ADHERENCE TO THE MEDITERRANEAN DIET IN ATHLETES

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Abstract

Proper nutrition is crucial for an athlete to optimize his or her performance for training and competition. The Mediterranean diet is characterized by typical foods of the Mediterranean basin such as legumes, fruits, cereals and olive oil, with a moderate consumption of eggs, fish and dairy products. The aim of this research was to evaluate the adherence to MedD in athletes. The aim of this paper was to find in the literature and summarize data relating to adherence to the Mediterranean diet by athletes. This is the first investigations summarizing adherence to the Mediterranean diet in athletes. The findings have implications for the design of nutritional interventions for athletes. Searches were run in the online databases PubMed, Google Scholar. The search strategy incorporated the terms (Mediterranean diet) AND (performance, sport, athletic*), and the filters applied were: humans, trial of athletes, and journal article. Based upon the specific aims of this paper, studies identified from the original search strategy were systematically excluded according to the following criteria: studies not conducted with living human participants; studies that were review articles. The diet of a large portion of the athletic population surveyed is not compliant enough with Mediterranean diet guidelines. This is the first investigations summarizing adherence to the Mediterranean diet in athletes. Future interventions should focus on an increase in vegetables and a decrease in red meat as a source of protein, an increase in pulses and fish/seafood, an increase in the consumption of fruit, and decreased consumption of carbonated sugar-sweetened drinks. It is essential to provide nutritional guidelines to athletes and instructing about the Mediterranean diet.

Key words: adherence, Mediterranean diet, athletes, nutrition, oxidative stress, sports.

Introduction

The Mediterranean Diet (MedD) is a well-known, prudent dietary pattern with health benefits supported by an exponentially increasing wealth of scientific evidence. MedD is characterized by a high intake of vegetables, legumes, fresh fruit, non-refined cereals, nuts, and olive oil (especially extra-virgin olive oil, i.e., obtained with a mechanical pressing and contained acidity rate lower than 0.8% (Regulations CEE n. 2568/91 and following updating European 2019), by a moderate consumption of fish and dairy, by a low intake of red meats, and by a moderate use of ethanol, mainly red wine consumed during the main meals (Table 1). The Mediterranean diet is characterized by positive, healthy and nutritional benefits as emerged by the large literature dedicated from 1960 to this dietary pattern; particularly the added value is due to a combination of healthy foods and their many nutritional benefits (high intake of vitamins and polyphenols) with the diversity of foods (from vegetables and fruits to meat and fish, without alcohol ban), the respect of seasonality of each ingredient, the freshness of products so to maximize the content of protective nutrients and substances, and the use of all available foods, sweets included, in a context of frugality and moderation (Trichopoulou & Lagiou, 1997) (Trichopoulou & Critselis, 2004). The positive relationship (beneficial effects) between the Mediterranean diet and sport performance is due to the high contents of antioxidants and anti-inflammatory nutrients contained in many foods of MedD (legumes, fresh fruit or nuts, vegetables, fish, and olive oil, especially extra-virgin olive oil), which have a protective effect in the fighting the negative effects of stress oxidative. The appearance of an oxidative stress and of its consequences in the body, can take the place both in certain pathological conditions (Ingrosso et al, 1995; Ingrosso et al., 1996; Gallietta et al., 2007; D'Angelo et al, 2012; D'Angelo et al, 2013), and, in particular, also as a consequence of competitive sports (Steinbacher & Eckl, 2015; Powers et al., 2016; Kawamura & Muraoka, 2018). Physical exercise always causes to varying degrees, a certain degree of mechanical and metabolic stress on the human body. This leads to two results: inflammation and oxidative stress. In fact, during physical activity, the demand for oxygen increases, particularly in skeletal muscle, causing a drastic change in blood flow in the various organs. The energy demand necessary for the performance of physical activity of a certain level increases the oxygen consumption at the tissue level. Another consequence of oxidative stress is the possible decrease in the levels of antioxidants in the target tissues and in the blood. Possible because vigorous exercise is also known to induce mitochondrial generation and/or loss of superoxide and hydrogen peroxide with or without reduction of vitamin E content in both muscle and liver. Antioxidants, such as polyphenols, help protect the body's cells from free radical damage, thus also controlling the aging rate (D'Angelo et al., 2012; Malaguti et al., 2013; Myburgh, 2014; D'Angelo & Sammartino, 2015; Motti et al., 2018).
Polyphenols are phytochemicals present in fruits and vegetables and have various properties (D’Angelo et al., 2017; Martino et al., 2009; D’Angelo et al., 2019a; D’Angelo et al, 2019b) including an antioxidant capacity (D’Angelo et al., 2009; Zappia et al., 2010; D’Angelo & Sammartino, 2015).

