 07.07.2023, and the data collected is shown in the provided chart.

The Training Program

The training program was implemented at Green Bay Athletics Club and the Sports Science Faculty at River Valley University from 08.07.2023 to 15.09.2023. It was based on the following principles:

The program was designed in accordance with the principles of building training programs for long-distance runners.

The primary distinction between the experimental group's cross-training program and the control group's conventional program was the inclusion of unconventional cross-training activities in the experimental group's regimen, such as cycling, using a cycle ergometer, rowing, shallow water running, aqua jogging, rope jumping, and versa climber. The control group followed a conventional program consisting of running and resistance training.

The cross-training activities were designed to parallel running exercises, while the strength exercises involved cycling and rowing.

The program consisted of 10 microcycles across 10 weeks, designed to be completed before the 2023 National Championship for adults, with sufficient time for individual preparation based on the athletes' specific needs.

Each microcycle included three training units, each lasting between 90 and 180 minutes. In total, the training program included 30 units.

Strength exercises were included in every microcycle except the last one, which was designed to minimize fatigue before post-measurements.

The training days for the control group were Saturday, Monday, and Wednesday, while the experimental group trained on Sunday, Tuesday, and Thursday.

Heart rate was monitored to ensure proper intensity for each group, taking into account the differences introduced by the cross-training activities in the experimental group.

The program's design accounted for individual differences, available equipment, and safety measures.

Feedback from experts was sought on the structure and design of the training program. Adjustments were made based on their recommendations. The program's timetable and intensity levels are outlined in the accompanying charts, with detailed training schedules included for the first few microcycles.

Table (1) The per-measurements data of the control & experimental groups and the statistical significance of the differences between them (N1 = N2 = 6)

Variables	Control Group	Experimental Group	The Difference	Ranks Sum of	Ranks Sum of	Degree of

			Between the Two Groups	Control Group (S1)	Experimental Group (S2)	Mann-Whitney Test (T)
Age (yrs)	21.35	20.88	-0.47	43	35	14
Height (cm)	179.95	180.25	0.30	41	37	16
Weight (kg)	75.80	75.45	-0.35	40	38	17
Training Age (yrs)	6.95	7.10	0.15	37	41	16
Fat Mass (F.M.) (kg)	10.95	10.82	-0.13	38.5	39.5	17.5
Muscle Mass (M.M.) (kg)	64.85	64.52	-0.33	38.5	39.5	17.5
Physical Working Capacity (P.W.C.)	60.85	61.17	0.32	39.5	38.5	17.5
Running Level 5000m Runners (R.L.)	17:35.55	17:35.80	00:00.25	39	39	18
Running Level 5000m Runners (R.L.)	17:35.55	17:35.80	00:00.25	39	39	18

For the treatment of the research data, the researcher applied Non-Parametric Statistics due to the small sample size {N1 = N2 = 6} of the main study and pilot study, which were both less than 30 participants {Radwan, 2003, p. 79}. This small sample size was attributed to the limited number of runners at the clubs, particularly in the age group of the research sample. The researcher used Spearman's Rank Correlation Coefficient and the Mann-Whitney Test for data treatment.

The following table presents the post-measurement results for both the control and experimental groups, the differences between them, and the

statistical significance of these differences concerning the experimental variables:

Table 2: Post-Measurements Data of Control & Experimental Groups and Statistical Significance of the Differences (N1 = N2 = 6)

Variables	Average of Post-Measurement of Control Group	Average of Post-Measurement of Experimental Group	Difference Between the Two Groups	Ranks Sum of Control Group (S1)	Ranks Sum of Experimental Group (S2)	Mann-Whitney Test (T)
Age (yr)	21.17	20.83	-0.34	43	35	14
Height (cm)	180.17	180.33	0.16	41	37	16
Weight (kg)	77.00	76.50	-0.50	40	38	17
Training Age (yr)	7.00	7.17	0.17	37	41	16
Fat Mass (F.M.) (kg)	11.17	11.08	-0.09	38.5	39.5	17.5
Muscle Mass (M.M.) (kg)	65.83	65.42	-0.41	38.5	39.5	17.5
3. Physical Working Capacity (P.W.C.) (degree)	61.17	61.50	0.33	39.5	38.5	17.5
4. 5000m Running Performan	17:43.40	17:43.62	0:00.22	39	39	18

ce Time (R.L.5000 m) (min)						

