REPORT

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NEW SCIENTIFIC EVIDENCE ON THE BENEFITS OF YOGHURT CONSUMPTION

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CONTENT

ABBREVIATIONS

BC	Breast cancer
Ca	Calcium
CARDIA	Coronary Artery Risk Development in Young Adults
CRC	Colorectal cancer
Cu	Copper
CVD	Cardiovascular disease
DGA	Dietary Guidelines for Americans
DM2	Diabetes mellitus type 2
EFSA	European Food Safety Authority
FA	Fatty acids
Fe	Iron
HTN	Hypertension
I	Iodine
K	Potassium
MetS	Metabolic syndrome
Mg	Magnesium
NANHES	National Health and Nutrition Examination Survey
NAOS	Spanish Strategy for Nutrition, Physical Activity and Obesity Prevention
P	Phosphorus
PREDIMED	Prevention with the Mediterranean Diet
s/d	Servings per day
SENC	Spanish Society of Community Nutrition
SFA	Saturated fatty acids
SUN	Seguimiento Universidad de Navarra
SUVIMAX	Supplementation with Vitamins and Antioxidant Minerals
TFA	Trans fatty acids
USDA	United States Department of Agriculture
Zn	Zinc

INTRODUCTION

Dairy products, such as yoghurt and other fermented milk-based products, have been part of the human diet for many years. Due to its organoleptic properties and high nutritional density, yoghurt is recommended as part of a healthy diet during various life stages and/or biological situations. This report aims to perform a complete analysis of the nutritional composition of yoghurt, current consumption recommendations for the general population, and new evidence on the associations between dairy consumption and the prevention of several chronic diseases.

WHAT IS YOGHURT?

Yoghurt can be defined as a coagulated milk product that results from the lactic fermentation processes of the bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, which come from pasteurised milk, pasteurised condensed milk, totally or partially skimmed pasteurised milk, condensed pasteurised milk or partially skimmed milk with or without added pasteurised cream, semi-skimmed or skimmed whole-milk powder, whey powder, milk proteins and/or other products derived from fractionated milk. In order to use the term yoghurt, the microorganisms that are responsible for lactic acid fermentation must be viable and present in the finished product with a concentration of 1 x 10^7 colonies per gram or millilitre. The presence of microbial activity in the product gives it specific nutritional and biological characteristics, which are described below[1].

Different types of yoghurt can be found on the market. Depending on the products added before or after fermentation or whether heat treatment is applied after fermentation, yoghurts can be classified as follows:

- Natural yoghurt;
- Sweetened yoghurt: yoghurt with sugar or other natural sweeteners added;
- Sugar-free yoghurt: yoghurt with approved sugar substitutes added;
- Yoghurt with fruit, juices and/or other natural products: yoghurt with added fresh, frozen, canned, freeze-dried or powdered fruits and vegetables, fruit puree, fruit pulp, compote, marmalade, preserves, syrups, juices, honey, chocolate, cocoa, nuts, coconut, coffee, spices and other natural ingredients;
- Flavoured yoghurt: yoghurt with approved flavouring agents added[1].

DEFINING FACTORS OF COMPOSITION AND QUALITY

- All yoghurts should have a pH less than or equal to 4.6;
- The minimum fat content from dairy in yoghurt should be 2 per 100 m/m, except for low-fat yoghurt which should contain less than 2 but more than 0.5 per 100 m/m. Non-fat yoghurt should contain less than 0.5 per 100 m/m;
- The minimum content of non-fat solids in all types of yoghurt should be 8.5 per 100 m/m;
- For yoghurts that contain fruit, juices and/or other natural products, the minimum amount of yoghurt in the final product should be 70 per 100 m/m.

ANALYSIS OF THE NUTRITIONAL COMPOSITION OF YOGHURT AND THE POTENTIAL BENEFITS OF ITS NUTRIENTS

The nutritional composition of yoghurt, like milk, varies due to several factors: animal of origin, breed, genetics, nutrition, number of milkings per day, age and manufacturing process. An example of the last-named factor is any thermal process that affects the composition of various nutrients, as in the case for some vitamins, or the state of the proteins[2]. The nutritional composition of the initial product (in this case, milk) is affected by lactic starters, which hydrolyse part of the lactose. This process produces lactic acid as a metabolite.

Yoghurt is part of a food group that the general public knows to be rich in calcium (Ca). As a nutrient-dense food, it is a good source of several nutrients that help to improve the quality of a healthy and balanced diet. In addition to Ca, it is important to note that yoghurt provides a high amount of protein and a small but consistent amount of phosphorus (P), magnesium (Mg), potassium (K), zinc (Zn), iron (Fe) and vitamins A, D, B2, and B12[3,4].

MACRONUTRIENTS

CARBOHYDRATES

Yoghurt, like other dairy products, such as milk, contains different types of carbohydrates. Lactose is the main carbohydrate found in yoghurt, although glucose, galactose, glycolipids, glycoproteins and oligosaccharides are also present in smaller quantities. Oligosaccharides have generated great interest due to their possible prebiotic effects[5].

