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Research Article

The Effect of Ergogenic Supplements and Mediterranean Diet on Cycling Performance; Differences According to Duration and Intensity

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Abstract

Aims: To record the prevalence and the type of supplement use among cyclists and to estimate the effect of caffeine, carbohydrates, energy drinks and meddiet score on 200m and 4km cycling time-trial performances in a Greek sample. **Methods:** Fifty male cycling athletes aged 32 ± 20 years participated in a randomized, double-blind study. The subjects were submitted to anthropometric measurements and body composition was assessed with bioelectrical impedance. All participants completed the meddiet Score questionnaire and a validated questionnaire about their ergogenic aids' preference. The athletes performed two cycling trials (200m and 4km) and their records were taken down and were evaluated according to their consumption of caffeine, carbohydrates and energy drinks and their meddiet score. For the statistical analysis SPSS, v20 was used. **Results:** Greek cyclists had a mean BMI value of 23.65 ± 2.74 and a mean body fat percentage of 15.82 ± 8.33. Endurance and speed performances were improved with caffeine consumption when compared to no consumption (7.42 ± 3.92 min vs 12.5 ± 3.16 min, $p < 0.001$ and 20.75 ± 15.69 sec vs 34.07 ± 16.25 sec, $p < 0.05$, respectively), as well as with energy drinks' consumption (8.77 ± 4.15 min vs 13.25 ± 2.47 min, $p < 0.001$ and 20.35 ± 14.08 sec vs 39.14±14.38 sec, $p<0.001$, respectively). Carbohydrates' intake improved performance in the endurance test (7.60 ± 3.72 min vs 12.86 ± 2.92 min, $p < 0.001$), but did not have a positive influence in the speed test (25.73 ± 18.68 sec vs 33.08 ± 15.95 sec, $p > 0.05$). **Conclusions:** Ergogenic aids had a positive effect on the athletic performance in terms of speed and endurance in cyclists.

Keywords: Cycling, Athletic performance, Ergogenic aids, Mediterranean diet

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1. Introduction

Dietary supplement use is expanding among athletes who are experimenting with a variety of substances, even illegal ones as to reach a competitive edge [15, 25, 33]. Ranges of age of cyclists vary and some athletes remain highly competitive into their 40s, although it is likely that performance peaks before 35 years of age. Ageing performance declines in similar way among several sports, yet, there are older, competitive and athletically ambitious athletes, called veterans or masters. Most likely to be founded positive for illegal substances are non-professional cyclists aged 30 to 50 years. Therefore, cycling is one of the most energy-expensive sports and the use of ergogenic aids is most popular [33].

Maintaining performance during endurance exercise is dependent on a variety of dietary factors, such as energy and water balance, appropriate macro and micronutrient intake. [19]. Many athletes do not seem to cover their energy demands [27] and are often leaded to limited energy supply [45, 55, 59, 82].

The main nutrient that can improve endurance and reduce fatigue is carbohydrates [20, 72], through maintaining blood glucose levels, CHO oxidation rates and preventing glycogen depletion [13]. Athletes consuming high proportion of carbohydrates had a better performance compared to others who consumed moderate quantities [14, 16, 38]. However, carbohydrates' consumption before and during brief exercise cannot act favorably [13].

Thus, carbohydrates act as ergogenic aid in endurance sports as cycling [13]. Other preferred ergogenic aids of cyclists, except for carbohydrates, are: proteins, caffeine, creatine, sodium bicarbonate beta-alanine and nitrates [18].

Sport beverages gained popularity as they attribute to both energy-giving and hydration- and electrolyte status maintaining in endurance performance. Experienced and older athletes are more likely to prefer sport beverages and to follow a drinking schedule during exercise [58, 88]. Energy drinks seem, also, to have a positive effect on performance [78] through hydration and energy supply [24, 37] and fatigue reduction [2, 14] and thus, they are of vital importance for endurance sports [39]. Elements contained in energy drinks are ginseng, guarana, taurine and caffeine which are not dangerous when received in recommended doses [17].

Caffeine can improve performance [7, 79] acting through an enhance in central nervous system and in fat oxidation rate [68, 86]. There are many studies suggesting that caffeine improves power and endurance compared to placebo or other supplements [26, 29, 35, 54, 57, 81]. A moderate dose of caffeine significantly improves performance

[44, 84], while very low doses of caffeine cannot be ergogenic [6] and a high dose may act against performance [48]. Chronic ingestion of low caffeine doses develops tolerance in low-caffeine consumers. Therefore, individuals with low-habitual intakes should refrain from chronic caffeine supplementation as to maximize performance benefits from acute caffeine ingestion [6].