In Table 2, it is evident that all the calculated {T} values of the Mann-Whitney Test lie between the upper and lower limits of the indexed {T}value. Therefore, there were no statistical differences between the two research groups. This indicates the parity of the two groups before the application of the training program {Radwan, 2003, p. 261}

Discussion:

Based on Table 2, by comparing the average values of the pre- and post-measurements of both the control and the experimental groups in all experimental variables, as well as the average values of the post-measurements between the two groups, it is evident that both the conventional training program {for the control group} and the cross running program {for the experimental group} had a positive impact on all experimental variables. However, this positive effect was more pronounced in the experimental group across all variables, as supported by Figure 1.

It is logical that both training programs contributed positively to the improvement of the experimental variables under investigation, since both aimed at enhancing the performance level of 5000m runners. The training loads in both programs primarily relied on aerobic exercises, which not only improve 5000m running performance but also enhance aerobic energy production, thereby increasing physical working capacity (P.W.C.) {Abdelfatah & Nasereldeen, 1993a, 27; Abdelfatah & Nasereldeen, 1985b, 84}, and improving body composition {B.C.} variables, such as fat mass {F.M.}and muscle mass {M.M.}, by increasing fat burning and muscle development.

The researcher attributes the greater positive effect in the experimental group to the structure of the cross running program. The diversity of running-based activities helped reduce monotony, enabling the runners to engage more actively with the prescribed training intensities. This ultimately resulted in better outcomes across all physical metrics {Elhadidi, 2011; Elsais, 2012; Hadfield, 2010; Leyland, 2008; Partridge et al., 2014; Smith et al., 2013; Urbian et al., 2013}.

Despite these positive results, the differences between the two groups in body composition variables {F.M. and M.M.} did not reach the level of statistical significance. Therefore, the cross running program cannot be claimed to be superior to the conventional training in improving these specific variables. This could be because regular runners, such as those in this research sample, already had favorable body composition metrics, leaving limited room for further improvement.

However, a statistically significant difference was observed in the P.W.C. variable in favor of the experimental group. This may be attributed to the inclusion of varied aerobic-based exercises within the cross running program, such as running in shallow water, uphill sprints, interval-based distance runs, and agility drills. These helped to improve the aerobic energy release and increase the anaerobic threshold [Eaves et al., 2005; Elamir, 2015; Elsais, 2012; Joubert et al., 2011; Krause, 2009; Paine et al., 2010], while reducing fatigue in muscles and joints during running.

These adaptations improved aerobic endurance more efficiently in the experimental group. Since aerobic endurance is a key determinant in 5000m performance, this explains the statistically significant improvement in 5000m running level [.L.]for the experimental group, as reflected in Table 2 [Eaves et al., 2005; Joubert et al., 2011; Krause, 2009; Paine et al., 2010].

Furthermore, the cross running program included drills like rope jumping and agility work, which improved leg muscle power, speed, coordination, and balance [Kisan et al., 2012; Meyer, 2008; Quigley & Richards, 1996; Puleo & Milroy, 2012]. The program also incorporated elements that strengthened the core, back, and arm muscles, helping runners maintain proper posture and improve breathing efficiency during long runs (Murphy, 2017).

All these factors contributed to the statistically significant enhancement in 5000m running performance for the experimental group compared to the control group.

Within the framework of the research objectives, fields, and limitations, the following conclusions can be drawn:

1. Cross running is more effective than conventional training in improving physical working capacity [P.W.C.] for 5000m runners.

