

ANALYSIS OF MUSCLE FATIGUE RECOVERY IN SKIERS: A NUTRITIONAL INTERVENTION

ANÁLISE NA RECUPERAÇÃO DA FADIGA MUSCULAR EM ESQUIADORES: INTERVENÇÃO NUTRICIONAL

ANÁLISIS EN LA RECUPERACIÓN DE LA FATIGA MUSCULAR EN ESQUIADORES: INTERVENCIÓN NUTRICIONAL



ORIGINAL ARTICLE
ARTIGO ORIGINAL
ARTÍCULO ORIGINAL

Rui Wang¹
(Physical Education Professional)
Chenxi Yang¹
(Physical Education Professional)

1. Northeast Agricultural University,
Department of Sports Science and
Physical Education, Harbin, China.

Correspondence:

Chenxi Yang, Harbin, China,
150030.
yang0321171@163.com

ABSTRACT

Introduction: Skiing is a sport that demands the high performance of motor coordination with high energy consumption, factors that strongly influence muscle fatigue. Athletes who experience this phenomenon tend to present a decline in performance, generating psychological irritability and impairment in concentration. Diet is closely related to athletic performance, but the proper prescription for skiing athletes still lacks studies. **Objective:** To explore the methods of recovery from sports fatigue in skiers by providing up-to-date perspectives for effective nutritional intervention during the recovery stage. **Methods:** Seven young male skiers were selected as research subjects, and caloric intake, among other conditions, was recorded in detail. After three weeks, indices of body weight, body fat rate, serum metabolism, cardiopulmonary capacity, and energy metabolism, among other relevant information, were duly recorded and compared. **Results:** The intervention did not significantly impact lean body mass indices ($p>0.05$). The athletes' body weight decreased significantly, and the body fat rate decreased significantly after the nutritional intervention; The analyzed biomarkers were positively impacted, except the urea nitrogen concentration that showed a tendency to increase after the nutritional intervention, an effect that may be linked to the proportional increase of protein intake. **Conclusion:** The proposed nutritional intervention positively impacted the skiers' energy metabolism, directly impacting the athletes' recovery from sports fatigue. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

Keywords: Skiing; Muscle Fatigue; Sports Nutritional Physiological Phenomena.

RESUMO

Introdução: O esqui é um esporte que exige alto desempenho de coordenação motora com um elevado consumo de energia, fatores que influenciam fortemente a fadiga muscular. Atletas que experienciam esse fenômeno, tendem a apresentar um declínio no nível do desempenho, gerando irritabilidade psicológica e prejuízos na concentração. A dieta está intimamente relacionada ao desempenho atlético, porém a receita adequada para os atletas em esqui ainda carece de estudos. **Objetivo:** Explorar os métodos de recuperação da fadiga esportiva nos esquiadores fornecendo perspectivas atualizadas para uma intervenção nutricional eficaz durante a etapa de recuperação. **Métodos:** Sete jovens esquiadores do sexo masculino foram selecionados como sujeitos da pesquisa, e a ingestão calórica, entre outras condições foram detalhadamente registradas. Após três semanas, índices de peso corporal, taxa de gordura corporal, metabolismo sérico, capacidade cardiopulmonar, metabolismo energético, entre outras informações relevantes foram devidamente registradas e comparadas. **Resultados:** A intervenção não impactou significativamente nos índices de massa magra corporal ($p>0,05$). O peso corporal dos atletas diminuiu significativamente e a taxa de gordura corporal diminuiu significativamente após a intervenção nutricional; os biomarcadores analisados foram positivamente impactados, a exceção da concentração de nitrogênio ureico que apresentou tendência de alta após a intervenção nutricional, efeito que pode estar atrelado ao aumento proporcional da ingesta proteica. **Conclusão:** A proposta de intervenção nutricional apresentou impactos positivos no metabolismo energético dos esquiadores, impactando diretamente na recuperação da fadiga esportiva dos atletas. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

Descritores: Esqui; Fadiga Muscular; Fenômenos Fisiológicos da Nutrição Esportiva.