American Dietetic Association, Dietitians of Canada and the American College of Sports state that anthropometric characteristics influence performance. Body composition and weight are the two main factors that can be manipulated and contribute to potential for athletic success. Specifically, body weight can add to an athlete's endurance, speed and power, while body composition improves agility, strength and appearance. However body mass and composition cannot solely predict the progression of a career and there is no optimal competitive body weight or composition for any sport or athletic group [74, 86]. Thus, body weight and composition are important indicators of physical fitness and can improve performance [3, 42]. Low body fat and high muscle mass levels are linked with better sports achievements [42].

Mediterranean diet contains an abundance of bioactive food constituents like complex carbohydrates, fibers, vegetable proteins, unsaturated fas, minerals, vitamins, polyphenols and phytosterols that can interact synergistically and affect beneficially metabolic pathways, lowering the risk of cardiometabolic disorders, cognitive decline and all-cause mortality [47, 75, 80]. Endurance exercise generates oxidative stress and acute inflammation [12], whereas Mediterranean diet improves immune system function [50], mitigates inflammation and enhances performance, recovery and injury repair [76]. For these reasons adherence to Mediterranean diet is essential for athletes following an exhaustive training program such as cyclists. Meddiet score is a useful tool that can evaluate the adherence to Mediterranean dietary pattern [60].

There is limited data regarging nutrition practices and energy needs of elite athletes, especially in Greece [31, 32, 61, 63, 64, 66, 67]. To the best of our knowledge there is no study on the effect of ergogenic aids and meddiet score on Greek cyclists' performance. Therefore, the goals of the present study were to record the prevalence and the type of supplement use among cyclists and to estimate the effect of caffeine, carbohydrates, energy drinks and meddiet score on 200m and 4km cycling time-trial performance in a Greek sample.

2. Methods

2.1. Population Sample

Fifty male cyclists aged 32 ± 20 years participated in this randomized double-blind study. Athletes responded to an announcement for this study posted in different cycling local training teams. Fifty cyclists fulfilled the inclusion criteria of the study (having a background for at least 6 sequentially years of training, having competed in the Greek National Championship and not having any orthopaedic/neuromuscular, restraining problems or taking any steroid supplements). The study was carried out in Thessaloniki, Greece, in 2015.

Participants have given their written consent prior to entering the study, which received approval by the Ethics Committee of the Alexander Technological Educational Institute of Thessaloniki, Greece, and is in accordance with the Declaration of Helsinki.

2.2. Procedures

The present study was divided into three meetings.

2.2.1. Anthropometric Characteristics and Body Composition

The first meeting took place one day before the first cycling trial. In the first meeting, an experienced dietitian performed all anthropometric measurements in the morning, after an overnight fasting and all athletes were in minimal clothing. Body weight was measured with the use of a calibrated digital scale with an accuracy of ±100g (Tanita 545N) and body height to the nearest 0.5 cm using a stadiometer, with an accuracy of 0.5 cm (SECA 220). Body mass index (BMI) was calculated as body weight divided by the square of height (kg/m^2). Body composition was estimated with the method of bioelectrical impedance analysis using portable bioelectrical impedance device (Tanita 545N). All cyclists were informed about the protocol for body composition assessment. They abstained from any type of exercise one day prior to measurement. Cyclists stood bare feet on the device, maintaining contact with their feet on electrodes and instructed to grasp the retractable handle as to have contact on electrodes with their palms.

2.2.2. Questionnaires

During the first meeting, a qualified dietitian instructed all subjects to complete the meddiet Score [60] and a questionnaire that has been evaluated in a previous study

Anthropometric characteristics	Min	Max	Mean	SD
Weight (kg)	51.00	123.00	74.6	12.2
Height (m)	1.61	1.92	1.77	0.08
Body Fat (%)	5.80	36.40	15.82	8.33
Body Water (%)	50.20	69.10	58.51	4.15
BMI (kg/m2)	19.00	33.40	23.65	2.74

TABLE 1: Anthropometric characteristics.

from our lab, regarding their ergogenic supplements' consumption (ie. Type of supplement, reasons for their use, source of information) [62, 65].

2.2.3. Cycling Trials

In the second meeting, all athletes completed a field based 200m speed race. In the third meeting, they completed a field based 4km endurance race. Their performance was evaluated according to the ergogenic supplement that each athlete had received, and their meddiet score.

2.3. Statistical Analysis

For the statistical analysis and the elaboration of the results, the computer package SPSS v20 was used. Results are presented as means ± standard deviation and/or percentages where appropriate. The level of significance was set at $p<0.05$.