Lactase is an enzyme that breaks lactose down into its constituent sugars. Part of the lactose in yoghurt is used as an energy substrate by microorganisms. There is scientific evidence indicating that yoghurt intake improves lactose digestion and alleviates the most common symptoms of lactose intolerance[6,7]. It has been shown that, in patients with lactose intolerance, yoghurt consumption lowers hydrogen excretion after lactose overload[8,9]. On the other hand, no significant differences have been observed in subjects that are not intolerant[10]. The EFSA (European Food Safety Authority) published a document in 2010 that compiled a total of 14 studies, 13 of which showed that yoghurt consumption improves lactose digestion and alleviates the symptoms of lactose intolerance. Although in one of the studies no improved digestion was observed, the data showed a reduction of symptoms. In individuals with poor lactose digestion, a cause-and-effect relationship has been established between yoghurt consumption and improved lactose digestion[11].

PROTEIN

Yoghurt is a food known for its protein content because it contains different types of casein (α, κ, ß and γ) and whey protein, especially α-lactalbumin, ß-lactoglobulin, serum albumin, proteose-peptones and immunoglobulins, in addition to metalloproteins such as lactoferrin, transferrin and ceruloplasmin and enzymes such as lipases, proteases and phosphatases[12].

Yoghurt contains a considerable amount of protein and is easily digested due to the proteolytic bacteria activity during the product's formation, releasing peptides and amino acids. Protein fermentation causes partial hydrolysis of the proteins that are found in yoghurt. *L. bulgaricus* hydrolyses proteins, usually ß-caseins followed by S-caseins. *Thermophilus* uses the resulting peptides, such as dipeptidases and aminopeptidases, to grow.

During the past few years, the peptides in yoghurt have been of great scientific interest. In particular, it not only has antihypertensive, antimicrobial, immunomodulatory and lipid-lowering properties, but it also has a significant effect on preventing abdominal obesity[13,14]. One example is lactoferrin, which, despite being found in smaller quantities, plays an important role in immune system modulation processes, anti-inflammatory responses and iron homeostasis[12]. Furthermore, it has been found that lactoferrin may be useful in eradicating *Helicobacter pylori*[15].

Yoghurt contains branched-chain amino acids such as leucine, isoleucine and valine. These amino acids play an important role in protein synthesis[16] and may influence body-fat deposits and glucose homeostasis[13,14]. In this sense, yoghurt can be considered an important food for maintaining muscle mass, although studies are needed to confirm this[17].

The nutritional composition of yoghurt makes it a product with a high satiating effect. It has been suggested that this effect is caused by yoghurt proteins, and manifests in a reduction of energy intake through various appetite-control mechanisms[18]. This effect may be connected to the high branched-chain amino acid content and the presence of various peptides and hormones[19].

All of the aforementioned traits make yoghurt protein one of the most important nutrients contained in yoghurt. Moreover, it is one of the few foods that contain all essential amino acids. Therefore, the type of protein that it contains is considered to be of high biological value.

LIPIDS

The lipids that are found in dairy products, like yoghurt, are essentially monoglycerides, diglycerides, triglycerides, phospholipids and cholesterol. The lipids found in dairy products have a high concentration of short-chain fatty acids (FAs) and a fast absorption rate. In general, FAs have different biological functions such as: to serve an energy substrate, to form part of the cell membrane structure, to affect platelet and immunological function, and to be involved in different inflammatory reactions and in processes that protect against apoptosis. Furthermore, they play a fundamental role as carriers for other nutrients, especially lipid-soluble vitamins[20].

Currently, milk fat is widely discussed with regard to its possible health benefits, especially saturated fatty acids (SFAs). Studies show that milk fat, especially from yoghurt, is highly associated with benefits that protect against diabetes mellitus type 2 (DM2), metabolic syndrome and obesity, among other cardiovascular risk factors. These benefits will be detailed in the section entitled "New Scientific Evidence on the Benefits of Yoghurt Consumption". However, various health authorities continue to recommend the consumption of low-fat dairy without sufficient scientific evidence[21].

In addition to SFA, yoghurt contains trans fatty acids (TFAs). Although it has been shown that there is an increase in the risk of cardiovascular disease associated with excessive TFA consumption from processed foods[22,23], and it is recommended to restrict consumption, there appears to be no increase in the risk of cardiovascular disease associated with the moderate consumption of TFAs from dairy products such as yoghurt [24,25]. In fact, various publications have linked either TFA intake or TFA plasma levels, like trans-palmitoleate, with lower insulin resistance[26,27].

MICRONUTRIENTS

VITAMINS AND MINERALS

Dairy products are an important dietary source of essential nutrients and other bioactive compounds necessary for good health, in particular Ca, a mineral that is difficult to obtain from a diet with limited or no dairy consumption. Dairy products contain multiple micronutrients, including a wide range of minerals and vitamins like Ca, P, Mg, Zn, I, K, vitamin A, vitamin D, and vitamin B complexes, especially B2 (riboflavin), B3 (niacin) and B12 (cobalamin)[28]. The lipid-soluble vitamins in dairy products vary in terms of fat content, since these types of vitamins are linked to the lipid fraction. The concentration of lipid-soluble vitamins in dairy products is not very high, although it contributes to the recommended dietary intakes. The main vitamins found in yoghurt are vitamins A and D. Vitamin D is added to some yoghurts in order to cover losses during the manufacturing process. Vitamins E and K are found in smaller quantities[29].