RESUMEN

Introducción: El esquí es un deporte que exige un alto rendimiento de coordinación motora con un elevado consumo de energía, factores que influyen fuertemente en la fatiga muscular. Los deportistas que experimentan este fenómeno, tienden a presentar un descenso en el nivel de rendimiento, generando irritabilidad psicológica y daños en la concentración. La dieta está estrechamente relacionada con el rendimiento deportivo, pero la prescripción adecuada para los atletas de esquí aún carece de estudios. **Objetivo:** Explorar los métodos de recuperación de la fatiga deportiva en los esquiadores proporcionando perspectivas actualizadas para una intervención nutricional eficaz durante la etapa de recuperación. **Métodos:** Se seleccionaron siete jóvenes esquiadores varones como sujetos de investigación, y se registró detalladamente la ingesta calórica, entre otras condiciones. Al cabo de tres semanas, se registraron y compararon debidamente los índices de peso corporal, el índice de grasa corporal, el metabolismo sérico, la capacidad cardiopulmonar y el metabolismo energético, entre otros datos relevantes. **Resultados:** La intervención no tuvo un impacto significativo en los índices de masa corporal magra ($p>0,05$). El peso corporal de los atletas



disminuyó significativamente y el índice de grasa corporal disminuyó significativamente después de la intervención nutricional. Los biomarcadores analizados tuvieron un impacto positivo, con la excepción de la concentración de nitrógeno ureico que mostró una tendencia a aumentar después de la intervención nutricional, efecto que puede estar relacionado con el aumento proporcional de la ingesta de proteínas. Conclusión: La propuesta de intervención nutricional presentó impactos positivos en el metabolismo energético de los esquiadores, impactando directamente en la recuperación de la fatiga deportiva de los atletas. **Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

Descriptor: Esquí; Fatiga Muscular; Fenómenos Fisiológicos en la Nutrición Deportiva.

DOI: http://dx.doi.org/10.1590/1517-8692202329012022_0167

Article received on 03/15/2022 accepted on 05/31/2022

INTRODUCTION

Skiing is a sport with high requirements in endurance, speed, skills, strength and other aspects. In the long-term training process, relatively monotonous training methods and strong physical training intensity will have a certain impact on Athletes' body and mind. In particular, skiing consumes too much physical energy, which is very easy to cause athletes' sports fatigue, this kind of sports fatigue will affect the athletes' state at least, and then affect their competitive performance. At the same time, it is easy to make athletes lack physical fitness and cause sports injury.¹ In view of this problem, athletes, coaches and relevant research staff have discussed it.

Sports fatigue, in short, is that the physiological condition of athletes at this time cannot support the required exercise intensity, resulting in the decline of their exercise level, and it is also easy to bring problems such as psychological irritability, anxiety and lack of concentration.² After analyzing the diet of some existing ski athletes, this paper found that the management of many teams did not pay too much attention to the diet, often only the nutritionist issued the relevant diet plan, did not formulate the appropriate diet according to the individual situation of the athletes, and did not strictly follow the relevant diet suggestions in the daily diet process of the athletes, Many athletes are picky about eating or overeating, which have a certain impact on the recovery of athletes' sports fatigue. In view of this situation, this paper takes the athletes of a ski sports team as an example, through the scientific nutritional matching of three meals a day, to explore the curative effect of nutritional intervention on ski athletes' sports fatigue, so as to provide some help for ski athletes' scientific diet and help them achieve better competitive results.³

METHOD

In this paper, seven young male skiers were selected as the research object. The previous week was the observation period before the intervention. Their daily diet, the proportion of three meals, energy intake and the intake of major nutrients were recorded, and their body weight, body fat rate, serum metabolism, cardiopulmonary capacity and energy metabolism index were measured and recorded. Then formulate relevant nutrition intervention plans according to their personal characteristics. In the following three weeks, athletes eat in strict accordance with the nutrition matching plan and fully record their energy intake. After three weeks, athletes also record and sort out their weight, body fat rate, energy metabolism, physiological function and so on. The study and all the participants were reviewed and approved by Ethics Committee of Northeast Agricultural University (NO. 2020NAUB45).

With the help of relevant professionals, this paper designs a measurement scheme including athlete weight, body fat rate, cardiopulmonary function, energy metabolism index, serum metabolism index and so on. The serum metabolic index was measured and analyzed by blood cell analyzer and semi-automatic biochemical analyzer in the form of

fasting venous blood collection; The cardiopulmonary function test of athletes uses the cardiopulmonary function tester to calculate the aerobic exercise; Anaerobic exercise uses the power bicycle to test the indexes of athletes' anaerobic exercise, and then uses the blood lactic acid tester to integrate and analyze its metabolic index, so as to systematically study the recovery effect of ski athletes' sports fatigue under nutritional intervention.

