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ORIGINAL RESEARCH

Investigation of the relationship between nutritional knowledge and nutritional supplement belief levels and athletic performances of elite cross-country skiers

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Abstract

The use of nutritional supplements provides support to the athlete, while the use of wrong and inappropriate supplements may adversely affect the performance of the athlete. This study investigated the relationship between the nutritional knowledge and nutritional supplement belief levels and athletic performances of elite cross-country skiers. A total of 19 elite cross-country skiers, 8 females and 11 males (mean age of 16.1±1.00 years) competing in the U-16 and U-18 categories, participated in the study. Inbody 120, 10 m, 20 m and 30 m sprint, agility, 20m shuttle run and hand grip tests were used to assess physical and psychological factors. Moreover, the Nutrition for Sports Knowledge Questionnaire (NSKQ) and the Sports Supplements Belief Scale (SSBS) were applied to the athletes. No significance was found in the comparison of the athletes in terms of Body Mass Index (BMI) classification ($p>0.05$). A positive relationship was found between the NSKQ and age ($r=0.466$; $p=0.044$), body fat percentage ($r=0.505$; $p=0.027$), and body fat mass ($r=0.642$; $p=0.003$) values. On the other hand, a positive relationship was found between the SSBS scale and body weight ($r=0.136$; $p=0.009$), body muscle mass ($r=0.681$; $p=0.001$), total body water ($r=0.647$; $p=0.003$), hand grip strength (right hand $r=0.621$; $p=0.005$; left hand $r=0.635$; $p=0.003$), while a negative relationship was found between the SSBS scale and 10m sprint ($r=-0.589$; $p=0.008$), 20m sprint ($r=-0.606$; $p=0.006$), 30m sprint ($r=-0.480$; $p=0.037$) and agility values ($r=-0.533$; $p=0.019$). These findings demonstrate that the sports nutrition knowledge level does not have a positive effect on athletic performance, but it has a positive effect on body muscle mass, strength, sprint, and agility values that affect athletes' athletic performances as athletes' nutritional supplements belief levels increase.

Keywords: Athletic performance, cross-country skiing, nutritional knowledge level, supplements.

Introduction

Cross-country skiing, which is an Olympic branch, is an outdoor activity that is enjoyed in many countries of the world. In cross-country skiing, the whole body works in harmony, and it is very common especially among young people (Kuzmin & Fuss, 2013; Sundstörm et al., 2013). When the physiological requirements of cross-country skiing are examined, competitors are expected to have high maximal oxygen consumption and high

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anaerobic threshold values. Moreover, parameters such as endurance, strength and sprint are important for success. It is reported that aerobic capacities of elite cross-country skiers in the world are similar due to their genetic structures, and the athletes with the highest maximal oxygen consumption among endurance sports are cross-country skiers. However, new competition formats require anaerobic capacity, upper body strength, high-speed techniques and tactical elements, apart from the declared parameters (Çetin & Yarım, 2006). These factors affect athletes' performance in competitions, and some of them may vary depending on athletes' personal characteristics (Mira, 2013). However, it is possible to regard environmental factors that are not under the athletes' control such as weather conditions and the characteristics of the competition track, but that can affect performance during the competition (Papadopoulou, 2012; Ateş, 2014).

As with all athletes, cross-country skiers also need adequate and balanced nutrition to meet physical training demands and optimize their athletic performance (Maughan et al., 2018; Garthe et al., 2018). Athletes need higher amounts of energy, protein, and carbohydrates due to higher activity levels, intense training structures, and increased lean body mass. Therefore, nutrition plays a key role in improving performance, adapting to training, replenishing energy stores, and reducing fatigue and recovery time (Ruano et al., 2020). Moreover, there are studies showing that appropriate intake of selected nutritional supplements can improve performance when needed (Dascombe et al., 2010; Lieberman et al., 2015; Hurst et al., 2017b; Ayaş, 2020). Nutritional supplements contain a wide variety of ingredients, including macro- and micronutrients (e.g., minerals, vitamins, proteins, amino acids) and ergogenic supplements (creatine, caffeine, β-alanine, etc.) and these supplements are commercialized in different pharmaceutical forms including drugs, beverages, bars, gels, liquid meals, etc. Nutritional supplements can be widely used by athletes, depending on the type of sport. The main purpose of supplements is to compensate for nutrient deficiencies caused by inadequate intake and/or increased need. The types and amounts of supplements needed by athletes vary depending on the sport they do and the characteristics of each sport (Čaušević et al., 2017; Senekal et al., 2021).

