Healthy food and their anti-inflammatory properties

Foods that fight inflammation

Doctors are learning that one of the best ways to quell inflammation lies not in the medicine cabinet, but in the refrigerator. Your immune system becomes activated when your body recognizes anything that is foreign - such as an invading microbe, plant pollen, or chemical. This often triggers a process called inflammation. Intermittent bouts of inflammation directed at truly threatening invaders protect your health. However, sometimes inflammation persists, day in and day out, even when you are not threatened by a foreign invader. That's when inflammation can become your enemy. Many major diseases that plague us - including cancer, heart disease, diabetes, arthritis, depression, and Alzheimer's- have been linked to chronic inflammation.

One of the most powerful tools to combat inflammation comes not from the pharmacy, but from the grocery store. "*Many experimental studies have shown that components of foods or beverages may have anti-inflammatory effects,*" says Dr. Frank Hu, professor of nutrition and epidemiology in the Department of Nutrition at the Harvard School of Public Health. Choose the right foods and you may be able to reduce your risk of illness. Consistently pick the wrong ones, and you could accelerate the inflammatory disease process.

To reduce levels of inflammation, aim for an overall healthy diet. If you're looking for an eating plan that closely follows the tenets of anti-inflammatory eating, consider the Mediterranean diet, which is high in fruits, vegetables, nuts, whole grains, fish, and healthy oils.

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The IDEFICS Study: prospective associations between dietary patterns and an inflammation marker in European children

EM. González-Gil and collaborators

Zaragoza University, SPAIN

High sensitivity C-reactive protein (hs-CRP) is the inflammatory marker most measured in epidemiological studies. It has been established that the hs-CRP is an emerging risk factor of cardiovascular diseases, even in children[1,2]. Numerous studies have shown that an unhealthy dietary patterns- characterized by high consumption of sugar or sugar products, processed foods, red meat and low F&V intake – is positively associated with the inflammatory status. Whereas, a dietary pattern rich in F&V is negatively associated with this status[3,4]. However, there are insufficient studies that link dietary patterns and chronic diseases in young populations.

The major aim of this multicenter study- the IDEFICS* study- is to describe the prospective relation between dietary patterns at baseline (T0) and at follow-up 2 years later (T1) and hs-CRP levels in European children aged between 2 and 9 years old (n=4020).

The three clusters of dietary patterns identified

Three consistent dietary patterns - defined by clusters- were found at T0 and T1, derived from the food frequency questionnaire (FFQ) that was administered to parents in order to evaluate the frequency of consumption of specific food items during the previous 4 weeks:

• Cluster 1: "healthy"– characterized by high frequency of F&V and whole grains food, and low consumption of sweet products;

• Cluster 2: "sweet and processed" – characterized by high frequency of sweet products and drinks, and low frequency of F&V;

• Cluster 3: "animal protein and refined carbohydrate"- characterized by high frequency of protein foods, water and some carbohydrate foods.

At both times, the dietary patterns were consistently similar in the two measurement points therefore it was possible to determine the relation between persistency/changes of dietary patterns over time in children and hs-CRP level.

A higher percentage of obese children were included in the "animal protein and refined carbohydrate" and "sweet and processed" clusters compared to the "healthy" cluster.

When analyzing the cluster memberships of children at baseline and follow-up, "animal protein and refined carbohydrate" cluster was the most stable because 76% of the children still follow this dietary pattern at T1, while 73.8% remained in the "sweet and processed" cluster over time and 71.2% persist in the "healthy" cluster until T1.

Associations between hs-CRP levels and dietary patterns

In addition, the associations between the hs-CRP and cluster membership at baseline (T0) and follow-up (T1) in children was assessed. For this purpose, subjects were categorized in two groups according to hs-CRP, i.e. the first and second sex-specific tertiles vs. the third sex-specific tertile.