RESULTS

Analysis of athletes' nutrition before and after nutrition intervention

In order to analyze the nutritional intervention of athletes, it is necessary to sort out the existing nutritional intake of athletes. Therefore, this paper observes the nutritional intake of athletes in a week and records it, as shown below:

As shown in Figure 1, A to G is the average proportion of three meals a week for seven athletes. The reference values of the proportion of three meals are 30% for breakfast, 40% for lunch and 30% for dinner. As can be seen from Figure 1, the average proportion of lunch is relatively high and the proportion of breakfast is relatively insufficient. It can be seen that most athletes have a high lunch diet and a relatively insufficient breakfast diet. Some athletes tend to take dinner as the most important diet of the day, so their dinner intake is the highest. Compared with the reference value, there are some misunderstandings, which is not conducive to the good absorption of nutrients.

Figure 2 shows the daily average total energy intake and the upper and lower limits of the reference value of the seven athletes before the nutritional intervention. Through figure 2, it can be found that only three of the seven athletes' total energy intake is within the reference value range, and the other four athletes' energy intake is significantly higher

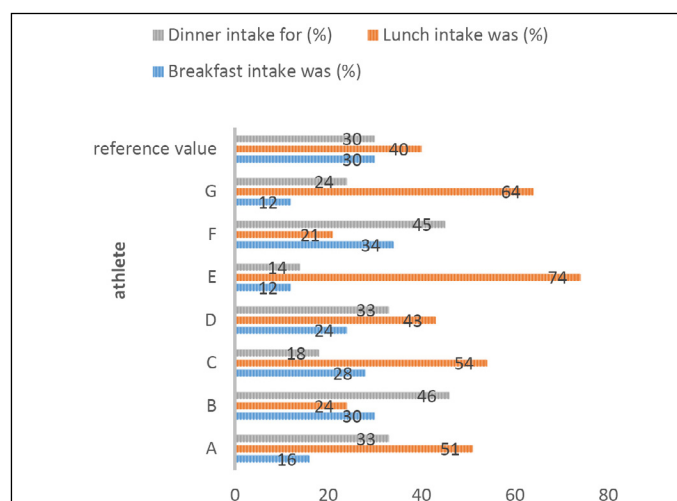


Figure 1. Proportion and reference value of three meals intake of the top seven athletes in nutritional intervention.

than the reference value. This shows that due to the excessive training intensity of ski athletes, their demand for energy is relatively high. Therefore, many athletes have excessive energy intake, but for a long time, some energy will not be metabolized and accumulated, which will have a certain impact on the athletes' body.

As shown in Figure 3, the proportion of vitamin intake of 7 athletes before nutritional intervention has obvious deviation from the reference value, which is mainly reflected in the serious shortage of vitamin B1 intake, the large deviation of vitamin A intake from the reference value, showing an insufficient trend, and the excessive intake of vitamin B2. Therefore, in the process of nutritional intervention, we should vigorously increase the intake of vitamin B1, moderately increase the intake of vitamin A, and balance and control the intake of vitamin B2.

As shown in Figure 4, among the three major nutrients, the recommended intake proportion of fat, sugar and protein is 55% sugar, 25% fat and 20% protein. However, at present, the diet of athletes is more carried out according to the preferences and cognition of athletes under the reference opinions of nutritionists, so there are deviations in the intake of many nutrients. For example, the intake of sugar is relatively insufficient for three athletes, which is only about 40%, while the intake of fat is generally high. The fat intake of five athletes exceeds the recommended value, the intake of protein is relatively low, and the protein intake of five athletes is insufficient. Therefore, the intake of three major nutrients should be reasonably configured in the process of nutritional intervention.

Effect of nutritional intervention on basic physical indexes of athletes

In discussing the impact of nutritional intervention on Athletes' basic physical indicators, this paper uses the method of intra group comparison to analyze the effect of nutritional intervention by comparing various indicators before nutritional intervention and after nutritional intervention, as follows:

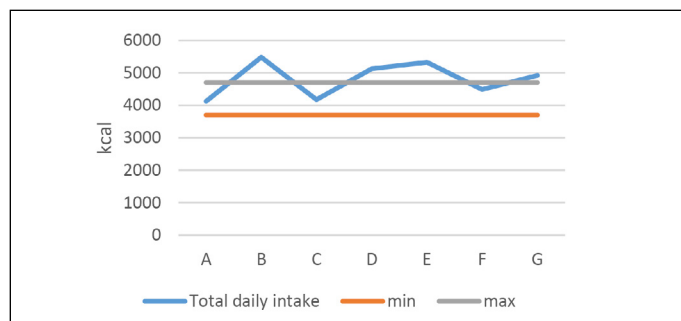


Figure 2. Average daily total energy intake and reference value of the seven athletes before nutritional intervention.