Inadequate nutritional knowledge can jeopardize athletes' ability to optimize their performance, recovery, and health. Studies show that athletes' education about nutrition is generally lacking (Čaušević et al., 2017; Druker et al., 2017). There are also inconsistencies in the literature about how athletes' nutrition knowledge should be evaluated. A higher level of an athlete's nutrition knowledge can positively affect the athlete's nutritional behavior and athletic performance. Literature reviews show that nutrition education interventions in athletes improve athletes' nutrition knowledge, diet quality, body composition and performance following the intervention (Garthe et al., 201; Mazzilli et al., 2021). It is currently unknown how athletes' nutrition knowledge affects cross-country skiers' body composition, or what other factors may contribute to an athlete's body weight goal.

In the literature, there are studies showing that athletes' gaining adequate, balanced and correct eating habits contributes to a more appropriate body composition (Folasire et al., 2015; Devlin et all., 2017; Garthe et al., 2018; Mazzilli et al., 2021). Moreover, it is frequently shown that adequate and balanced nutrition is possible when the athlete has sufficient nutritional knowledge. However, studies showing its effects on athletic performance are limited (Spendlove et al., 2012; Spronk et al., 2015; Trakman et al., 2016). It is also reported that the use of nutritional supplements when needed provides support to the athlete, and the use of incorrect and inappropriate supplements may adversely affect the athlete's performance and body composition (Dascombe et al., 2010; Lieberman et al., 2015; Hurst et al., 2017b; Ayaş, 2020). All reported studies were conducted with popular team athletes (football, basketball, handball, etc.) in general (Trakman et al., 2016; Gümüşdağ & Kartal, 2019; Lökbaş et al., 2020; Kaçar & Yeşilkaya, 2020) and there is no similar study in the branch of cross-country skiing, which has recently attracted great interest and attention around the world. In this context, the aim of this study was to investigate the relationship between nutritional knowledge and nutritional supplement belief levels and athletic performances of elite cross-country skiers. We hypothesized that nutritional knowledge and nutritional supplement belief levels would lead to a better improvement in athletic performance responses.

Methods

Participants

A total of 19 elite cross-country skiers, 8 females and 11 males, competing in the U-16 and U-18 categories, with an age average of 16.1±1.00 years, participated in the study. The study was carried out during the preparation period of the athletes. All tests were carried out at the Arkut Mountain Cross-Country Center (Bolu, Turkey).

Procedure

The measurements were taken at 10:00 a.m. on the day that the athletes did not train, they were asked to have breakfast at least 90 minutes before the measurements, and then the athletes were included in the test. Agility, sprint and 20m Shuttle Run Test measurements were made one day apart. Before the study, each of the subjects was given detailed information about the study. All participants gave their written consent prior to taking part in the study. The study was conducted in accordance with the Helsinki Declaration and approved by the by the Non-Interventional Ethics Committee of Karabuk University (2022/1156) prior to the registration of participants.

Parameters, Tests, and Measurements

Body composition

The participants' height (cm) was measured with a stadiometer, body weight (kg) was measured with the Inbody 120 device, and the athletes' body mass indexes. Body Mass Index (BMI); The BMI of the participants was calculated by dividing their body weight by the square of their height, and the BMI classification was evaluated according to the World Health Organization (WHO) Standards. BMI; 18.50-24.99 kg/m2 normal; It was evaluated as 25.00-29.99 kg/m2 overweight and ≥30.00 kg/m2 obese. Those with a BMI of 30 and above were included in the study (WHO, 2022). Body fat percentage (%) and body muscle percentage (%) was measured by the Inbody 120 body analysis measuring device.