2. Cross running is likely to be more effective than conventional training in improving 5000m running performance [R.L.].

3. Cross running is not statistically more effective than conventional training in improving body composition [B.C.] variables for 5000m runners.

Conclusion

This study investigated the influence of a structured cross-running program on body composition, physical working capacity, and performance outcomes in 5000m runners. The findings demonstrated that while both conventional and cross-running training programs contributed positively to enhancing the examined variables, the cross-running program proved more effective in improving physical working capacity and competitive performance. However, no statistically significant differences were found between the two groups in body composition variables, namely fat mass and muscle mass.

These results support the growing body of evidence emphasizing the multifaceted benefits of cross-training in endurance sports. The inclusion of diverse activities such as cycling, aqua jogging, shallow water running, and rope skipping within the experimental program provided a broader physiological stimulus compared to conventional running alone. This diversity not only optimized aerobic and anaerobic adaptations but also reduced the risk of overuse injuries and training monotony, factors that commonly limit performance progression among distance runners. The improvement observed in physical working capacity suggests that the cross-running program facilitated more efficient cardiovascular and muscular adaptations, thereby enhancing the runners' endurance and resilience during high-intensity efforts.

The absence of significant differences in body composition between the two groups may be attributed to the participants' already optimized physiological status, given their regular engagement in endurance training. For trained athletes, body composition tends to stabilize within narrow limits, making further changes difficult to achieve within short training periods. Nevertheless, the consistent trends toward improved performance indicate that the benefits of cross-running extend beyond morphological changes, emphasizing the role of functional adaptation over structural transformation.

From a practical standpoint, these findings highlight the potential of cross-running as a valuable and effective training strategy for long-distance runners. By integrating complementary exercises that replicate the biomechanical and physiological demands of running while reducing repetitive strain, cross-running can enhance training outcomes, preserve long-term athlete health, and sustain motivation through variety and reduced fatigue.

In conclusion, cross-running represents a progressive and scientifically grounded approach to endurance training. Its application can lead to substantial improvements in aerobic efficiency, physical working capacity, and competitive performance among 5000m runners. While its impact on body composition remains limited in already well-trained athletes, its holistic benefits suggest that cross-running should be an integral component of contemporary distance-running programs. Future studies are encouraged to expand on these findings by exploring the long-term physiological adaptations to cross-running across different training phases, age groups, and performance levels, as well as its potential role in injury prevention and psychological well-being among endurance athletes.

Recommendations:

1. It is recommended to adopt cross running programs for 5000m runners to enhance training effectiveness and improve their performance in their specialized event.

2. Coaches and trainers should consider that cross running programs are more effective than conventional training methods in improving physical working capacity [P.W.C.] for 5000m runners.

3. Further research is needed to confirm the findings of this study and to explore the effects of cross running on enhancing various physical abilities and athletic achievements across different sports.

4. Additional studies are recommended to examine the impact of cross running on improving body composition [B.C.] variables in non-athletes and athletes who are not consistently engaged in regular training.