So a diet that turns out to be rich in antioxidant nutrients, such as MedD, could promote sports performance from all points of view. For example, the intake of foods rich in antioxidant molecules such as polyphenols could accelerate muscle recovery and reduce the consequences of oxidative stress that is generated during sports (Myburgh, 2014; D’Angelo, 2019).

Some studies have analyzed eating habits in athletes from various individual sports disciplines (combat sports), mountain bike and road cyclists, ballet dancers, swimmers, athletes, riders, and canoeists and collective (rugby players and soccer players), highlighting that athletes show mostly incorrect eating habits. For example, in canoeists of calm waters of international level was found a consumption of fats higher than recommended, especially monounsaturated fats, although their diet should be characterized by being low in fat and high in carbohydrates, with adequate protein consumption (García-Rovés et al., 2000). This may be due to the fact that coaches working with adolescent athletes of different sports have very superficial knowledge about nutrition, and there is a tendency to promote protein intake and low-fat diets, in order to find that the subject controls their weight and gain muscle mass, planning only in more detail the pre-competition intakes. In fact, 52% of elite athletes say they vary their diet before the competition. However, it would be necessary to program the diet of athletes thinking not only at the time of the competition but also in stages before and after it to achieve an optimal state of health and performance (Alacid et al., 2014; D’Angelo, 2019).

It could be expected that most of the population presented a high adherence to MedD, considering due to its multiple benefits. However, the MedD has decreased worldwide in recent decades, especially in the inhabitants of the Mediterranean basin: for example, in Spain, only between 12-33% of the population has high MedD (León-Muñoz et al., 2012).

It is assumed that MedD is able to cover nutritional needs in the majority of athletes and the aim of this paper is to find in the literature and summarize data relating to adherence to the Mediterranean diet by athletes.

Materials and methods

Computerized searches were run in the online databases PubMed, Google Scholar, during October 2019, and articles published up until this time was considered.

The search strategy incorporated the terms (Mediterranean diet) AND (performance, sport, athletic*), and the filters applied were: English language, humans, clinical trial, and journal article. References listed within bibliographies of the retrieved records, in addition to articles already known to the authors, were also considered for inclusion. Based upon the specific aims of this paper, studies identified from the original search strategy were systematically excluded according to the following criteria: (A) studies not conducted with living human participants; (B) studies that were review articles.

Results

Table 2 reports data related the publications identified by our search strategy. Unfortunately, the number of studies that were eligible for inclusion in this meta-analysis was small, which did not allow the statistical of the analyses. Therefore the data have been briefly described.

In 2009, Sanchez-Benito (2009) tried to evaluate the degree of adherence to MedD in a team of young Spanish cyclists. The Mediterranean Adequacy Index (IAM) was calculated by dividing the sum of the percentage of total energy of the typical Mediterranean food groups (cereals, legumes, fruit, fish), by the sum of the percentage of total energy from food not typical of MedD (meats, eggs, biscuits, industrial dishes). The average IAM value measured in the collective of male cyclists was 2.31 (modest value); and the IAM of the young homologous control males is 1.51 (low value). The IAM in Italy, a few previous decades, was 7.2 (very good), when adherence to MedD was high. These results showed that around 20% of cyclists did not follow MedD, although some blood chemistry parameters were good. The diet followed by the cyclists was still good, but it needed to be improved, showing however that young Spaniards do not follow the traditional MedD very much.

In a 2014 paper, the most of the canoeists analyzed show medium or excellent adherence to the Mediterranean diet; although there are aspects in which it could be improved, for example the intake of more pieces of fruit, vegetables and nuts. A clear relationship between adherence to the Mediterranean diet and anthropometric parameters of athletes has not been found (Alacid, 2014). Rubia-Aria et al. (2015) found about 50% of the athletes follow the MedD. No difference on athletic performance in Spanish futsal sportmen (5-a-side football) who followed the Mediterranean diet or not, a performance assessed on the ability to repeat sprints were observed. In a paper published in 2017, the adherence to MedD of a population of athletes who practice cycling was analyzed again. The results obtained reinforce the idea that most of the population does not have a good adherence to MedD, (mainly associated with a low consumption of olive oil, vegetables, fruit, vegetables, fish), and the 40% of the athletes followed this type of nutritional protocol (Mayolas-Pi, et al., 2017).
Table 1. Typical food of the Mediterranean diet and frequency of consumption.

