

Adherence to Mediterranean Diet among athletes participating at the XXX summer universiade

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Abstract

Background: A well-balanced diet is essential in sport. Due to its typical content in high-quality proteins, low glycemic index foods, and unsaturated fats, Mediterranean Diet (MD) may represent a good choice to cover nutritional needs of athletes. The aim of this study was to explore how the dietary habits of elite athletes, such as those competing at the XXX Summer Universiade, comply with the MD model. A comparison between athletes coming from the Mediterranean and non-Mediterranean countries was also assessed. **Methods:** The Mediterranean Diet Serving Score (MDSS) questionnaire was administered to a sample of 433 university student athletes from all over of the world to evaluate the level of adherence to the MD pattern and possible differences between geographical areas. **Results:** The total sample showed a medium adherence to the MD, with a mean MDSS of 15.73 ± 3.71 out of a total of 23 points. A satisfactory consumption of fruits and vegetables was reported. Athletes from Northern European countries had a lower MD pattern adherence than the other ones. **Conclusions:** These findings suggest that the MD model is common among elite athletes, and it may be promoted as a healthy dietary pattern in the sport setting.

Keywords

community-based research, mediterranean diet, nutrition, sport, wellness

Introduction

The Mediterranean Diet (MD) model is based on the traditional eating habits of the countries surrounding the Mediterranean basin. In general, it includes high intakes of extra virgin olive oil, leafy green vegetables, fruits, cereals, pulses/legumes and nuts, moderate intakes of fish and other meat, dairy products and red wine, and low intakes of eggs and sweets (Davis et al., 2015).

Over the last few decades, the MD model has been recognized as one of the healthiest dietary patterns due to its beneficial role in preventing chronic diseases and increase longevity. These effects are not only linked to the individual elements or foods included in MD but mainly to their combination and interaction (Dinu et al., 2018).

However, it has been observed that the modern MD pattern differs from the traditional model based on the Cretan, Greek and South Italian diets characterized in the past century, as Mediterranean countries are shifting towards a Westernized eating model, with a high consumption of refined sugars and animal fats and a reduced use of

fruits and vegetables (Dinu et al., 2018; Kyriacou et al., 2015; León-Muñoz et al., 2012; Vilarnau et al., 2019).

A well-balanced diet is essential for active individuals, especially for those who practice sport.

Evidence shows that a dietary model designed to meet energy and nutrients needs of athletes is fundamental to optimize training adaptations, improve performance and prevent illness and injuries (Kerksick et al., 2018). In

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fact, an adequate energy intakes with a well-balanced macronutrient and micronutrient intakes are fundamental to guarantee the availability of fuel and components needed during training and in the post-exercise recovery (Thomas et al., 2016). Furthermore, Kavouras *et al.* has demonstrated that increased physical activity and greater adherence to the MD were associated with increased serum total antioxidant capacity of the human body (Kavouras et al., 2011).

Due to its typical content in high-quality proteins, low glycemic index foods, and unsaturated fats, MD may represent a good choice to cover nutritional needs of athletes. In addition, foods included in the MD pattern supply high quantity of micronutrients especially antioxidants, which can help athletes to fulfil the increased requirements of minerals and vitamins and to face the exercise-induced oxidative stress (Castro-Quezada et al., 2014; Dai et al., 2008). However, only few studies have explored so far the adherence to MD in athletes and the majority of them were performed in Spain and involved cyclists (Alacid et al., 2014; D'Angelo and Cusano, 2020; Gabaldón et al., 2018; Mayolas-Pi et al., 2018; Munguia-Izquierdo et al., 2017; Muros and Zabala, 2018; Philippou et al., 2017; Rubio-Arias et al., 2015; Sánchez-Benito et al., 2009).

In order to explore how the dietary habits of elite athletes from the Mediterranean countries comply to the MD model as compared to other geographic regions, we examined the level of adherence to the MD pattern in a sample of athletes participating to the XXX Summer Universiade in Naples.

Materials and methods

Study design

This cross-sectional study was performed on a sample of athletes from all over of the world competing at the XXX Summer Universiade that took place in Naples from 3 to 14 July 2019. A questionnaire was administered to the athletes during time off, away from training and competitions, after obtaining permission from their respective Sport Federations.

All participants received a disclosure and completed a written consent form. The study was performed in line with the ethical principles of the Declaration of Helsinki for medical research. Ethical approval was granted by the University of Naples "Luigi Vanvitelli" (approval code number 403/2019).