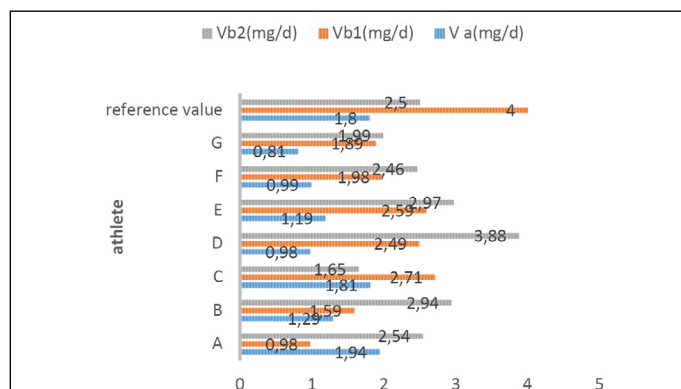


Figure 3. Vitamin intake ratio and reference value of the top seven athletes in nutritional intervention.

As shown in Table 1, the athletes' body weight, fat removal weight and body fat rate were sorted and analyzed before and after the experiment. It can be seen from table 1 that there was no significant difference in the changes of athletes' fat removal weight ($P > 0.05$), the total weight of athletes decreased significantly after the nutritional intervention ($P < 0.05$), and the body fat rate increased significantly ($P < 0.01$).

As shown in Table 2, serum creatine kinase (CK) and serum urea nitrogen (BUN) were selected as the test indexes of athletes' serum metabolism. They were in the normal range before and after the experiment. The content of CK in the experimental group decreased after nutritional intervention, but there was no significant difference within the group ($P > 0.05$); Bun increased after nutritional intervention, and the value was significant ($P < 0.01$).

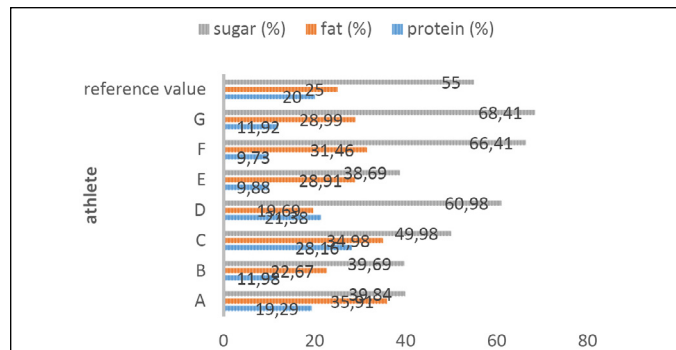


Figure 4. Intake proportion and reference value of three major nutrients of the top seven athletes in nutritional intervention.

Table 1. Test results of basic physical indexes of athletes.

Option	Period	Test group
Weight (kg)	Before intervention	70.18±7.31
	After intervention	69.84±6.07
Take fat weight (kg)	Before intervention	59.64±4.52
	After intervention	59.42±4.62
Sensory fat ratio (%)	Before intervention	14.45±2.74
	After intervention	14.57±2.81

Table 2. Test results of serum metabolic indexes of athletes.

Option	Period	Test group
CK (U/L)	Before intervention	311.15±139.27
	After intervention	292.34±140.44
BUN (mmol/L)	Before intervention	5.02±1.23
	After intervention	5.31±1.11

DISCUSSION

Due to its own particularity, the nutritional supplement of skiing is also different from other sports. For example, skiing athletes exist in the vast white ice and snow for a long time, which is easy to produce the phenomenon of snow blindness and cause great damage to the athletes' eyes and eyesight. Therefore, the content of vitamin a and retinol should be supplemented meaningfully in the process of daily diet, So as to ensure the eyesight of athletes; In the process of skiing, especially in some difficult skiing, athletes' nerves are always in a state of high tension, which is easy to produce two types of fatigue: sports fatigue and nerve fatigue. Therefore, in the case of dietary intervention, we should pay attention to increasing the supply of nutrients such as protein, vitamin a, vitamin C and vitamins B1 and B2. Before nutritional intervention for athletes, it is necessary to cultivate athletes' awareness of healthy diet and make athletes aware of the importance of healthy diet to competition results, so as to pay attention to healthy diet ideologically,

actively cooperate with the work of coaches and nutritionists, give full play to their subjective initiative, make reasonable dietary arrangements, avoid picky eating, excessive eating, and eat less or no snacks, Promote the scientific absorption of their own body nutrition as far as possible.⁴