From a nutritional point of view, yoghurt can be considered equivalent to milk. However, the constituent microorganisms in yoghurt and the products resulting from its subsequent fermentation give it the nutritional value for which it is recognised. Due to the formation of partially soluble salts resulting from the acidity of the medium, different minerals, such as iron (Fe), copper (Cu) and zinc (Zn), can be absorbed more easily. In the same sense, minerals such as Ca, Mg, and P form complexes with the products resulting from protein hydrolysis, promoting their absorption[30].

Traditionally, dairy products are known for their excellent Ca/P ratio[30]. In terms of P, the consumption of two servings of yoghurt covers approximately 27% of the daily-recommended nutritional intake for adults (700 mg/day).

The nutritional requirements for Ca can be covered by other food sources such as nuts, seeds, fish rich in fatty acids, various leafy green vegetables and other plant-based beverages that are rich in Ca. Nevertheless, the total elimination of dairy products from one's diet has been associated with greater difficulty in meeting the recommended

intake for this mineral, as well as other nutrients[21]. The estimated average requirement for Ca in mg/day corresponds roughly to the following figures according to age:

- 800 mg/day (children 4–8 years old);
- 1,100 mg/day (children/adolescents from 9–18 years old);
- 800 mg/day (adults 19–50 years old);
- 1,000 mg/day (women 51 years of age and older).

The consumption of just two servings of yoghurt (one serving of dairy) provides approximately 350 mg of Ca. In short, just one serving of dairy covers 32-44% of the necessary Ca requirements at different life stages. In order to replace the requirements met by two servings of yoghurt (one serving of dairy), one would have to consume any of the following: 400 g/day of spinach, 350 g/day of broccoli, 250 g/day of sardines, 200 g/day of raw lentils or 400 g/day of cooked lentils, or 140 g/day of almonds. Therefore, although the Ca requirement can be covered by other foods, it is still difficult to achieve with a dairy-free diet, as demonstrated by the aforementioned list of foods.

It should be noted that not only the amount of Ca in food is important, but also its bioavailability. The Ca found in dairy products, including yoghurt, is easily absorbed. Ca is located in the non-fat fraction. It has been suggested that can also be absorbed in the absence of vitamin D because of the influence of other elements such as lactalbumin, lactose or P[31–33]. By contrast, Ca that comes from other sources (legumes, nuts or vegetables) is not as easily absorbed due to the high content of fibre and other substances that reduce bioavailability.

Another mineral, which is generally not given much consideration, is iodine (I). Milk and yoghurt have very similar I concentrations[34]. According to various scientific publications, the I concentration in dairy products like milk, and therefore yoghurt, has been gradually increasing (especially in the last decade) due to agronomic changes, animal hygiene and animal diet, among other factors[35,36]. It is therefore important to take this new source of dietary I into account, especially for vulnerable groups.

YOGHURT AS A PROBIOTIC FOOD

In the human body, bacterial cells account for more than half of colon weight. More than 400 different species have been described. Colonisation begins at birth and continues throughout life. Bacteria can be found in places other than the intestine, although most are located in the gastrointestinal tract. These bacteria form what is known as gastrointestinal microbiota.

Probiotics can be defined as the live microorganisms associated with various health benefits when consumed in adequate quantities. The latest scientific evidence shows that the microorganisms living in food may provide health benefits to those who consume them.

Fermented milk may contain thermophilic or mesophilic bacteria or combinations of mesophilic bacteria and other microorganisms. In the case of yoghurt, *L. bulgaricus* and *S. thermophilus* are thermophilic bacteria, the perfect symbiosis of which acidifies the medium, lends an adequate texture and helps to develop organoleptic properties, in particular yoghurt's characteristic flavour and aroma[37]. The amount of bacteria needed to help maintain a good state of health varies depending on the type of strain and species of the probiotic. Usually, yoghurt contains between 100 million and 10 billion live probiotics per serving[38].

Different probiotic strains have been associated with the prevention of diarrhoea caused by other bacteria and viruses, inflammatory diseases, different types of cancer, immune system changes, allergies, cardiovascular diseases, genitourinary disorders, bacterial vaginosis and vaginitis due to yeast and urinary tract infections. However, due to the inherent limitations of the studies conducted, it would be too early to draw definitive conclusions in terms of the efficacy of probiotics in the prevention of these kinds of disorders and abnormalities[38].

In terms of intestinal transit, the benefits of yoghurt consumption as suggested by various clinical trials are limited. Many of the benefits are due to various factors: type of yoghurt, use of different strains and addition of other food products with potential prebiotic functions[39–41].

Yoghurt consumption has not been shown to improve gastrointestinal disorders, such as acute diarrhoea, with the exception of episodes of diarrhoea due to the use of antibiotics and the eradication of *Helicobacter pylori*. It is thought that yoghurt consumption can reduce the risk of this infection in adults. In a recently published meta-analysis, yoghurt consumption showed no consistent effect in preventing antibiotic-induced diarrhoea[42]. However, three randomised clinical trials linked yoghurt consumption to a lower risk of antibiotic-induced diarrhoea[43–45]. Scientific evidence supports the idea that fermented dairy products such as yoghurt may play an important role in reducing the risk of antibiotic-induced diarrhoea in adults.

As for the eradication of *Helicobacter pylori*, various meta-analyses conclude that probiotics can play an important role in the effectiveness of medical treatment[46,47]. Additionally, a review published in 2014 suggests that fermented dairy products and bovine lactoferrin may provide benefits in eradicating the bacterium. However, the number of studies compiled in this review is limited, and many of them have significant limitations[15]. Due to the increased prevalence of *Helicobacter pylori*[48] infections and the possible effects attributed to yoghurt, more high-quality clinical trials are needed in order to establish high-calibre evidence.