Grip strength (kg)

Holtin brand hand dynamometer was used for grip strength. The best result obtained as a result of two trials with the participants' dominant and non-dominant hands each was accepted as the highest value.

T-agility test (sec)

To conduct the test, 4 funnels were placed on a flat surface during the preparation of the track. Smart Speed brand photocell was used. The photocells were placed in funnel A. The participants started when they felt ready and started running straight from the funnel "A" to the funnel "B" and touching the funnel with their right hand. Then they ran to the left towards the "C" funnel with sidesteps and touched the funnel with their left hands. Afterwards, they ran to the right with sidesteps and touched the "D" funnel with their right hands. From here they sidestepped back to the "B" funnel, touched it with their left hands, and then sidestepped back to the "A" funnel and passed through the photocell. This test was performed twice with complete rest and the best duration was recorded (Bayraktar, 2013).

Sprint (10m, 20m, 30m) test (sec)

The length of the running area was determined as 10m, 20m and 30m. As a stopping distance, a distance of at least 10 meters was reserved beyond the finish line. The ground was smooth and the start and finish lines were marked with a straight line. Photocells were placed at the start and finish lines. Moreover, the start and end points were determined with signs. The participants' 10m, 20m and 30m grades were recorded and their best grades were recorded after two trials. The measurement was made with Fusion brand Smart Speed reactive wireless photocell.

20m Shuttle Run test (VO_{2max})

The purpose of this test is to estimate the participants' maximum oxygen consumption capacity. The participants were allowed to warm up for 5 minutes before starting the test. The participants ran the 20m distance as a round trip. The participants had to start running at the first signal tone and reach the other line until the second signal. When they heard the second signal, they turned back to the starting line. When the participants heard the signal, they adjusted their own tempo so that the second signal tone would be at the other end of the track. The speed, which was slow at first, gradually increased every 10 seconds. Even if the participants missed a signal tone and caught the second, they continued with the test. However, the test ended when the participants missed two signal tones in a row (Meredith & Welk, 1992).

Nutrition for Sports Knowledge Questionnaire (NSKQ)

The Nutrition for Sports Knowledge Questionnaire (NSKQ) was developed by Trakman et al. (2017) to evaluate athletes' nutritional knowledge. The Turkish validity and reliability study of the scale was conducted by Çırak & Çakıroğlu (2019). NSKQ is a 3-point Likert-type multiple-choice scale consisting of 68 items and 6 sub-dimensions. The sub-dimensions of the scale are Weight Control (3 items), Macro Nutrients (22 items), Micronutrients (12 items), Sports Nutrition (11 items), Supplements (11 items), and Alcohol (9 items), respectively. While the Cronbach's Alpha Coefficient of the scale was found to be 0.906 in the Turkish validity-reliability study, it was found as 0.733 in this study. The knowledge level scores of the participants were calculated based on the correct answers. The total score in NSKQ was accepted as 100% for 68 items, and the scoring system was rated in a way as "low" knowledge (0-49%), "average" knowledge (50-65%), "good" knowledge (66-75%), and "excellent" knowledge (75-100%).

Sports Supplements Belief Scale (SSBS)

To measure the athletes' belief in nutritional supplements, The Sports Supplements Belief Scale developed by Hurst et al. (2017) and adapted into Turkish by Karafil et al. (2019) was used. The scale consists of six unidimensional question items. The scale ranges from strongly disagree (1) to strongly agree (6).