Results of this study showed that there is a positive association between the "sweet and processed" and "animal protein and refined carbohydrate"

patterns and inflammation over time. Children allocated in baseline and after two years to "sweet and processed" patterns had 44% higher probability of being in the highest hs-CRP category compared with those allocated to "healthy" cluster at baseline and follow-up while those allocated to "animal protein and refined carbohydrate" patterns over time had 47% higher probability of being in the highest hs-CRP category compared with those allocated to "healthy" cluster in both measurement times (Figure 1).
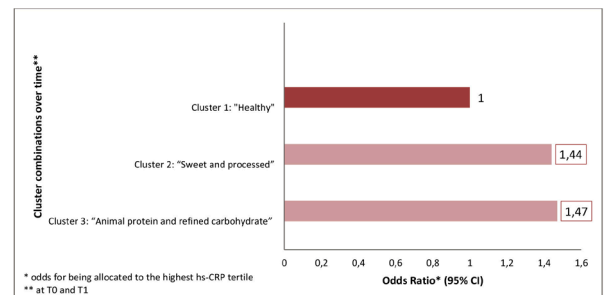

Figure 1: Multilevel logistic regression between dietary patterns over time and hs-CRP

When all the co-variables (Figure 2) were included, children allocated over time to "sweet and processed" pattern still had significantly higher probability (39%) of being in the highest hs-CRP category than those allocated to the "healthy" cluster in both measurement points.
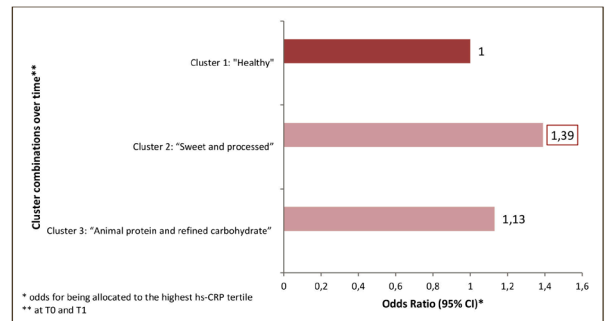

Figure 2: Multilevel logistic regression between dietary patterns over time and hs-CRP when co-variables were included (age, parental education and BMI at T1, hs-CRP at T0 and sex, study region and medication)

A low F&V consumption in childhood is related with inflammation

These findings support the fact that a pattern characterized by a high-frequency intake of sugar, sugar products and processed products along with a low-frequency intake of F&V maintained over time is related to an inflammatory status in children. Thus, efforts to implement interventions and programs aimed at the increase of F&V consumption and the reduced consumption of sugar and processed products could prevent future disease risk related to inflammation.

* Identification and prevention of dietary-and lifestyle-induced health effects in children and infants

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The Global Fruit & Veg Newsletter

Diet, BMI, inflammation and mental health in adolescents

Mental illness is expected to become one of the world's most serious health problems by 2020. Similarly, obesity and its complications are a worldwide scourge. The pathophysiological pathways associated with mental disorders and obesity are the same. They particularly include chronic inflammation[1]. People with more mental disorders are often overweight or obese[2]. Moreover, many data show that the inflammatory response potentially contributes to the pathophysiology of depression[3]. More than 50% of mental illnesses in adults occur before the age of 14 (vs 25% before the age of 24)[4]. Thus, adolescence is a decisive period of significant biological changes for obesity and mental health.

Australian researchers recently studied the relationship between diet, adiposity, inflammation and mental health in 843 adolescents between the ages of 14 and 17 who participated in the Western Australian Pregnancy Cohort (Raine) Study.

Recording of eating habits and biological tests

In order to determine the participants' eating habits, a Food Frequency Questionnaire (FFQ) was completed by the parents with the help of their children. Two dietary patterns were thus identified:
• A 'Western' dietary pattern characterised by high intake of red meat, takeaway, refined foods and confectionery;
• A 'Healthy' dietary pattern characterised by high intake of F&V, whole grains and fish.