The effect of probiotics is a little-studied area, and considering the publications to date, more systematic studies are needed in order to confirm any health benefits. Even so, the large increase in publications on the subject suggests that probiotic foods, like yoghurt, may play an important role in the health of the consumer.

YOGHURT CONSUMPTION AND DIET QUALITY

Various studies indicate that the consumption of milk and yoghurt is associated with a better diet quality index score[4,49–52].

Yoghurt consumption can help improve the intake of various nutrients[51] and maintain metabolic well-being as part of a healthy and energetically balanced diet. As it contains various vitamins and minerals, is low in sodium and contributes no more than 1.0% of added sugars to the diet, it can help improve the quality of the consumed diet.

In the United States, 90% of children and adults consume less than one cup of yoghurt per week, and some authors have therefore suggested that its consumption should be encouraged. As yoghurt is a densely nutritional food and contains various nutrients, the consumption of which is worryingly low in the diets of the US population, the authors believe that the consumption of one yoghurt per day would help satisfy the appropriate nutritional recommendations[51]. When applying the adequate nutritional intake probability index in a sample of Italian adults and elderly people, it was found that the nutritional adequacy index was significantly higher in people who eat yoghurt, i.e., they had a higher probability of adequate intake of vitamins and minerals than non-yoghurt consumers. It has also been found that people who eat yoghurt also eat more fruits and vegetables and fewer meat products, which would suggest that they have healthier diets than non-consumers[52]. In line with this evidence, the Framingham Heart Study Offspring cohort, which included 6,526 adults, showed a better score in the diet quality index in yoghurt consumers compared to non-consumers. Yoghurt consumers are 47%, 55%, 48%, 38% and 34% less likely to have adequate intakes of B2 and B12, Ca, Mg and Zn, respectively, compared to non-yoghurt consumers (all p-values ≤ 0.001)[4]. Therefore, as yoghurt is a good source of various micronutrients, it could help improve the quality of people's diets and prevent certain cardiometabolic diseases, as we will discuss below.

RECOMMENDATIONS FOR DAIRY INTAKE ACCORDING TO DIFFERENT DIETARY GUIDELINES

Dietary guidelines are educational instruments that have been adapted to communicate current scientific knowledge of nutritional recommendations through practical messages. They are used to assist people in selecting and consuming healthy foods.

In general, all dietary guidelines recommend the daily intake of dairy products, which includes milk and/or low-fat yoghurts and/or cheese. However, the amount of fat found in milk and yoghurt is much lower than in cheese. Cheese does not compare nutritionally to yoghurt and milk, and should therefore not be considered as part of the same category. Current guidelines are sending mixed messages by putting cheese, especially cured cheese, on the same level as milk and yoghurt. This will be discussed and reflected upon in further detail below.

The following section describes the recommendations for yoghurt consumption according to the various dietary guidelines created by different institutions.

THE SPANISH FOOD AND NUTRITION AGENCY: NAOS STRATEGY

The Spanish Strategy for Nutrition, Physical Activity and Obesity Prevention (NAOS) recommends a daily intake of 2-4 servings of dairy derived from fresh milk: fresh cheese, curds, yoghurt and other similar products. Foods found on the second level of the NAOS pyramid tend to have one trait in common: they are sources of protein. Given their nutritional composition, this guide considers cheeses, which are also derived from milk, as sources of protein. The guide does not use fat content as a basis for its recommendations concerning which type of milk or yoghurt to consume[53].

THE SPANISH SOCIETY FOR COMMUNITY NUTRITION (SENC)

The 2007 version of this guide also recommends 2-4 servings of dairy per day (s/d), and it specifies the recommendations for adults (2-3 s/d), children (2-3 s/d), adolescents (4 s/d), nursing infants (4-6 s/d), menopausal women (3-4 s/d), pregnant women (3-4 s/d) and the elderly (3 s/d)[54]. Although the pyramid does not state whether the dairy products should be whole-fat or low-fat, the SENC recommends the consumption of low-fat dairy, especially for populations over 70 years of age and for people who are obese or who have cardiovascular disease. Low-fat dairy is recommended because it

has fewer calories, saturated fats and cholesterol. The SENC has recently published an updated pyramid for 2015. It also recommends the consumption of low-fat milk or yoghurt, or cheese (the representative icon for cheese in the food pyramid is cured cheese)[55].

THE MEDITERRANEAN DIET FOUNDATION

The Mediterranean Diet Foundation recommends the consumption of fermented dairy products which are typical in Mediterranean countries: yoghurt and cheese (especially sheep or goat). The Mediterranean Diet Foundation emphasises the consumption of fermented milk products like yoghurt because of the concentration of live microorganisms that are associated with different health benefits and gastrointestinal microbiota equilibrium. The Mediterranean Diet Foundation recommends 2 low-fat s/d[56]. However, it should be noted that even low-fat cheese has much more fat than low-fat yoghurts.