Data Analyses

The statistical analyzes were performed using a package program called SPSS (IBM SPSS Statistics 23.0). Frequency tables and descriptive statistics were used to interpret the results. Chi-Square ($\chi2$) tables were used to examine the relationship of qualitative variables with each other. The Spearman relationship coefficient was used to examine the relationship of measurement values with each other. The interpretations of relationship coefficients were interpreted as r=0; no relationship, r=.01-.29; weak relationship, r=.3-.7; moderate relationship, r=71-.99; high relationship, r=1; perfect relationship. The analysis results were interpreted at 95% confidence level and 0.05 significance value for comparison tests, and 95% and 99% confidence levels and 0.05 significance values for relationship tests.

Results

The age average of the athletes was 16.1±1 years, and 8 (42.11%) were female and 11 (57.89%) were male. 17 (89.4%) of the athletes were of normal weight, 15 (78.95%) were high school graduates, 14 (73.68%) of them had been doing professional sports for 5-10 years, 7 (36.84%) had received nutrition education and they evaluated their knowledge as sufficient, 10 (52.63%) evaluated their general nutritional status as good (Table 1).

The results of the Chi-square comparison test between the athletes' some characteristics and the BMI-classes are presented in Table 2. No statistically significant relationship was found between the BMI-classes and gender, training age, time spent as a national athlete, educational level, duration of engaging in professional sports, daily training duration, number of snacks, daily fluid consumption, status of receiving nutrition education, level of knowledge on sports nutrition, and general nutritional status (p>.05).

Table 1
Demographic characteristics.

Variables		n	%
Gender	Female	8	42.11
	Male	11	57.89
Age (years)	Female (Mean±SD)	(15.8±0.2)	
	Male (Mean±SD)	(16.2±0.1)	
Sports Age (years)	4	4	21.05
	5	1	5.26
	6	4	21.05
	7	6	31.58
	8	1	5.26
	10	3	15.79
National Athlete (years)	1	1	9.09
	2	2	18.18
	4	4	36.36
	6	1	9.09
	7	2	18.18
	8	1	9.09
BMI (kg/m^2)	Thin	1	5.30
	Normal	17	89.40
	Fat	1	5.30
Educational Level	High school	15	78.95
	Associate Degree	1	5.26
	Bachelor's Degree	3	15.79
Professional Sports Time (years)	1 - 5	3	15.79
	5 - 10	14	73.68
	+ 10	2	10.53
Daily Fluid Intake	<2 liters	2	10.53
	2 - 3 liters	16	84.21
	3 -4 liters	1	5.26
Nutritional Education Receiving Status	Yes	7	36.84
	No	12	63.16
The Extent of Knowledge on Sports Nutrition	Adequate	7	36.84
	Not adequate	4	21.05
	No idea	8	42.11
Nutritional Status	Very good	2	10.53
	Good	10	52.63
	Moderate	7	36.84

Table 2
Comparison of the participants' some characteristics and BMI classification.