Subjects

With 127 participating countries and 18 sport disciplines, a total of 7285 athletes have been registered to participate in the XXX Summer Universiade. To be admitted to the games, athletes had to be at least 18 and not older than 25 years of age and they need to be national of the country they represented. 433 athletes (21.74 ± 2.11 years old; 50.6% male) practicing 8 different sports disciplines from across the World voluntarily participated to this study.

Procedures

Participants were asked to self-report their age, gender, weight, height, living country, ethnic origin, degree course, sport discipline, training length expressed in training volume (hours/week). Their living countries were stratified according to 5 areas as proposed by Da Silva *et al.* (Da Silva et al., 2009) (Mediterranean Europe, Other Mediterranean countries, Northern Europe, Central Europe and Other World countries). Participants included in the study were coming from: Mediterranean Europe (Albania, Cyprus, France, Greece, Italy, Malta, Portugal, Spain, Turkey, Yugoslavia), Other Mediterranean countries (North Africa, Middle East, Algeria, Egypt, Israel, Lebanon, United Arab Emirates, Morocco, Syria, Tunisia), Northern Europe (Denmark, Estonia, Finland, Ireland, Norway, Sweden, United Kingdom), Central Europe (Austria, Bulgaria, Czechoslovakia, Germany, Hungary, Netherland, Poland, Romania, Switzerland, Ukraine) and Other World countries (Argentina, Australia, Brazil, Canada, Chile, China, Ghana, Islamic Republic of Iran, Japan, Korea, Malaysia, Mauritania, Mexico, New Zealand, Philippines, Russia, Singapore, South Africa, United States of America, Uzbekistan).

The Mediterranean Diet Serving Score (MDSS) was used to determine the level of adherence to the MD (Monteagudo et al., 2015), <https://doi.org/10.1371/journal.pone.0128594.t001>. This questionnaire includes 13 items based on the recommended consumption frequency of different foods and food groups from the latest Mediterranean Diet Pyramid (Bach-Faig et al., 2011). For each question the number of recommended servings expressed in times/meal, times/day, or times/week, respectively was shown.

Participants had only to tick "yes" or "no" answer, each question was scored 3, 2 or 1 if the answer was "yes", depending on the frequency consumption and was scored 0 if the answer was no, producing a derived score ranging from 0 to 23. For instance, three points were given for 1–2 servings of fruits consumed during the main meals, three points were given for 1 serving of olive oil consumed during the main meals, two points were given for 1–2 servings of nuts consumed during the day, one point was given for ≥ 2 servings of legumes consumed during the week. MDSS was designed to give greater importance to foods that should be consumed in every meal, followed by those that should be consumed daily and finally, those that should be consumed weekly. The higher the score, the greater the adherence to the MD. At the end of the questionnaire, athletes were asked if they received nutritional advice by a dedicated nutritionist (yes/no).

The optimal food frequency was estimated according to the recommendations of the new Mediterranean diet pyramid (Bach-Faig et al., 2011).

Statistical analysis

Data were expressed as mean and standard deviation or median values and interquartile ranges or as percentage

values. Categorical variables were presented according to their frequency distribution and associations between them were determined using the Chi-square test. Data were analysed using the IBM-SPSS version 26.0 software for Windows (Armonk, NY, USA: IBM Corp.). The level of significance was set at 0.05.

Results

Athletes, who satisfactorily completed the questionnaire, were differently distributed by sport disciplines, 258 for individual sports (35 for fencing, 64 for archery, 30 for tennis, 52 for athletics, 77 for taekwondo) and 175 (40.4%) for team sports (127 for soccer, 21 for basket, 27 for volleyball). Table 1 lists the general characteristics of the study population. The sample was equally distributed by gender. Eighteen % of athletes were regularly supported by a nutritionist. The group of Central Europe and other World countries had a lower mean height compared to the Mediterranean Europe ($p = 0.000$), without affecting BMI ($p = 0.078$). The group of North Europe had significantly less hours of weekly training compared to Mediterranean Europe ($p = 0.006$).

The mean MDSS was 15.73 ± 3.71 out of a total of 23 points. Considering the five geographical areas the MDSS was significantly lower in North Europe countries than the other areas ($p < 0.000$), and the other Mediterranean countries, although at a lesser extent ($p = 0.064$) (Figure 1).