DIETARY GUIDELINES IN THE UNITED STATES

The current version of the Dietary Guidelines for Americans (DGA) includes revisions based on the Scientific Report of the 2015 Dietary Guidelines Advisory Committee ("Advisory Report", published in February 2015). The new guidelines recommend the consumption of low-fat dairy products (except for young people) in an attempt to minimise the consumption of saturated fat, a nutrient that is consumed in excess[57]. The 2015 Advisory Report measures its dairy intake recommendations in cups (240 ml). Two cups for children 2-3 years old, 2.5 cups for children 4-8 years old and 3 cups for adolescents (9-18 years old) and adults[57].

The United States Department of Agriculture (USDA) developed a tool called "MyPlate". The guide is a graphical representation of five food groups: vegetables, fruits, whole-grain products, low-fat dairy products and protein-rich foods. MyPlate recommends that members of the general population who are on a 2,000-kcal diet consume 3 cups of low-fat yoghurt a day[58].

THE HARVARD SCHOOL OF PUBLIC HEALTH

The Nutrition Department at the Harvard School of Public Health published "The Healthy Eating Pyramid". This guide recommends a yoghurt intake of 1-2 s/d. The guide also states that there is not enough scientific evidence to tell the public that consuming increased levels of dairy can prevent osteoporosis, and that high consumption of this food group is associated with an increased risk of ovarian or prostate cancer[59]. The same department has also created another tool: the "Healthy Eating Plate", which also recommends 1-2 s/d[60].

ARE ALL DAIRY PRODUCTS EQUAL AND CAN THEY BE RECOMMENDED INTERCHANGEABLY?

As outlined above, various institutions recommend 1-3 servings of dairy per day, and they include yoghurt as well as other foods in the same group, such as cheese, in their recommendations. In addition, the majority of dietary guidelines also recommended consuming low-fat milk and yoghurt. They also show an icon of a cheese that is similar to cured cheese, which has a concentration of fat and salt that is significantly higher than other foods in the same food group. Therefore, the general population receives the message that 1 serving of milk, yoghurt or cheese is equal in nutritional value. However, these three foods are very different in terms of nutrition and calories. In terms of calories and nutrition, milk and yoghurt are more or less comparable. However, cheese contains a much higher concentration of salt and fat. This deviates greatly from the nutritional and caloric properties of the previous two. Therefore, the recommended intake of cheese should be different from that recommended for milk and/or yoghurt. In addition, as explained in this review, yoghurt has very distinct properties and nutritional composition. According to recent scientific evidence, this appears to be associated with certain health benefits regardless of its fat content. In fact, the consumption of whole-milk yoghurt has been associated with better cardiovascular health[61]. One of the clearest examples is the inverse relationship between whole-milk yoghurt consumption and the emergence or reversal of metabolic syndrome (MetS) or its symptoms[62,63], or the incidence of DM2[64–66]—a relationship which has been reported in recent epidemiological studies.

Therefore, in light of recent evidence and for the reasons discussed above, we believe that the dairy intake recommendations should be revised in order to take nutritional and caloric content into account. Furthermore, as we will later discuss, there is no scientific evidence to demonstrate that skimmed or low-fat dairy products are better than whole products. Indeed, the latest evidence suggests the opposite, even though whole dairy products may be beneficial from a cardiometabolic perspective. There is therefore no reason to continue recommending only low-fat dairy products at this time.

NEW EVIDENCE ON THE BENEFITS OF YOGHURT CONSUMPTION

Properly designed interventional studies are one of the best tools for studying the cause-effect relationship between the onset or prevention of a disease. However, clinical studies evaluating the possible effects between yoghurt and overweight or obesity, DM2, cardiovascular disease (CVD), hypertension (HTN), MetS, cancer or the risk of premature death are limited. That said, several epidemiological studies have studied the relationship between yoghurt consumption and the various chronic illnesses described above. The scientific evidence from these studies is discussed below.

YOGHURT, OVERWEIGHT AND OBESITY

Overweight and obesity represent an imbalance between calorie intake and expenditure. This leads to a consistent excess of calories that usually accumulates in the form of fatty deposits. It is a multifactorial disease, and in most cases, there is a genetic predisposition that can be triggered by certain environmental and cultural factors.

Since 1980, the number of people who are overweight or obese has doubled worldwide. Currently, approximately one out of every two adults in the world is overweight. In all, 13% of the world's population is obese, and in Spain this prevalence is about 16%. Obesity ranks fifth on the list of factors that cause premature death[67,68].

Obesity increases the risk of developing various metabolic diseases, such as DM2, atherogenic dyslipidaemia or hypertension, or cardiovascular disease[69], which increases the risk of mortality for various reasons. Although obesity is multifactorial in nature, poor dietary habits, such as being physically inactive, have been recognised as major risk factors for developing the disease. In large population cohorts, the excessive consumption of foods such as potatoes, refined grains, processed meats, sugary drinks and fruit juice has been linked to an increased risk of weight gain or obesity. On the other hand, the frequent consumption of nuts, fruits, vegetables, whole grains and yoghurt has been consistently associated with an inverse relationship to weight gain[70].

Very few studies have attempted to evaluate the exact relationship between yoghurt consumption and weight gain or waist circumference. Observational evidence has shown that only two out of nine prospective studies have not found any link between yoghurt consumption and obesity[71,72]. In the rest of the studies, yoghurt consumption was associated with a lower risk of developing the disease[62,70,73–76]. Furthermore, in four out of five prospective studies, yoghurt consumption was linked to a lower risk of abdominal obesity or a larger waist circumference[62,70,74,77].