3. Results

A total of 50 male cyclists participated in the study, with their age varying from 15 to 50 years.

Table 1 depicts anthropometric characteristics of our sample.

Frequency of training is presented in table 2. Each session lasted 1.5h, approximately.

Cyclists used 10 different nutritional supplements (Table 3). 44% of the cyclists consumed energy drinks, while caffeine, carbohydrates, proteins and vitamins were used by 24%, 30%, 30% and 22%, respectively. Also, it is worth to mention that 38% of the athletes did not take any supplement in order to improve their performance.

Sessions per week	N	Percentage
1-3 / week	13	26%
3-6 / week	24	47%
6-7 / week	14	27%

Table 2: Frequency of training.

Ergogenic aids	N	Percentage
Energy drinks	22	44%
Athletic drinks	9	18%
Caffeine	12	24%
Carbohydrates	15	30%
Protein / Acids	15	30%
Sodium	1	2%
Vitamins / Minerals	11	22%
Creatine	2	4%
Carnitine	3	6%
Glutamine	4	8%
Nothing	19	38%

Table 3: Supplements consumption.

Endurance and speed performances were improved with caffeine consumption when compared to no consumption (7.42 ± 3.92 min vs 12.5 ± 3.16 min, $p < 0.001$ and 20.75 ± 15.69 sec vs 34.07 ± 16.25 sec, $p < 0.05$, respectively), as well as with energy drinks' consumption (8.77 ± 4.15 min vs 13.25 ± 2.47 min, $p < 0.001$ and 20.35 ± 14.08 sec vs 39.14 ± 14.38 sec, $p < 0.001$, respectively). Carbohydrates' intake improved performance in the endurance test (7.60 ± 3.72 min vs 12.86 ± 2.92 min, $p < 0.001$), but did not have a positive influence in the speed test (25.73 ± 18.68 sec vs 33.08 ± 15.95 sec, $p > 0.05$) (Table 4).

Adherence to the Mediterranean diet was assessed by the meddiet Score (theoretical range: 0-55). Forty-three out of 50 cyclists had a median score regarding the adherence to the Mediterranean diet (score 28-41), while six cyclists had low scores (score 14-27) and only 1 cyclist had great adherence to the Mediterranean diet. Level of adherence to the Mediterranean diet played no significant role in endurance ($p = 0.563$) and speed test results ($p = 0.462$) (Table 5).

Supplements' consumption		N	Endurance performance (minutes)	Speed Performance (seconds)
	Yes	12	7.42 ± 3.92 (p = 0.001)	20.75 ± 15.69 (p = 0.016)
Caffeine	No	38	12.5 ± 3.16 (p = 0.001)	34.07 ± 16.25 (p = 0.016)
	Yes	15	7.60 ± 3.72 (p = 0.001)	25.73 ± 18.68 (p = 0.163)
Carbohydrates	No	35	12.86 ± 2.92 (p = 0.001)	33.08 ± 15.95 (p = 0.163)
	Yes	22	8.77 ± 4.15 (p = 0.001)	20.35 ± 14.08 (p = 0.001)
Energy drinks	No	28	13.25 ± 2.47 (p = 0.001)	39.14 ± 14.38 (p = 0.001)
Total cyclists regardless supplement consumption		50	11.28 ± 3.97 (p = 0.001)	30.88 ± 16.96 (p = 0.001)

Table 4: Performance in endurance and speed tests according to supplements' consumption.

Meddiet Score	N	Performance of resistance (minutes)	Performance of speed (seconds)
Score 14-27	6	12.50 ± 3.56 (p = 0.563)	30.63 ± 18.63 (p = 0.462)
Score 28-41	43	11.05 ± 4.06 (p = 0.563)	30.42 ± 16.84 (p = 0.462)
Score 42-55	1	14.00 (p = 0.563)	32.00 (p = 0.462)

Table 5: Performance in endurance and speed tests according to adherence to the Mediterranean diet.

4. Discussion

As it regards, the anthropometric variables, Greek cyclists had a mean BMI value of 23.65 ± 2.74 and a mean body fat percentage of 15.82 ± 8.33. Cyclists of the present study had higher values in both BMI and body fat levels compared to 6 professional road cyclists participated in the Tour of Andalusia, a 4stage race covering 647.6 Km [77]. In comparison to other endurance sports, Greek cyclists presented similar BMI and body fat levels with Greek male cross country skiers [63], with the New Zealand Ironman triathlon male athletes [41] and with the non-professional male triathletes, that participated in the Daurada Extreme Man Salou-Costa triathlon [4].