Table 2 shows the adherence to MDSS recommendations for each food group stratified according to the different area. Regarding the total sample, the mean consumption of fruits, vegetables, cereals, potatoes, olive oil, red meat and sweets was within recommendations. The highest adherence to the recommendations was identified for fruits (85%), eggs (84%), vegetables (83%) and white meat (82%), whereas the lowest was registered for nuts (40%) and legumes (53%). Significant differences between geographical areas were found for potatoes, olive oil, nuts, legumes, eggs and white meat. More specifically, the prevalence of athletes who adhered to the recommendations was higher in the Mediterranean Europe area compared to the other world countries for potatoes and to the north Europe for olive oil and legumes; compared to all except central Europe for white meat. The area of north Europe had the major number of individuals not adherent to the recommendations for nuts compared to the other world countries.

Discussion

This study examined the adherence to MD in a sample of athletes from the Summer Universiade 2019. A medium adherence to the MD was identified, with an MDSS score of 15.7. Of note, this value was very close to the threshold suggested by Monteguado *et al.* for a satisfactory adherence ($MDSS \geq 16$) (Monteguado *et al.*, 2015). Furthermore, it was higher than the score obtained by previous studies

performed in the general adult population, which reported a mean MDSS score ranging from 10.4 to 14.4 (Barnaba *et al.*, 2020; Benhammou *et al.*, 2016; Kolčić *et al.*, 2016; Relja *et al.*, 2017). To our knowledge, MDSS questionnaire has never been used in athletes. Instead, several studies have analysed the MD adherence in athletes using different tools and obtained heterogeneous findings. Generally, studies that compared adherence to the MD pattern between athletes' and control groups or the general population found a higher adherence to the MD pattern in athletes (Alacid *et al.*, 2014; Gabaldón *et al.*, 2018; Munguia-Izquierdo *et al.*, 2017; Muros and Zabala, 2018).

Countries from all over the world have drifted away from a Mediterranean-like dietary pattern (Da Silva *et al.*, 2009). Analysing the worldwide trends of adherence to the MD since 1961 to 2011, many countries moved away from the MD model (Vilarnau *et al.*, 2019). This phenomenon was most pronounced in the Mediterranean Europe, Southern Mediterranean and Central Europe subcategories. Even so, the MD adherence in Mediterranean Europe was consistently higher than that exhibited by the Northern Europe and Central Europe subgroups throughout the three time periods studied. The Northern European countries maintained the lowest MD adherence over the last 50 years (Vilarnau *et al.*, 2019). Comparing the five geographical areas in our study, the North Europe countries had a lower resemblance to the MD pattern proposed by the MDSS than the others, with a significantly lowest number of subjects adherent to the recommendations for nuts and a noteworthy lower consumption of legumes and olive oil compared to the others geographical areas. Moore *et al.* analysed the barriers to adopting a MD in Northern European adults by identifying specific limits as cultural differences, perceived difficulty living in a colder climate, perceived impact on body weight and the acceptability of a MD (Moore *et al.*, 2018). Therefore, also recent studies analysing the adherence to MD pattern in the adolescent population revealed that MD adherence varied widely within countries. In particular, adolescents living in North America, Europe or Oceania are far from being compliant with the principles of the MD pattern (De Santi *et al.*, 2020; Iaccarino Idelson *et al.*, 2017; Naja *et al.*, 2020; Rosi *et al.*, 2019). In our sample of young athletes, the group from the other world countries (Argentina, Australia, Brazil, Canada, Chile, China, Ghana, Islamic Republic of Iran, Japan, Korea, Malaysia, Mauritania, Mexico, New Zealand, Philippines, Russia, Singapore, South Africa, United States of America, Uzbekistan) and Northern Europe (Denmark, Estonia, Finland, Ireland, Norway, Sweden, United Kingdom), had a significant lower consumption of some Mediterranean foods such as legumes and olive oil compared to the Mediterranean Europe. Probably the availability of most of the Mediterranean foods in the Mediterranean regions can contribute to the adherence of the MD pattern.

The scientific literature shows that MD adherence is directly associated with physical activity, physical fitness and

Table 1. Characteristics of participants in the whole sample and in groups of participants from different geographical areas.