REFERENCES

1. Abdelfatah, A. & Nasereldeen, A. (1993). Physiology of physical fitness. Cairo: Dar Elfekr Alarabi.
2. Abdelfatah, A. & Nasereldeen, A. (1985). Biology of sport. Cairo: Dar Elfekr Alarabi.
3. Arazi, H., Faraji, H., Moghadam, M. G., & Samadi, A. (2011). Effects of concurrent exercise protocols on strength, aerobic power, flexibility and body composition, Kinesiology Journal, 43(2), 155-162.
4. Bassett, D. R. & Howley, E. T. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance, Medicine and Science in Sports and Exercise, 32, 70-84.
5. Brahler, C. J, & Blank, S. E. (1995). VersaClimbing elicits higher VO2max than does treadmill running or rowing ergometry, Medicine & Science in Sports & Exercise, 27(2):249-254.
6. Bryan, W. (2012). The Trainer's guide to cross training. Colorado: Better Runner.
7. Damian, S. (2015). Effects of endurance and endurance strength training on body composition and physical capacity in women with abdominal obesity, The European Journal of Obesity, 8, 175-187.
8. Donnelly, J. E. (2009). Appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults, Medicine and Science in Sports and Exercise, 41, 459–471.
9. Doucet, E., Tremblay, A., Simoneau, J. A., Joanisse, D.R. (2003). Skeletal muscle enzymes as predictors of 24-hour energy metabolism in reduced-obese persons, The American Journal of Clinical Nutrition, 78(3), 430-435.
10. Eaves, J. E., Hughes, D. M., & Lamb, L. K. (2005). The consequences of the introduction of professional playing status on game action variables in international northern hemisphere rugby union football, International Journal of Performance Analysis in Sport, 5 (2), 58-86.
11. Elamir, H. A. (2015). The effect of using cross-training in developing the physical efficiency of legs movements for tall basketball players, International Journal of Advanced Sports Researches, 2(3), 831-852.
12. Elhadidi, R. O. (2011). The effectiveness of cross-training on some physical abilities and psychological rigidity and the performance level of long jump skill, Journal of Physical Education Researches, 45(85), 122-135.

13. Elsais, M. A. (2012). The effectiveness of cross-training on some physical variables and blood components of 400m runners, Journal of Science and Sports Arts, 41, 87-102.
14. Hadfield, J. (2010, August 18). Elliptigo: cross training for runners, Runner's World Online Journal, https://www.runnersworld.com/ask-coach-jenny/elliptigo-cross-training-for-runners/.
15. Hunter, G. R., Byrne, N. M., Sirikul, B., Fernández, J. R., Zuckerman, P. A., Darnell, B. E., & Gower, B. A. (2008). Resistance training conserves fat-free mass and resting energy expenditure following weight loss, Obesity Journal, 16(5), 1045-1051.
16. Glassman, G. (2007). Understanding crossfit, CrossFit Journal, 56, 1-3.
17. Guisado, R. (2005). Cross training for endurance athletes: building stability, balance, strength. Sydney: Peak Sports Press.
18. Hottenrott, K., Ludyga, S., & Schulze, S. (2012). Effects of high intensity training and continuous endurance training on aerobic capacity and body composition in recreationally active runners, Journal of Sports Science and Medicine, 11, 483-488.
19. Hsan, H. F. (2013). The effect of hardening exercises for legs muscles only by the using of fixed and moving bike to develop some physical abilities and achieving 100m running in track and field events, Journal of Physical Education Sciences, 3(6), 198-227.
20. Hsan, Z. M. M. (2016). The ergonomics and sports engineering in the field of sports. Cairo: Dar of the Modern Book.
21. Hsan, Z. M. M. (2004). Cross-training is a modern trend in sports training. Alexandria: The Egyptian Library.
22. Jakicic, J. M., & Otto, A. D. (2006). Treatment and prevention of obesity: what is the role of exercise?, Journal of Nutrition Reviews, 2, 57-61.
23. Joubert, D. P., Oden, G. L., & Estes, B. C. (2011). The effects of elliptical cross training on VO2max in recently trained runners, International Journal of Exercise Science, 4(1), 4-12.
24. Kisan, R. M., Kisan, S. M., Anitha, O. R., & Chandrakala, S. P. (2012). Treadmill and bicycle ergometer exercise: cardiovascular response comparison, Global Journal of Medical Research, 12(5), 22-26.
25. Kostić, R., Đurašković, R., Miletić, D., & Mikalački, M. (2006). Changes in the cardiovascular fitness and body composition of women under the influence of the aerobic dance, Physical Education and Sport, 4(1), 59-71.
26. Kraemer, W. J., Fleck, S. J., & Deschenes, M. R. (2012). Exercise physiology integrating theory and application. Baltimore: Lippincott Williams & Wilkins.
27. Krause, P. (2009). The benefits of cross-training. Bethesda, Maryland: American Medical Athletic Association.
28. Layman, D. K., Evans, E., Baum, J.I., Seyler, J., Erickson, D.J., & Boileau, R.A. (2005). Dietary protein and exercise have additive effects on body