The BMI of the participants was measured at the ages of 14 and 17 and a blood test was conducted at the age of 17 to determine the level of inflammatory markers (leptin and hs-CRP). To assess mental health, two tests were used at the ages of 14 and 17: a test measuring depression in young people and a test to assess internalising[a] and externalising problems in adolescents.

A diet rich in F&V protects against inflammation

Structural equation modelling[b] was used to test the following hypotheses:

Hypothesis 1: Dietary patterns and BMI at the age of 14 predict BMI and inflammatory markers at the age of 17:
The results in 14-year-old adolescents showed a significant relationship between a 'Western' diet and high BMI. This dietary pattern at the age of 14 was also significantly associated with high BMI and high levels of leptin and hs-CRP at the age of 17. On the other hand, a 'Healthy' diet at the age of 14 was significantly associated with low BMI and low levels of leptin and hs-CRP at the age of 17. Thus, BMI at the age of 14 was able to predict BMI and levels of leptin and hs-CRP at the age of 17.

Hypothesis 2: Inflammation at the age of 17 predicts depressive symptoms and internalising and externalising problems:
BMI as well as leptin and hs-CRP levels at the age of 17 were positively associated with depressive symptoms and with internalising and externalising problems.
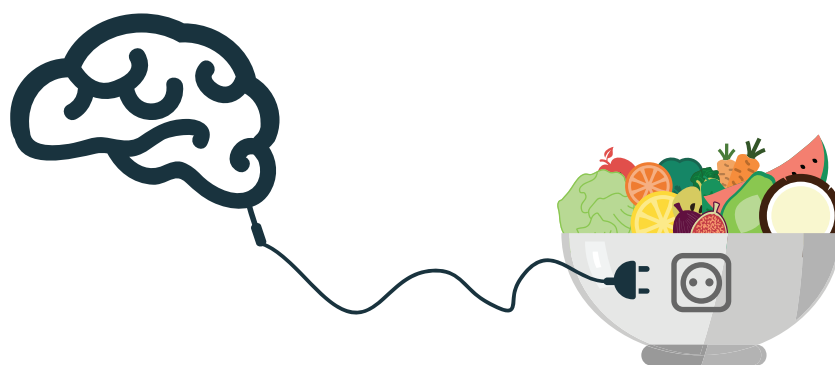
Hypothesis 3: Depression at the age of 14 predicts dietary patterns at the same age:
The results showed that depression occurring at the age of 14 did not predict dietary patterns at the same age. This hypothesis can thus be ruled out.

However, the fact of having mental health problems at the age of 14 was a significant risk factor for mental illness at the age of 17.

Magnesium, fibre, flavonoids and carotenoids influence inflammatory markers

The results of this analysis confirm that a healthy diet rich in F&V is associated with lower rates of obesity, inflammation and mental disorders in adolescents. It was shown that certain nutrients such as magnesium, fibre, flavonoids and carotenoids in fruits and vegetables are capable of reducing the level of inflammatory markers[5].

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a. A type of emotional and behavioural disorder that consists in internalising one's problems.

b. A diverse set of mathematical models, computer algorithms and statistical methods that fit networks of constructs to data; often useful in the social sciences because of its ability to impute relationships between unobserved constructs (latent variables) from observable variables.

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F&V intake and inflammatory marker in pre-pubertal girls

C. Garcés and collaborators.

Lipid Laboratory, IIS-Fundación Jiménez Díaz, Madrid, SPAIN

High sensitivity C-reactive protein (hs-CRP) is an inflammatory marker that has been associated with obesity and considered to activate all stages of atherosclerosis[1]. There is broad consensus on the role of diet in influencing CRP levels. Particularly, the consumption of F&V- major source of antioxidant vitamins- has been related to lower CRP levels in several studies[2-4]. Similarly, a high intake of vegetables is associated with a low CRP level according to the IDEFICS study in European children[5]. However, the influence of dietary patterns on inflammation in children remains under study. The aim of this study was to analyze the influence of diet on hs-CRP levels in a pre-pubertal population.