<table>
<thead>
<tr>
<th>Mediterranean Diet food</th>
<th>Serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read and processed meat (beef, pork,)</td>
<td>Very low consumption</td>
</tr>
<tr>
<td>Sweets (cakes, sugar, honey, sugar drinks)</td>
<td>Very low consumption</td>
</tr>
<tr>
<td>Eggs</td>
<td>Low to moderate consumption</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Moderate consumption</td>
</tr>
<tr>
<td>Pulses (beans, peas, lentils, chickpeas)</td>
<td>Regular intake</td>
</tr>
<tr>
<td>Sea food (Red mullet, sardines, anchovies, swordfish, sea bream, sea bass, squid, octopus)</td>
<td>Moderate consumption</td>
</tr>
<tr>
<td>Dairy products (fresh milk, yoghurt low fat)</td>
<td>Low consumption</td>
</tr>
<tr>
<td>Olive oil (virgin and extra virgin olive oil)</td>
<td>Principal source of fat (rich in poly- and mono-unsaturated fatty acids; low in saturated fat)</td>
</tr>
<tr>
<td>Fruits (apples, pears, oranges, strawberries, blackberries, blueberries, pomegranate, blackberries, tangerines)</td>
<td>Daily basis (seasonal varieties)</td>
</tr>
<tr>
<td>Nuts (walnuts, hazelnuts, pistachios) and seeds (flax seeds, pumpkin seeds, sunflower seeds)</td>
<td>Regular basis (generally as snacks)</td>
</tr>
<tr>
<td>Vegetables (cucumber, tomatoes, onions, lettuce, beets, spinach, cabbage, broccoli, pumpkin, eggplants, peppers, carrots, mushrooms)</td>
<td>Daily basis (seasonal varieties)</td>
</tr>
<tr>
<td>Non-refines cereals and products (whole-grain breakfast cereals, whole-grain toasted bread, brown rice, whole grain pasta)</td>
<td>Regular intake</td>
</tr>
<tr>
<td>Red wine</td>
<td>Low to moderate (particularly during meals)</td>
</tr>
<tr>
<td>For flavor: reduce salt and use more fresh herbs, garlic, citrus, and spices.</td>
<td>Just enough</td>
</tr>
</tbody>
</table>

Table 2. Current information on the adherence of athletes to the Mediterranean diet

<table>
<thead>
<tr>
<th>Reference</th>
<th>Sport practiced</th>
<th>Methods</th>
<th>Data used for study</th>
<th>Adherence to the MedD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sánchez-Benito et al., 2009</td>
<td>Cycling</td>
<td>Mediterranean Adequacy Index (MAI)</td>
<td>45 male athletes</td>
<td>Young people are abandoning the adherence to the MedD</td>
</tr>
<tr>
<td>Alacid et al., 2014</td>
<td>Canoeing</td>
<td>KIDMED questionnaire</td>
<td>90 female athletes</td>
<td>Medium or excellent Mediterranean diet adherence. Not clear relationship between anthropometric parameters and the degree of Mediterranean diet adherence</td>
</tr>
<tr>
<td>Rubio-Arias et al., 2015</td>
<td>Futsal</td>
<td>KIDMED questionnaire</td>
<td>12 Elite female athletes</td>
<td>Low MedD adhesion was observed. No significant differences in performance between the players that scored below the optimal index with those with a low level of adhesion were observed</td>
</tr>
<tr>
<td>Mayolas-Pi et al., 2017</td>
<td>Cycling</td>
<td>MEDAS-14 questionnaire</td>
<td>1,023 amateur cyclists and 781 indoor cycling practitioners</td>
<td>Most of the population shows high MedD adherence. Transient positive effects of participation in a cycling endurance event.</td>
</tr>
<tr>
<td>Muros &amp; Zabala, 2018</td>
<td>Cycling or triathlon</td>
<td>Mediterranean Diet Adherence Screener (MEDAS)</td>
<td>2037 cyclists and 2000 triathletes</td>
<td>Large proportion of the surveyed athletic population were not meeting the MedD guidelines</td>
</tr>
</tbody>
</table>

The adherence to various MedD foods was assessed in a cross-sectional study, conducted on a sample of athletes regularly engaged in cycling or triathlon. There were 75,871 cyclists (male: 95%) of which 2037 (male: 95.5%) satisfactorily completed the questionnaire and 27,760 triathletes (male: 82.3%) of which 2000 (male: 84.5%) satisfactorily completed the questionnaire. The study showed that the diet of a large portion of the athletic population surveyed did not comply with MedD guidelines, particularly male cyclists. Triathletes seemed more likely to meet the recommendation for proper consumption of fruit, nuts and carbonated and sugary drinks than cyclists. This could be related to the reasons that push athletes to compete in different endurance sports (Muros & Zabala, 2018).