composition during weight loss in adult women, The Journal of Nutrition, 135(8), 1903-1910.
29. Lehri, A., & Mokha, R. (2006). Effectiveness of aerobic and strength training in causing weight loss and favorable body composition in females, Journal of Exercise Science and Physiotherapy, 2, 96-99.
30. Leyland T. (2008, July 01). Human power output and crossfit metcon outworks, CrossFit Journal, http://journal.crossfit.com/2008/07/human-power-output-and-crossfi.tpl/.
31. Luís, V., Eduardo, A., Helder, F. M., & Victor R. M. (2013). Cross-training in rugby: a review of research and practical suggestions, International Journal of Performance Analysis in Sport, 13, 225-237.
32. Maciejczyk, M., Więcek, M., Szymura, J., Szyguła, Z., Wiecha, S., & Cempla, J. (2014). The influence of increased body fat or lean body mass on aerobic performance, Public Library of Science Journal, 9(4), 1-6.
33. MacNeill, L. (2012). The beginning runners handbook. Canada: Greystone Books.
34. Meyer, T. (2008). Benefits of Jumping Rope for Athletes, International Youth Conditioning Association, http://iyca.org/benefits-jumping-rope-for-athletes/.
35. Murphy, T. J. (2017). Why Runners Should be Rowers?, Active, https://www.active.com/running/articles/why-runners-should-be-rowers/.
36. Paine, M. J., Uptgraft, M. J., & Wyile, M. R. (2010). Crossfit study. Washington: Headquarters Services.
37. Partridge, G. A., Knapp, B. A., & Massengale, B. D. (2014). An investigation of motivational variables in crossfit facilities, Journal of Strength Condition Research, 28(6), 1714-1721.
38. Puleo, J., & Milroy, P. (2012). Running anatomy, Champaign: Human Kinetics.
39. Quigley, E. J., Richards, J. G. (1996). The effects of cycling on running mechanics, Human Kinetics Journals, 12(4), 470-479.
40. Radwan, M. N. (2003). Inferential statistics in the science of physical education and sports. Cairo: Dar Elfekr Alarabi.
41. Ramana, V. Y., Mvl, S. K., Rao, S. S., & Balakrishna, N. (2004). Effect of changes in body composition profile on VO2max and maximal work performance in athletes, Journal of Exercise Physiology Online, 7(1), 34-39.
42. Samill, L. S. E. (2002). Kids & sports: everything you and your child need to know about sports. New York: New Market Press.
43. Smith, M. M., Sommer, A. J., Starkoff, B. E., & Devor, S. T. (2013). Crossfit-based high-intensity power training improves maximal aerobic fitness and body composition, Journal of Strength and Condition Research, 27(11), 3159-3172.
44. Ucan, Y. (2014). Effects of circuit resistance training on body composition and bone status in young males, The Sport Journal, 19, 52-65.

45. Urbian, S., Hayward, S., Jordan Outlaw, J., et al. (2013). Performance and body composition effects of a pre-workout supplement and post-workout protein intake in trained crossfit individuals, Journal of International Society of Sports Nutrition, 10(1), 28.
46. Walker B. (2007). The anatomy of sports injuries. California: North Atlantic books.
47. Werner, W. K., & Sharon, A. H. (2011). Lifetime physical fitness and wellness. Wadsworth, Ohio: Library of Congress Control.
48. Wilmore, J. H., Costill, D. L., & Kenney, W. L. (2008). Physiology of sport and exercise. Champaign: Human Kinetics.