In 2002, a prospective cohort study entitled CARDIA (Coronary Artery Risk Development in Young Adults) was published, which did not find any links between yoghurt consumption and obesity in American adults[71]. Two years later, the Québec Family Study was published. It had a sample size of 248 volunteers whose dietary habits, weight changes and waist circumference were monitored for six years. The study concluded that the consumption of yoghurt with less than 2% fat was not associated with

changes in weight, but it was associated with an increase in waist circumference. It is important to note that the study did not clearly specify the amount of yoghurt consumed nor did it discuss the increase in waist circumference in the results[73]. Vergnaud et al., with the same objective as the previous study, conducted a prospective study in France with a total of 2,267 adults. The results showed an inverse relationship between yoghurt consumption, an increase in body weight and similarly an increase in the waist circumference of overweight men[74].

More recent studies have provided more information on the role of yoghurt. These studies have included people without weight problems and who did not have chronic diseases at the beginning of the study. Mozaffarian et al. studied these relationships in three major American cohorts that included a total of 98,320 women and 22,557 men. Yoghurt consumption was inversely related to the risk of weight gain. The study also concluded that the consistent consumption of 1 serving of yoghurt per day showed a protective effect of up to 28% in terms of changes to waist circumference when compared to those who did not consume yoghurt[70]. Furthermore, Wang et al. found that the consumption of 3 or more servings of yoghurt per week was directly related to a 50% lower risk of weight gain when compared to those who consumed less than 1 serving of yoghurt per week[75]. Following the same line of research, in a sample of 8,516 university graduates, the SUN study (Seguimiento Universidad de Navarra) observed that those who consumed more than 7 servings of yoghurt a week had a 20% lower risk of becoming overweight or obese. When the data were evaluated according to fat content, an even lower risk was found [OR: 0.62 (0.47–0.82)][76]. However, in the same cohort study, Sayón-Orea et al. reported that the consumption of 7 or more portions of yoghurt per week was inversely associated with abdominal obesity, compared with individuals who consumed 2 or less portions per week. It was also found that this inverse relationship was the same with total yoghurt consumption [OR: 0.85 (0.74–0.98)] and whole yoghurt consumption [OR: 0.85 (0.73–0.99)], but not with low-fat yoghurt[72]. More recent evidence from the PREDIMED cohort (Prevention with the Mediterranean Diet) supports these results. The total yoghurt consumption, irrespective of fat content, was significantly associated with a 20% lower risk of abdominal obesity[62]. Finally, in a sample of 4,545 individuals from the same cohort with baseline abdominal obesity, it was observed that, after five years of follow-up, the individuals who had a greater intake of whole yoghurt, compared with those with lower intake, had a greater likelihood of reversing abdominal obesity [OR: 1.43 (1.06–1.93)] and a smaller waist circumference[77].

Despite the fact that there is a large number of observational studies and a few randomised controlled trials that have studied the role of dairy products on the loss and/or maintenance of healthy weight, there are very few that focus on the specific role of yoghurt consumption.

One recent review analysed the specific prospective studies already mentioned, along with a total of two randomised clinical trials. The two trials showed greater weight loss in the groups that consumed yoghurt. The limitation of these two studies is their short duration. Moreover, neither of the two included a different dairy product as a control. These studies are not enough to conclude that the observed effects were due to yoghurt consumption. Only one of the studies significantly linked the effect of yoghurt to weight loss in the context of a low-calorie diet[78].

Taking into account all the literature published to date, yoghurt should be considered as a potential tool for preventing and/or reversing obesity. However, randomised trials with a longer duration are needed in order to confirm these results.

YOGHURT AND METABOLIC SYNDROME

Metabolic syndrome (MetS) is a very serious public health issue. It is defined as a set of metabolic abnormalities that includes at least three of the following cardiovascular disease risk factors: abdominal obesity, hypertriglyceridaemia, high blood pressure, high levels of fasting plasma glucose and low levels of HDL cholesterol.

Approximately 25% of the world's population has MetS[79]. This condition increases the risk of cardiovascular diseases by 1.7 times and the risk of DM2 by 5 times[80].

Although the aetiology of MetS is not known, it is thought that it stems from a complex interaction with unknown genetic determinants and environmental factors, including eating habits. A sedentary lifestyle, smoking, low sociocultural status, as well as an adherence to Western eating habits, have been associated with the risk of developing MetS. In recent years, many publications have shown that the consumption of dairy products can have a beneficial effect on several of the risk factors that define metabolic syndrome. Two cross-sectional studies have found an inverse relationship between yoghurt consumption and the risk of this syndrome[81,82]. In the first one, the objective was to study the association between the consumption of a variety of dairy products and their nutrients with different cardiovascular pathologies, such as the symptoms of MetS. These analyses were performed on a sample of 4,519 individuals in the NANHES (National Health and Nutrition Examination Survey) study. Yoghurt consumption has an inverse relationship with the presence of MetS [OR=0.40 (0.18-0.89)][81]. On the other hand, Kim et al. observed a linear but not statistically significant trend between the consumption of yoghurt and the prevalence of MetS (P=0.067) in a sample of 4,862 Koreans. Individuals who consumed between 4 and 6 servings of yoghurt per week had a 23% lower risk of developing this condition [OR=0.77 (0.62-0.95)][82].