Variables		Body Mass Index Classification						Chi-Square	p
		Thin		Normal		Slightly Fat			
		n	%	n	%	n	%		
Gender	Female	2	40.0	6	46.2	0	0.0	0.824	0.662
	Male	3	60.0	7	53.8	1	100.0		
Sports Age (years)	4	3	60.0	1	7.7	0	0.0	12.082	0.280
	5	0	0.0	1	7.7	0	0.0		
	6	1	20.0	3	23.1	0	0.0		
	7	1	20.0	5	38.5	0	0.0		
	8	0	0.0	1	7.7	0	0.0		
	10	0	0.0	2	15.4	1	100.0		
National Athlete (years)	1	1	50.0	0	0.0	0	0.0	10.656	0.385
	2	0	0.0	2	25.0	0	0.0		
	4	1	50.0	3	37.5	0	0.0		
	6	0	0.0	1	12.5	0	0.0		
	7	0	0.0	1	12.5	1	100.0		
	8	0	0.0	1	12.5	0	0.0		
Educational Level	High school	5	100.0	10	76.9	0	0.0	6.821	0.146
	Associate Degree	0	0.0	1	7.7	0	0.0		
	Bachelor's Degree	0	0.0	2	15.4	1	100.0		
Professional Sports Time (years)	1 - 5	2	40.0	1	7.7	0	0.0	3.716	0.446
	5 - 10	3	60.0	10	76.9	1	100.0		
	+ 10	0	0.0	2	15.4	0	0.0		
Daily Training Time (hours)	2	0	0.0	1	7.7	0	0.0	0.487	0.784
	4	5	100.0	12	92.3	1	100.0		
Number of Snacks	0	1	20.0	5	38.5	1	100.0	5.32	0.503
	1	3	60.0	7	53.8	0	0.0		
	2	0	0.0	1	7.7	0	0.0		
	3	1	20.0	0	0.0	0	0.0		
Daily Fluid Intake	<2 liters	0	0.0	2	15.4	0	0.0	1.644	0.801
	2- 3 liters	5	100.0	10	76.9	1	100.0		
	3 -4 liters	0	0.0	1	7.7	0	0.0		
Nutritional Education Receiving Status	Yes	3	60.0	4	30.8	0	0.0	1.942	0.379
	No	2	40.0	9	69.2	1	100.0		
The Extent of Knowledge on Sports Nutrition	Adequate	3	60.0	3	23.1	1	100.0	4.145	0.387
	Not adequate	1	20.0	3	23.1	0	0.0		
	No idea	1	20.0	7	53.8	0	0.0		
Nutritional Status	Very good	0	0.0	2	15.4	0	0.0	3.616	0.460
	Good	4	80.0	5	38.5	1	100.0		
	Moderate	1	20.0	6	46.2	0	0.0		

** p<.05*

The relationship between the individuals' Nutrition for Sports Knowledge Questionnaire (NSKQ), (Mean±SD=22.1±8.1), Sports Supplements Belief Scale (SSBS), (Mean±SD=22.5±7.1) scores and age, body weight, BMI, BFP (%), BFM (kg), BMM (kg), Total body water, Grip right hand, Grip left hand, Sprint 10m (sec), Sprint 20m (sec), Sprint 30m (sec), T-agility (sec), and VO_{2max} (ml/kg-1/min-1) are presented Table 3. A positive, weak, statistically significant relationship was found between age and NSKQ (r=0.466; p=0.044). A positive, moderately statistically significant relationship was found between body weight and SSBS (r=0.559; p=0.013). No statistically significant relationship was found between body mass index and VO_{2max} (ml/kg-1/min-1) and the scales. A positive, moderately statistically significant relationship was found between BFP (%), BFM and NSKQ (r=0.505; p=0.027; r=0.642, p=0.003). Similarly, a positive, moderately statistically significant relationship was found between BMM (kg), Total body water, grip right hand and grip left hand and SSBS (r=0.681; p=0.001; r=0.647, p=0.003; r). r=0.621, p=0.005; r=0.635, p=0.003). A negative, moderately statistically significant relationship was found between Sprint 10m (sec), Sprint 20m (sec), and T-agility and SSBS-scores (r=-0.589, p=0.008; r=-0.606, p=0.006; r) =-0.533, p=0.019). A negative, weak, statistically significant relationship was found between Sprint 30 m (sec) and SSBS-scores (r=-0.480; p=0.037).

Table 3

Examination of the relationships between the individuals' Nutrition for Sports Knowledge Questionnaire (NSKQ), Sports Supplements Belief Scale (SSBS) scores and various variables.