This study included 571children aged between 6 and 8 years old - 301girls and 270 boys. We have ensured that all of the subjects included were free of metabolic, endocrine, liver or kidney disorders, and had an hs-CRP level ≤10 mg/L to avoid biasing the results.

Food Frequency Diet (FFQ) adapted to primary school population was used to obtain information on food and nutrient intake.

Food consumption and nutrients intakes were analyzed by tertile of hs-CRP levels:
- Tertile 1: hs-CRP ≤0.15 mg/L;
- Tertile 2: 0.16 ≤ hs-CRP ≤ 0.61 mg/L;
- Tertile 3: hs-CRP ≥0.62 mg/L.

High intake of F&V is associated with lower hs-CRP levels in pre-pubertal girls

When analyzing nutrient intake and food consumption in boys, no differences were found.

In pre-pubertal girls, those in the lowest hs-CRP tertile had significantly higher vegetable intakes (181 g/day in tertile 1 and 2) than those in the terile 3 (154.6 g/day) (Figure 1a). Similarly, fruit intakes were the highest in pre-pubertal girls in the lowest hs-CRP tertile (210 g/day in the tertile 1 and 194 g/day for the tertile 2) compared to those in the tertile 3 (173.2 g/day) (Figure 1b). This seems to be due to the high fiber content and high antioxidants levels in fruit and vegetables.

Fiber, vitamin A and E intake play a role on inflammatory marker

Fiber intakes were lower in pre-pubertal girls in the highest hs-CRP tertile (17.9 g/day) compared to those in the tertile 1 and 2 (20.8 g/day in the tertile 1 and 19.3 g/day in the tertile 2) (Figure 1c). It remains unclear how fiber could modulate hs-CRP levels; maybe, it's related to its effects on slowing glucose absorption and modulating inflammatory cytokines production by gut microbiota[6].

Besides, the study reported a lower intake of vitamin A and E in pre-pubertal girls in the tertile 3 compared to those in the tertile 1 and 2. This finding supports the fact that antioxidant nutrients may be responsible for reducing hs-CRP levels.

Regarding fatty acid, a higher intake of saturated fats was noted in pre-pubertal girls in the highet hs-CRP tertile (17,1% in the tertile 3 vs 15,7% in the tertile 1 and 16,6% in the tertile 2).

The overall dietary quality was also assessed using the Healthy Eating Index (HEI). We found an inverse significant association between hs-CRP with HEI. The HEI score of the highest tertile of hs-CRP levels in pre-pubertal girls (62.8) was also significantly lower than the HEI score in the tertile 1 (66.1) and in the tertile 2 (64.7) (Figure 1d). This score was associated with a higher intake of vegetable and a lower intake of fats.
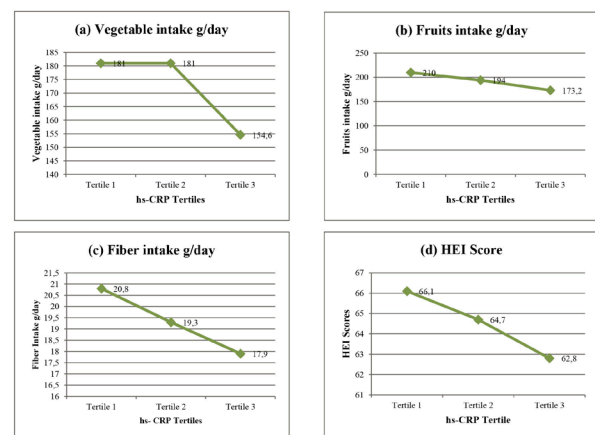

Figure 1: (a) Vegetable, (b) Fruit, and (c) Fiber intakes and (d) HEI score by hs-CRP tertiles in pre-pubertal girls

The need of dietary guidelines to prevent high hs-CRP levels in children

These findings support the hypothesis that diet can influence hs-CRP levels at the pre-pubertal age. This highlights the importance and the need to set up dietary guidelines in preventing hs-CRP levels from childhood.

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