On a prospective level, there are very few studies that have evaluated the relationship between yoghurt consumption and the risk of developing MetS. In a recent PREDIMED study of a population with a high risk of cardiovascular disease (n=1,866), the individuals in the upper tercile of yoghurt consumption showed a lower risk of developing MetS [OR=0.78 (0.66-0.92)] regardless of its fat content. Individuals who were in the upper tercile of whole-milk and non-fat yoghurt consumption also showed a 27% and 22% lower risk of MetS, respectively[62]. The same inverse relationship was observed in a Brazilian cohort of 15,105 adults from the ages of 35-74, which took yoghurt consumption and cardiometabolic risk into account[63].

In some cohorts, the association between yoghurt consumption and incidence of MetS was not apparent[72,83]. This is the case in the SUN study conducted by the University of Navarra. It is worth noting that the majority of the participants in the SUN cohort are young, and therefore the reported incidence of MetS was low. For this reason, it is possible that an insufficient statistical power prevented an inverse relationship between yoghurt consumption and the risk of MetS, as described in other studies, from being observed. Nevertheless, the individuals in this cohort that consumed 7 or more servings of yoghurt a week and also 2-3 pieces of fruit a day were associated with a 39% lower risk of developing the syndrome when compared with those who did not[72]. This suggests that yoghurt consumption is also associated with healthy eating habits, and this might explain why a clear association between these confounding factors was not observed.

As is evident in epidemiological studies, yoghurt consumption, especially whole-milk yoghurt, protects against the risk of MetS. However, due to the observational nature of these studies, it is not possible to establish a causal relationship. As much as study models have been adjusted for possible confounding variables, the existence of residual factors that explain the observed relationships cannot be ruled out. Scientific evidence on yoghurt consumption and the risk of MetS should continue to be studied through well-designed clinical trials.

YOGHURT AND DIABETES MELLITUS TYPE 2

More than 381 million people worldwide suffer from diabetes. DM2 is a strong risk factor for cardiovascular diseases (cerebral thromboembolism and ischaemic heart disease). Other notable complications of this disease are microvascular retinopathy (which causes blindness), nephropathy (which leads to renal failure and dialysis), or even the amputation of the lower limbs. These complications may lead to a significant decrease in the quality of life. It is estimated that within 20 years, the number of people with diabetes will increase to 591 million worldwide. Diabetes is also responsible for 5% of deaths and its incidence is estimated to increase by 50% within the next 10 years[84].

DM2 occurs when the body becomes insulin resistant or when there is a deficit in the production of the hormone insulin. While it is true that genetics play an important role in the risk of diabetes, various lifestyle factors, such as maintaining a healthy weight, physical activity, quitting smoking and healthy eating habits, should be considered in terms of prevention and treatment.

Studies published during the past few years have suggested that yoghurt consumption may lower the risk of DM2.

Even though some studies could not prove a significant inverse relationship between yoghurt consumption and the incidence of diabetes[84–88], most have observed a trend in protection. Recent studies conducted on the most significant cohorts have also demonstrated a statistically significant inverse association[65, 89–92]. It should be highlighted that, to date, none of the prospective studies have shown a detrimental relationship between yoghurt consumption and the incidence of DM2; the association is either inverse or neutral.

A 2011 meta-analysis of the prospective studies[64] showed an inverse association between the frequency of yoghurt consumption and the risk of developing DM2 [0.83 (95% CI; 0.74-0.93)] among those who were in the top consumption category. In two other meta-analyses, published in 2013 and 2014, it was concluded that individuals who consumed 2 or more servings of yoghurt a week had a 28% lower risk of developing DM2 than those who consumed less than 1 serving of yoghurt a week[66] and a 17% lower risk than those who consumed 1 serving of yoghurt a day[65]. Three other meta-analyses[66, 93,94] also showed an inverse relationship between yoghurt consumption (irrespective of its fat content) and incidence of DM2. The results of the most recent meta-analysis, which included 22 cohort studies, showed a non-linear inverse relationship between yoghurt consumption and incidence of DM2, with a 14% lower risk in the incidence of DM when consumption was between 80 g and 125 g/day compared with non-consumption[94].

Current evidence from prospective studies and prospective meta-analysis studies suggests that yoghurt consumption, regardless of fat or sugar content, protects against the risk of DM2. However, future interventional studies are needed in order to establish a causal relationship.

YOGHURT AND HYPERTENSION

One of the biggest risk factors for cardiovascular disease is hypertension (HTN). Adults are considered to have hypertension when systolic blood pressure is ≥ 140 mmHg and/or when diastolic blood pressure is ≥ 90 mmHg[95].

According to the WHO, one in every three adults has high blood pressure[95]. HTN affects more than one billion people worldwide, and it is estimated that more than 9 million die because of it.

Various scientific studies have found an association between the consumption of dairy products, including yoghurt, and HTN. Three cross-sectional studies[96–98] and seven prospective studies[93–99] have found an inverse association between the risk of having HTN and the consumption of dairy products. Two meta-analyses[99–100], published in 2012, showed the same results: an inverse association between dairy product consumption and the risk of HTN. However, there are very few studies that have specifically evaluated yoghurt and its association with this risk factor. The Framingham cohort followed 2,636 adult subjects for 14 years. It was noted that, in comparison to individuals who rarely consumed yoghurt, the consumption of more than 1 serving of yoghurt a week was associated with a 5% lower risk of developing HTN[101]. Nonetheless, the CARDIA cohort (n=4,304 young adults followed for 7 years) showed no evidence of an inverse association between yoghurt consumption and presence of HTN. This was not statistically significant (P=0.14)[102].