Given the limited scientific literature that deals with the adherence at the MedD from sportsmen, as well as the effects on the physical performance of this diet, it was decided to verify information relating to the action of the typical MedD foods on physical activity. But even in this case, there are few scientific publications that address this topic, due to a scarce availability of volunteer sportsmen and therefore who accept to ingest specific foods for a sufficiently long period of time from an experimental point of view. Young athletes were given a functional drink based on almonds and olive oil enriched with α-tocopherol and docosahexaenoic acid. Athletes performed maximal exercise tests before and after a month of such integration. The drinks did not alter the performance parameters during the maximum exercise.
But supplementation would appear to protect against oxidative damage and improve the gene expression of antioxidant enzymes in peripheral blood mononuclear cells after exercise and improve a circulating pro-inflammatory environment (Capó, 2016).

Studies on resveratrol, naturally occurring polyphenol (contained in the skin of red grapes), have provided some information on the potential of sirtuins, both in terms of improving well-being and maintaining the regenerative function of muscle cells. Treatment with such polyphenol improves the state of inflammation in the differentiation of skeletal muscle cells. In a study involving 14 athletes, supplementation with resveratrol has been shown to inhibit lipid peroxidation caused by exercise. The authors suggested that resveratrol optimizes fatty acid metabolism and that it may contribute to the increased response of the contractile force of skeletal muscles. But these are studies on a nutrient not on food (Dolinsky, 2014).

Experimental data are not always clear. Pistachio ingestion (3 oz /d, two weeks) has been tested for effects on exercise performance and for 21-hour post-exercise recovery from inflammation, oxidative stress, immune dysfunction and metabolic changes. But researchers showed that pistachio intake was related to impair cycling performance of 75 km in cyclists having a negative impact on mitochondrial function (Nieman, 2014).

**Discussion and conclusion**

 Athletes have many strategies they can use when fueling for performance. Nutrition can play a crucial role in optimizing training sessions as well as with recovery and metabolic adaptation. This paper aimed to systematically evaluate the current body of research on adherence to the Mediterranean diet of athletes. Whilst five eligible articles were identified, substantial methodological variation exists between studies, thus making it difficult to draw firm conclusions with regards the adherence and to the potential efficacy of MedD for analyzed populations. As is the case with many nutrition studies, it seems likely that a number of factors, including but not limited to, the dose and timing of food ingestion, individual responsiveness, and the type, duration, and/or intensity of exercise, modulate the responses observed.

A major limitation is of a limited number of articles dealing with this topic and they are studies carried out by Spanish researchers on samples of athletes living in Spain. Probably, the question of the Mediterranean diet is deeply felt in this nation. Researchers are convinced that their results have important implications for the design of nutritional interventions on athletes across Spain.

It is essential to provide nutritional guidelines to athletes to promote MedD in general. The researchers concluded studies by saying that future interventions should focus on increasing vegetables and decreasing red meat and hamburgers or sausages as a source of protein, especially in men. Another important goal of nutritional interventions with athletes should be an increase in legumes and fish/seafood regardless of gender, region or discipline, an increase in fruit consumption and a lower consumption of carbonated sugary drinks (Patino-Alonso et al., 2014; Muros & Zabala, 2018).

Two main recommendations emerge from the present findings. Firstly, although nutritional policies in Mediterranean countries have focused on the preservation of MedD, nutritional intervention evidently requires comprehensive and specific messages about the different components of this diet.

**Conclusion**

Success for young people who play a sport depends not only on adequate training, but also on proper nutrition, healthy life habits and psychological attitudes that are developed by complex emotional learning. The high content of foods with antioxidants and foods that exhibit anti-inflammatory activity make the Mediterranean food model an effective nutritional protocol for the improvement of many functions and parameters, therefore useful for maintaining health and preventing many chronic diseases. As for the use of the Mediterranean nutritional protocol to be recommended to athletes, variations will certainly be necessary as regards the quantities of food ingested. The differences are given by the fact that the sportsman, especially the professional one, must endure an intense daily training, sometimes even twice, for this reason he needs a different diet (from a quantitative point of view) compared to those who practices amateur sport. But the quality of the food of the Mediterranean diet should also be followed by athletes, considering in particular how the Mediterranean diet can guarantee the right intake of vitamins and antioxidants, i.e. the food-derived bioactive (such as polyphenols).

**References**


D’Angelo, S., et al.: Adherence to the Mediterranean diet in athletes


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