	Mean±SD		NSKQ	SSBS
Age (years)	16.05±0.97	r	0.466*	-0.131
		p	0.044	0.594
Height (cm)	163.94±0.08	r	-0.234	0.585**
		p	0.334	0.009
Body Weight (kg)	53.63±8.46	r	0.136	0.559*
		p	0.579	0.013
BMI (kg/m^2)	20.03±2.23	r	0.388	0.284
		p	0.101	0.239
Body Fat Percentage (BFP) (%)	13.16±5.73	r	0.505*	-0.363
		p	0.027	0.127
BFM (kg)	7.02±3.34	r	0.642**	-0.239
		p	0.003	0.325
BMM (kg)	47.34±8.97	r	-0.093	0.681**
		p	0.704	0.001
Total Body Water (%)	34.44±6.04	r	-0.157	0.647**
		p	0.522	0.003
Grip Strength Right hand (kg)	36.63±9.69	r	-0.131	0.621**
		p	0.592	0.005
Grip Strength Left hand (kg)	35.28±10.5	r	-0.126	0.635**
		p	0.606	0.003
Sprint 10m (sec)	1.82±0.08	r	0.217	-0.589**
		p	0.373	0.008
Sprint 20m (sec)	3.14±0.05	r	0.190	-0.606**
		p	0.436	0.006
Sprint 30m (sec)	4.54±0.24	r	0.348	-0.480*
		p	0.145	0.037
T-Agility (sec)	11.70±1.1	r	0.262	-0.533*
		p	0.278	0.019
VO_{2max} (ml/min/kg)	51.12±5.83	r	-0.201	0.089
		p	0.410	0.718

**p<0.05; **p<0.01*

Discussion

In this study, elite cross-country skiers were subjected to scrutiny to assess the association between their nutritional knowledge and beliefs regarding nutritional supplements, and their athletic performances. The results of the analysis reveal that with advancing age among cross-country skiers, there is a corresponding increase in their Nutritional Supplement Knowledge Questionnaire (NSKQ) scores, exhibiting a positive correlation ($r = 0.466$; $p = 0.04$). Similarly, as body fat percentage ($r = 0.505$; $p = 0.027$) and overall body mass ($r = 0.642$; $p = 0.02$) increase, NSKQ scores also exhibit a positive trend. Nonetheless, it is noteworthy that our findings diverge from existing literature, as prior studies suggest that athletes who cultivate sound, balanced, and appropriate dietary habits tend to achieve a more favorable body composition (Folasire et al., 2015; Devlin et al., 2017; Garthe et al., 2018; Mazzilli et al., 2021). Furthermore, our study reveals that the mean NSKQ score for elite female cross-country skiers is 27.13 ± 3 points, whereas for their male counterparts, it stands at 18.64 ± 8.91 points. These outcomes underscore that the participants' levels of nutritional knowledge, as measured by NSKQ, fall within the lower range of proficiency (0-49), signifying a deficiency in nutritional knowledge. Consequently, despite their status as national-level athletes, it is evident that their NSKQ scores indicate a suboptimal level of nutritional knowledge.

As the athletes' Sports Supplements Belief Scale (SSBS) increased, their body weight ($r=0.559$; $p=0.01$), body muscle mass ($r=0.681$; $p=0.00$), grip right hand ($r=0.62$; $p=0.00$), grip left hand ($r=0.63$; $p=0.00$), 10m ($r=-0.58$; $p=0.00$), 20m ($r=-0.60$; $p=0.00$), 30m ($r=-0.48$; $p=0.03$) speed and agility ($r=-0.53$; $p=0.01$) performances also increased. It can be said that SSBS has positive effects on the performance of the athletes. Similar to the findings of our study, it is reported that the use of nutritional supplements when needed provides support to the athlete, while the use of incorrect and inappropriate supplements may adversely affect the performance and body composition of the athlete (Dascombe et al., 2010; Lieberman et al., 2015; Hurst et al., 2017b; Ayaş, 2020). However, studies examining the effects of NSKQ and SSBS on athletic performance are limited (Spendlove et al., 2012; Spronk et al., 2015; Trakman et al., 2016).