According to [42], high body fat affects negatively cyclists' performance and increased BMI acts against racing effort [5, 40]. In [85] investigated the effects of training and anthropometric characteristics on male marathon and ultra-marathon performance and found that body fat levels above 15% can negatively affect performance.

In our sample, most cyclists trained less than 9 hours per week, which is less than the appropriate training load that maximizes athletes' performance, according to [73].

In the present study, 62% of the cyclists took supplements in order to improve their performance. A total of 44% of the cyclists consumed energy drinks, while caffeine, carbohydrates and proteins and vitamins were used by 24% 30%, 30% and 22%, respectively. A small percentage of Greek cyclists consumed carnitine, which lacks scientific evidence for boosting performance [10, 86].

A recent study of [87] in 778 Dutch athletes with elite status, reported that when athletes received dietary counseling had a higher consumption of vitamin D, isotonic drinks, recovery drinks, energy bars, isotonic sports drinks with protein, probiotics, beta-alanine and sodium bicarbonate. In contrast when they did not have any counseling, they preferred combined vitamin supplements, calcium, energy gels BCAA/ other amino acids and energy drinks.

Previous studies reported that dietary supplements are used by athletes as to allow them to improve performance through harder training, quicker recover (Ziegler et al., 2003), [52] and prevention from injuries and illness (Ziegler et al., 2003), [69]. The prevalence of dietary supplementation among elite athletes falls in the range of 62–91% for athletes under 20 years of age [9, 22, 23, 56], and 51–99% for elite adult athletes [9, 21, 23, 36, 83, 87].

The use of dietary supplements is alarming as athletes consume different supplements [21, 22, 69] that can interact with each other [10, 71] or provoke negative consequences such as allergic reactions or toxicity in large doses (Lawson et al., 2007), [71] or have as a result misinformation [49] and inadvertent product contamination [28]. There is lack in universal regulation and consequently there are differences across countries in the ergogenic aids' practice and approach. There is often a gap between scientific evidence and marketing hype [71].

Regarding the impact of supplementation on cycling performance, the present study concluded that energy drinks' consumption was associated with better performance in both endurance ($p = 0.001$) and speed races ($p = 0.001$), a finding which comes in agreement with other studies in cyclists showing that performance was improved with energy drinks comparing to placebo [1, 24, 37]. We should bare in mind that energy drinks should be consumed in rational proportions as to act in favor of exercise, otherwise they may become dangerous, causing hypertension, cardiac dysrhythmias, tachycardia or heart failure [17, 24, 71].

Accordingly, in the present study, carbohydrates showed a positive impact on athletic performance during the endurance test (p = 0.001), similar with other experimental studies in cyclists [20, 46]. However, regarding the speed test of 200m, the consumption of carbohydrates from our cyclists did not have any ergogenic benefit (p = 0.163), which is suggested by [13].

Finally, our results indicated that caffeine consumption improved performance in both endurance and speed races, when comparing to other cyclists who did not consume caffeine. The ergogenic impact of caffeine is supported by a plethora of studies [8, 26, 30, 34, 35]. However, caffeine intake can provoke side effects such as headache, hypertension, tachycardia and gastrointestinal upset [11, 51] and acts differently in every athlete [70].

Regarding the results from the meddiet Score, 86% of our cyclists had a median adherence to the Mediterranean diet, whereas 12% had a low adherence. This finding is in accordance with a study in 45 young Spanish cyclists, reporting that approximately 20% of them did not comply to the Mediterranean diet, confirming a gradual abandoning of the Mediterranean Diet [76].

In the present study, there was no significant effect of the Mediterranean diet on speed or endurance cycling performance. To the best of our knowledge there is no study estimating the effect of Mediterranean diet on sport performance.

5. Conclusion

The current study provides insight into supplement use of Greek cyclists. The consumption of carbohydrates, caffeine and energy drinks was beneficial for the cycling performance. Athletes lack knowledge about ergogenic aids, as they are often consulted by their coaches who had limited nutrition and ergogenic aids information. The presence of certified sports dietitians is vital in order to maximize athletes' records and protect them from receiving useless aids.

Further research is needed to evaluate supplement use of athletes, in combination with their nutrition status and Mediterranean diet adherence in larger groups of athletes. Variables, like duration of supplementation, quantity and type of supplements should be considered in future studies as they might have beneficial or adverse effects on cyclists' performance. Given the widespread use of supplements, dietitians and physicians have to collaborate in order to counsel cyclists about supplements' effectiveness, safety and legality.

6. Limitations

The results regarding the impact of ergogenic aids such as caffeine, carbohydrates and energy drinks on cycling performance should be presented with reservation, as the sample was small and we did not take into account the quantity, frequency and combined use of ergogenic supplements received by each athlete.

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