For skiers, the main goal of the training preparation period before the competition is to consolidate and improve the existing sports level. In terms of nutritional intervention, the main goal is to adjust the level of various abilities of the body and complete the physical reserve, which is mainly reflected in the improvement of oxygen supply ability, muscle strength and related energy reserve. It is mainly divided into the following points: the first is to improve the function of the body's immune system, including the functional level of various organs such as heart and lung, respiratory system and central nervous system, so as to improve the energy and oxygen supply capacity of various parts of the body, enhance the body's immunity and meet the upcoming competition in the best state; The second is the improvement of the body's oxygen supply capacity, including the improvement of hemoglobin content, the improvement of red blood cell level and the synthesis of related enzymes, which requires to enhance the supplement of protein, especially high-quality protein, and combine with sports training to enhance the athletes' support capacity, so as to promote the recovery of sports fatigue and improve the body's oxygen supply capacity; The third is to improve the muscle strength of athletes, so as to enhance the strength and physical endurance level of skiers and promote the recovery of sports fatigue. On the one hand, it mainly supplements high-quality protein. Whey protein powder can be combined with vitamins and trace element supplements in the form of drinking, and its taste can be adjusted according to the taste of athletes for athletes to drink, so as to supplement energy in time and lay a good physical function foundation for the next competition.⁵

During the competition, in order to ensure the fairness of the competition and prevent the use of stimulants and other contraband, many organizers often establish an athlete canteen, and all athletes' meals are uniformly provided by the organizing committee. At this time, the main meal type of athletes is the form of buffet. Although it is impossible to

match the food for athletes, it can guide athletes to consciously choose good food. During the competition, the main nutritional goal is to supply energy. Therefore, its diet should be dominated by a large amount of carbohydrates and an appropriate amount of protein. When selecting carbohydrates, try to choose staple foods made of coarse grain and brown rice. Such staple foods can provide a large amount of energy for sports mobilization continuously during the competition, some seemingly high carbohydrate substances, such as refined rice and noodles, can also provide a lot of energy, but the release rate of sugars in these foods is fast, resulting in certain pressure on sugar metabolism, which is not conducive to the maintenance of athletes' good competitive level. In addition, we should also increase the food supplement of nuts, so as to provide a stable energy supply for athletes during the competition.⁶

CONCLUSION

Through the research of this paper, it can be seen that good nutrition matching can not only improve the physical quality level of athletes, but also promote the recovery of their sports ability and sports fatigue. Therefore, coaches should actively cooperate with dietitians and other personnel to provide good dietary reference for athletes. While athletes should fully understand their own needs, actively cooperate with the nutritional recipes proposed by dietitians, and purposefully complete the supplement of nutrients at different stages before, during and after the competition, so as to improve its anti-fatigue ability and sports fatigue recovery ability, keep it in a good competitive state, and promote the improvement of the competitive level of skiing.

ACKNOWLEDGEMENTS

This paper was supported by Heilongjiang Social Science Fund Project (20TYE336): Soft environment research on sustainable development of skiing tourism in Heilongjiang Province during the window period of Beijing 2022 Winter Olympic Games.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Every author has made an important contribution to this manuscript. RW: writing; CY: execution.

REFERENCES

1. Pan SN, Lyu XH, Liu Q, Guo QY. Pay attention to the imaging study of sport injury and illness in winter olympics sports. *Chin Med J (Engl)*. 2018;131(9):1013-5.
2. Smith DM, DeCaro JA, Murphy SL, Parmelee PA. Momentary reports of fatigue predict physical activity level: wrist, waist, and combined accelerometry. *J Aging Health*. 2020;32(9):921-5.
3. Bertoli M, Tecchio F. Fatigue in multiple sclerosis: Does the functional or structural damage prevail?. *Mult Scler*. 2020;26(14):1809-15.
4. Bemben MG, Lammont HS. Creatine supplementation and exercise performance. *Sports Med*. 2005;35(2):107-25.
5. Rankin JW. Dietary carbohydrate and performance of brief, intense exercise. *Sports Sci Exchange*. 2000;13:1.
6. Institute of Medicine. *Dietary Reference Intakes for water, potassium, sodium, chloride, and sulfate*. Washington: The National Academies Press; 2004.