	Total sample	Mediterranean Europe	Other Mediterranean countries	Central Europe	North Europe	Other World countries	p value
Subjects <i>n</i> (%)	433 (100)	81 (18.7)	23 (5.3)	75 (17.3)	47 (10.9)	207 (47.8)	-
Female <i>n</i> (%)	214 (49.4)	30 (14)	9 (4.2)	45 (21)	32 (15)	98 (45.8)	0.003 ^b
Age years	21.7 ± 2.1	21.6 ± 1.8	21.6 ± 2.1	21.6 ± 2.2	21.7 ± 2.2	21.9 ± 2.1	0.737
Weight kg	68.6 ± 11.9	71.1 ± 10.8	68.2 ± 10.8	69.1 ± 10.3	68.9 ± 13.1	67.5 ± 12.6	0.737
Height <i>m</i>	1.75 ± 0.09	1.78 ± 0.09	1.78 ± 0.08	1.77 ± 0.08	1.73 ± 0.11*	1.73 ± 0.09 [#]	0.000 ^a
BMI kg/m ²	22.3 ± 2.6	22.4 ± 1.9	21.6 ± 3.0	21.8 ± 2.1	22.9 ± 2.6	22.5 ± 2.8	0.078
Training Volume hours/week [#]	15.9 ± 9.8	18.7 ± 11.5	15.1 ± 6.7	17.2 ± 7.4	12.5 ± 7.5*	15.4 ± 10.3	0.006 ^a
Team Sports Players %	40.4	21.1	0	12.6	11.4	54.9	0.000 ^b
Having a sport nutritionist %	17.6	30.3	6.6	15.8	2.6	44.7	0.007 ^b

Statistical analysis ^at-Test, ^bChi² test *North Europe vs Mediterranean Europe; Others World Countries vs Mediterranean Europe and Central Europe. [#]The training volume was calculated multiplying each training session duration by the week frequency (hours).

better nutrition knowledge (Calella et al., 2020; Iaccarino Idelson et al., 2017; Manzano-Carrasco et al., 2020). Despite the heterogeneity of the countries of provenance,

we found that elite athletes participating in such special competition shared some of the characteristics of the MD model, with a high adherence to the recommendations for

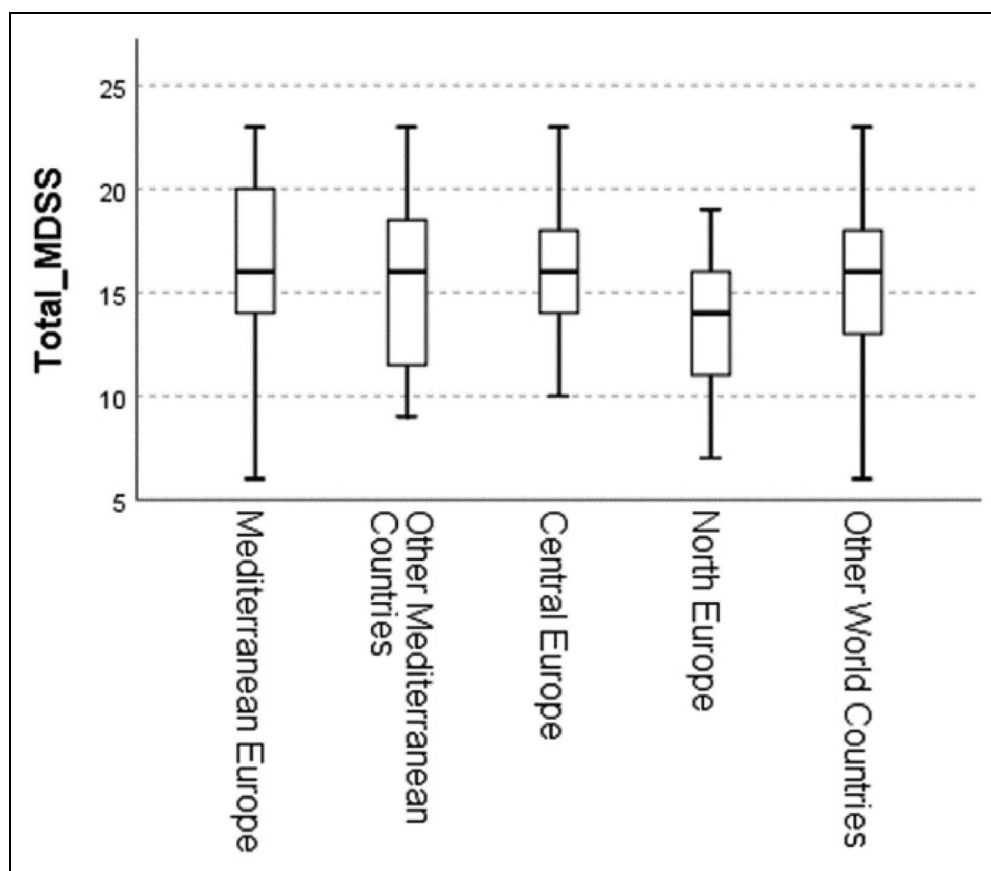
**Figure 1.** Median values and interquartile ranges of the Mediterranean diet serving score for the five geographical areas.

Table 2. Adherence to Mediterranean diet evaluated with the Mediterranean diet serving score questionnaire in the whole sample and in groups of participants from different geographical areas.