A positive relationship was found between the NSKQ and age, body fat percentage (%), body fat mass (kg) values ($p<.05$). It can be said that as age increases, NSKQ-scores increase, but this increase is not effective on BFM and BFP. In fact, as NSKQ-scores increase, an increase in parameters related to athletic performance can be expected. However, our study and other studies in the literature cannot give a clear answer about NSKQ-scores and parameters related to athletic performance. For example, in a study involving 66 football players, contrary to our findings, although a negative relationship was found between the athletes' NSKQ-score and body fat percentage ($r=-0.041$, $p= 0.036$) (Devlin et al., 2017), in another study, it was reported that there was no relationship between the nutritional knowledge level of football players and their anthropometric parameters (Folasire et al., 2015). Again, in another study conducted with football players, although it was seen that football players with high nutritional knowledge had higher body weights compared to football players with low nutritional knowledge, no significant difference was observed between BMI, body fat percentages and body muscle mass (Nikolaidis & Theodoropoulou, 2014). Similarly, in the study conducted by Walsh et al. (2011), no significant difference was observed between the athletes' nutritional knowledge levels and their body fat percentages. All these results show that nutritional knowledge level alone does not affect athletic performance. Because what really matters is how much athletes apply their nutritional knowledge in their daily lives.

On the other hand, a significant positive relationship was found between the SSBS scale and body weight (kg), body muscle mass (kg), total body water (%), right- and left-hand grip strength (kg) while a significant negative relationship was found between the SSBS scale and 10, 20, 30m sprint (sec) and agility (sec) values ($p<.05$). These results may indicate that the level of belief in sports supplements positively affect athletic performance. Because these results show that as the level of belief nutritional supplements increases, right- and left-hand grip strength, speed, and agility performance also increase. In the literature, it is frequently reported that nutritional supplements used before, during and after exercise increase the volume and intensity of exercise and accelerate recovery. Of course, these nutritional supplements and consumption times vary according to the character of the exercise. In their studies, Dascombe et al. (2010) reported that 87.5% of the athletes use nutritional supplements; Lieberman et al. (2015) reported that 66% of the athletes use nutritional supplements; Lun et al. (2009) reported that 87% of the athletes use nutritional supplements, and Aljoloud et al. (2013) reported that 93.3% of the athletes use nutritional supplements. Yarar et al., (2011) stated that 75.7% of the athletes needed to use additional vitamins or minerals. Özturk et al. (2020) stated that 40% to 100% of the athletes use nutritional supplements, but the use of nutritional supplements will have a negative effect on the health and performance of the athletes, despite the sufficient nutritional elements of the athletes. Moreover, Hurst et al. (2017b) showed a positive relationship between the use of sports supplements by athletes and their beliefs about their effectiveness. In another study, it was concluded that the weekly training duration, age, and gender of the athletes have no effect on their belief in nutritional supplements. In the graphs examining the levels of belief in nutritional supplements on the basis of substances, it was shown the athletes believe, at a rate of 70%, that nutritional supplements will increase their self-confidence and performance, which will increase their chances of winning (Ayaş, 2020).

The fact that only 19 elite cross-country skiers competing in the U-16 and U18 categories participated in our study and that the study coincided with the preparation period are among the important limitations of the study. At the same time, the fact that the study was conducted only on national cross-country ski athletes can be stated as another limitation. Because the tests performed before an athlete who has just come out of the transition period is included in the intense training plans can affect the performance outcomes. In this context, the findings of this study should not be generalized for all athletes, different genders, and branches. It should be kept in mind that the results of studies to be conducted with athletes in different annual training periods and with more participants may differ.

Conclusion

It can be said that the sports nutrition knowledge level does not have a positive effect on athletic performance, but it has a positive effect on body muscle mass, strength, sprint, and agility values that affect athletes' athletic performances as athletes' Nutritional Supplements Belief levels increase. However, it should not be forgotten that the important thing is how well athletes can use their knowledge and belief levels in practice.

Authors' Contribution

Study Design: NA, HDG, PG, MŞA; Data Collection: NA, MEY; Statistical Analysis: NA; Manuscript Preparation: HDG, PG, MŞA; Funds Collection:

Ethical Approval

The study was approved by the Non-Interventional Ethics Committee University of Karabuk Ethical Committee (2022/1156) and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki.

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Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this research.

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