

Role of Mediterranean diet in bone health

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Summary

Mediterranean Diet (MeDi) is a nutritional life style which has been developed in Mediterranean Countries. It is well known to be a balanced diet playing a key role in maintaining the good health of the individual, preventing chronic metabolic diseases, and optimizing genetic inheritance. It involves the presence of all macro- and micronutrients distributed in a balanced manner during the daily meals, with a prevalence of food of vegetal origin, such as cereals, legumes and olive oil, used as main dressing. Numerous recent studies have demonstrated the protective role of the MeDi on the skeleton, confirming that a definite and correct dietary approach such as MeDi can play an important key environmental factor for the maintenance on bone health and the prevention of osteoporosis.

KEY WORDS: Mediterranean diet; bone health; fragility fracture; skeletal homeostasis.

Mediterranean diet and bone: clinical and animal studies

A balanced diet plays a key role in maintaining good health of individuals, in preventing chronic metabolic diseases and in optimizing the genetic inheritance of each subjects. A balanced diet requires the presence of all macro- and micronutrients distributed in a balanced manner in the various daily meals. No food alone provides all the essential nutrients to

maintain the well-being of the organism, including that of the bone tissue and it is therefore essential that proper nutrition is as varied as possible to optimize skeletal homeostasis. The ideal diet is the Mediterranean diet. The first studies on the Mediterranean diet and on the importance of a correct diet to correct cardiovascular risk factors such as cholesterol are those implemented by Ancel Keys in the 1950s in Italy in a specific region of Salento (1). These studies showed how a diet rich in vegetable origin products (legumes, unrefined cereals, fruit and vegetables), poor in foods of animal origin (preferably fish and white meat), and extra virgin olive oil, as fats, was significantly related to a reduced risk, of chronic metabolic pathologies and, also, to a greater longevity (2). After these initial studies, several recent studies have focused on the evaluation and characterization of the mechanisms underlying the positive effect of MeDi on the health status of the subject (3). More recently, a review has analyzed the studies regarding the role of MeDi on musculoskeletal health, suggesting that MeDi can improve muscle and bone health even though some contradictory data exist (4). First of all, it has been demonstrated that MeDi is also based on an optimal distribution of nutrients (5), as also published in the latest revision of the recommended levels of intake of nutrients (LARN) for the Italian population (LARN 2014): 45-60% of the daily calories must come from carbohydrates, preferably complex limiting simple sugars (WHO 2016), less than 30% of calories must come from fats, mostly unsaturated, and about 12-18% from proteins mainly of plant origin (LARN, 2014). There are many clinical studies that have shown a positive effect of MeDi on the reduction of the risk of developing chronic metabolic diseases such as diabetes mellitus, cardiovascular diseases, arterial hypertension, but also neurodegenerative diseases (6-10), likely through an inhibition of pathways linked to chronic subclinical inflammation. However, the interest of a possible role of MeDi in modulation of skeletal health is novel. In recent years, in fact, several studies have shown how components of MeDi can modulate skeletal homeostasis. A recent study, performed in an animal model, assessed the possible role of MeDi components, such as olive oil as a source of polyphenols, played an important role in skeletal wellbeing. To evaluate this potential role of olive oil, an identified amount of extra virgin olive oil (refined or virgin olive oil fortified with vitamin D₃) was administered to control or ovariectomized mice. After 30 days of exposure, both bone mineral density and gene expression of specific markers of osteoblastic activity were then evaluated. The data reported in this study showed that virgin olive oil, fortified with vitamin D₃, counteracted an alteration of remodeling and bone mineral density in ovariectomized mice as well as levels of inflammation and oxidative stress suggesting an impact protective of extra virgin olive oil as a source of polyphenols, together with vitamin D₃, on bone metabolism through the improvement of oxidative stress and inflammation (11). But if the results obtained in

animal models are important, studies that associate adherence to MeDi with a maintenance of skeletal wellbeing, bone mineral density and a reduced risk of fragility fracture (12, 13) are even more interesting. In fact, a recent study by García-Gavilán et al. demonstrated that greater consumption of EVOO (Extra Virgin Olive Oil) is associated with a lower risk of osteoporosis-related fractures in an older Mediterranean population at high cardiovascular risk, suggesting that the consumption of EVOO, one of the key foods of the MeDi, might play a key role in the prevention of osteoporosis-related fractures (14).

Studies published in 2009 by Kontogianni et al. already showed how adherence to the MeDi induced an increase in bone mineral density, suggesting how the nutritional characteristics of MeDi can positively influence skeletal homeostasis (15). Data also confirmed by more recent results, published by an Italian group, which demonstrate a positive correlation between bone health and adherence to MeDi, suggesting that high adherence to MeDi promotes bone health (16). More recently, a scoping review of the literature, assessing the impact of dietary patterns, revealed a beneficial impact of higher adherence to a “healthy” dietary pattern, using a data-driven method (the MeDi, HEI, AHEI, Dietary Diversity Score, Diet Quality Index–International, BMD Diet Score, Healthy Diet Indicator, and Korean Diet Score) on bone. In contrast, the “Western” dietary pattern and those featuring some aspects of an unhealthy diet were inversely associated with bone health (17).

In addition, in a recently published study, Benetou et al. evaluated the association of adherence to the MeDi with the incidence of hip fracture in a cohort evaluated in eight European countries. A total of almost 200,000 participants were evaluated in a prospective cancer and nutrition study. The data extrapolated from the study showed that the increase in adherence to MeDi was associated with a 7% decrease in the incidence of hip fracture. It is interesting that in this study this association was more evident among men and stronger in older individuals, suggesting that increased adherence to MeDi protects against hip fracture, particularly among men. Recently studies have further highlighted the role of MeDi on cohorts of subjects in several European countries, confirming a positive role of MeDi in the prevention of skeletal changes and fragility fractures (18, 19).

The role between adherence to MeDi and maintenance of bone mineral density and reduction of the fracture risk have also been highlighted by a recent meta-analysis that displayed that all studies demonstrate that adherence to MeDi is associated with a 21% reduced risk of hip fracture (total RR 0.79; 95% CI 0.72-0.87). Furthermore, adherence to MeDi was positively associated with BMD of the vertebral column and femoral neck. The meta-regression of the observational studies included in the meta-analysis revealed an inverse linear association between adherence to MeDi and the risk of hip fracture (20).

Finally, a recent study by Mousavi et al. demonstrated that mice fed with a MeDi during pregnancy and different concentrations of olive oil have induced an increase in the proliferation of osteoblastic cells in the skeleton of the unborn during neonatal life (21), suggesting a pivotal role of a correct diet also during the phase of embryonic life, which could therefore have important repercussions in adult life.

The results of a recent study show that even with the lack of connection between MeDi scale scores and total fractures, high quality diet, characterized by adherence to a MeDi, is

associated with a lower risk for hip fractures (22). These results are confirmed by another study, involving 2371 participants aged 40-75, in which higher MeDi scale scores were positively and dose-dependently associated with higher BMD at all of the bone sites analyzed. The conclusions of the study highlighted the importance of a specific bone-related MeDi scale, which indeed could be created to better evaluate the connection between MeDi with skeletal health (23).

In conclusion, the observations in the literature, to date, confirm that a specific dietary approach, such as MeDi, can be a modifiable environmental factor for prevention of osteoporosis, yet, further studies will be needed to characterize the mechanisms through which this effect is implemented.

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