Food groups	Recommended serving ^a	Mediterranean diet					Total	World geographical areas			
		Mediterranean Europe	Other Mediterranean countries	North Europe	Central Europe	Other World countries					
Fruit (servings/main meal)	1-2	82.7	82.6	72.3	88.0	85.0	82.6	88.0	87.9	87.9	
Vegetables (servings/main meal)	≥ 2	79.0	87.0	72.3	89.3	83.1	87.0	89.3	84.5	84.5	
Cereals (servings/main meal)	1-2	65.4	52.2	66.0	64.0	66.3	52.2	64.0	69.1	69.1	
Potatoes (servings/week)	≤ 3	85.2*	73.9	66.0	68.0	70.0	73.9	68.0	65.2	65.2	
Olive Oil (servings/main meal)	1	80.2**	56.5	34.0	60.0	57.0	56.5	60.0	52.2	52.2	
Nuts (servings/day)	1-2	40.7	39.1	21.3*	37.3	39.7	39.1	37.3	44.4	44.4	
Dairy products (servings/day)	2	56.8	69.6	78.7	74.7	70.9	69.6	74.7	73.4	73.4	
Legumes (servings/ week)	≥ 2	69.1**	60.9	34.0	50.7	52.9	60.9	50.7	50.7	50.7	
Eggs (servings/ week)	2-4	80.2	82.6	76.6	77.3	83.7	82.6	77.3	89.4	89.4	
Fish (servings/ week)	≥ 2	67.9	65.2	48.9	53.3	60.5	65.2	53.3	62.3	62.3	
White meat (servings /week)	2	96.3 [#]	73.9	78.7	86.7	82.2	73.9	86.7	76.8	76.8	
Red meat (servings/ week)	< 2	72.8	60.9	63.8	70.7	70.4	60.9	70.7	72.0	72.0	
Sweets (servings/ week)	≤ 2	58	73.9	51.1	72.0	62.4	73.9	72.0	61.8	61.8	

^aaccording to the food frequency as recommended in the new Mediterranean diet pyramid (Bach-Faig et al., 2011).

Statistical analysis: Chi² test.

*p < 0.05 compared to "other World countries".

**p < 0.05 compared to "North Europe" and "other World countries".

[#]p < 0.05 compared to all except "Central Europe".

fruits, eggs, vegetables, and white meat, although the sub-optimal consumption of nuts and legumes. According to the review by Al-Jawaldeh (Al-Jawaldeh et al., 2020), the Eastern Mediterranean Region presented an inadequate consumption of milk and dairy products while a more dated study highlighted as the Mediterranean dietary habits still exist in the Mediterranean regions considering the appropriate consumption of olive oil, dairy products and nuts (Tur et al., 2004).

This study has some limitations. First, researchers were allowed to approach athletes away from competitions. For this reason, it was possible to recruit only a small part of the whole sample. Consequently, the size of the sample and its heterogeneity in terms of practiced sport, gender and country of origin did not allow a comparison between these different categories. Furthermore, considering the difficulty to recruit non athlete youths from the same geographical areas and the same cultural and social conditions, the study lacks a control group. The comparison with non-athlete subjects with the same age range and origin could have better contribute to define the influence of sport on dietary habits. However, it may represent an important contribute to the characterization of MD adherence in the sport setting, since it involved athletes from several countries, including also non-Mediterranean countries.

Conclusions

In conclusion, this sample of athletes participating at the Summer Universiade 2019 presented a medium adherence to MD model and showed a satisfactory consumption of fruits and vegetables. Athletes from Northern European countries showed a lower MD adherence than those from the other countries. Interventions of nutritional education in the elite sport setting might further improve athlete's awareness about the relationship between diet and health and favour healthy food choices.

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Authors' contributions

Conceptualization, S.D.A., G.L., F.G. and G.V.; methodology, P.C., G.L., F.G. and G.V.; formal analysis, P.C. and G.V.; investigation, P.C., S.D.A., G.C., N.P., R.R.; data curation, P.C.; writing—original draft preparation, P.C., F.G., G.V.; review and editing, P.C., S.D.A., G.C., N.P., R.R., G.L., F.G., G.V.; supervision, G.L., F.G., S.D.A., G.V. All authors have read and agreed to the published version of the manuscript.

Availability of data and materials

Data is available upon request

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

This study was approved by the University of Naples “Luigi Vanvitelli” (403/2019).

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Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the University of Naples “Luigi Vanvitelli” (approval code number 403/2019).

Informed consent statement

Informed consent was obtained from all subjects involved in the study.

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