In conclusion, the effect of yoghurt consumption on HTN has yet to be determined. The epidemiological studies published so far have suggested that the consumption of dairy products protects against this condition. However, more epidemiological studies analysing yoghurt per se are needed, as well as interventional studies that can establish a causal relationship.

YOGHURT AND CARDIOVASCULAR DISEASE

Cardiovascular diseases contribute significantly to the total number of deaths per year worldwide. Cardiovascular disease (CVD) is currently the leading cause of mortality in the world. It is responsible for 17.3 million deaths each year. The most common cardiovascular diseases are cerebrovascular accidents, ictus and coronary artery disease[103,104].

Very few studies have directly evaluated the role of yoghurt on CVD.

In a case-control study conducted in Italy, with a sample of 507 cases of myocardial infarction and 478 controls of both genders aged 25-79, it was observed that individuals who consumed yoghurt on a daily basis had a 45% lower risk of myocardial infarction

when compared to those who did not [OR 0.55 (95% CI: 0.32–0.95); P-trend=0.015][105].

In a sample of 29,133 Finnish men, the relationship between a variety of dairy products, including yoghurt and sour milk, and the risk of a cerebral vascular accident, cerebral thromboembolism or haemorrhagic stroke was evaluated. Individuals in the top quintile of yoghurt and sour milk consumption had a 10% lower risk of suffering a cerebral vascular accident. No statistically significant relationship in terms of cerebral thromboembolism and haemorrhagic stroke was found. However, it is important to note that the data on yoghurt consumption were only on a baseline level, and changes in frequency of consumption were not evaluated during patient follow-up. Moreover, the male population studied was middle-aged and had a high risk of cardiovascular disease due to smoking. This makes it difficult to extrapolate data for other populations[106].

An Australian cohort followed for 16 years (n=1,529) showed no significant associations between yoghurt consumption and the risk of developing CVD[107]. The Rotterdam Study, which followed a cohort of 4,235 individuals for 17 years, also found no statistically significant relationship between yoghurt consumption and risk of CVD[108]. Two other prospective studies showed yoghurt intake to have a protective effect against myocardial infarction, but the association was not statistically significant in either study[109,110].

Carotid intima-media thickness was considered an indicator of subclinical atherosclerosis and cardiovascular disease. This was seen in a prospective study that followed a group of women (n=1,080) over 70 years old for a total of five years. Individuals who consumed more than 100 g of yoghurt per day had significantly thinner carotid intima-media than those who consumed less yoghurt[111].

Various reviews and meta-analyses that have focused on dairy product consumption have observed protection against CVD in individuals who consume dairy. However, these results cannot be extrapolated for yoghurt consumption[112–117].

YOGHURT AND CANCER

Cancer is a global public health problem. In this disease, malignant cells replicate uncontrollably in the body. Tumour cells alter certain genetic mechanisms which allow them to grow greatly in size and invade neighbouring tissues. Cancer is a disease that is influenced by many factors; two of the most important ones are genetic inheritance and environment. In fact, one out of every three cancer-related deaths can be attributed to poor diet and bad lifestyle habits (e.g. being sedentary and smoking)[118,119]. In 2012, there were about 14 million new cases of cancer and 8.2 million cancer-related deaths worldwide[120,121].

There is limited and not entirely convincing evidence on the relationship between yoghurt consumption and different types of cancer.

Colorectal cancer (CRC) is the second most common cancer in the world. Of the different types of malignant tumours, CRC is most strongly associated with diet.

The evidence from epidemiological studies shows that yoghurt consumption may be inversely associated with this disease. In a case-control study conducted in Burgundy

(France) (n=362 vs. n=427), individuals with greater yoghurt consumption had a 50% lower risk of developing CRC than those who did not consume yoghurt [0.5 (95% CI; 0.3-0.9)][122]. Similarly, a modest inverse relationship [OR=0.97 (0.95-0.98)] was seen in another case-control study with a sample of 196 CRC-diagnosed individuals in Madrid who were matched by age and sex[123].

Prospective studies with great scientific relevance have obtained similar results. In the EPIC (European Prospective Investigation into Cancer and Nutrition) study, an Italian cohort (n=45,241) was followed for 12 years. EPIC showed that individuals in the upper tercile of yoghurt consumption have a 35% lower risk of developing this disease when compared to those who did not consume yoghurt[124]. Overall, the entire EPIC cohort (n=477,122 men and women followed for 11 years) showed an inverse association between yoghurt consumption and CRC in the following categorical models [≥ 109 g/day vs. non-consumers, HR 0.90 (95% CI:0.81–0.99); P-trend=0.043][125].

In men, the second most common tumour and the fifth leading cause of mortality is prostate cancer. For years, various studies have shown that there may be a direct connection between the consumption of dairy products and the emergence of this type of cancer[126], although there are also results that contradict this.

In a case-control study published in 2006, it was suggested that daily yoghurt consumption might increase the probability of developing prostate cancer. However, this modest and direct association was not statistically significant. Moreover, the cases and controls were not properly matched due to potentially significant confounding factors with regard to predicting the risk of this type of cancer[127].

The consumption of yoghurt has been linked to this type of cancer in various prospective studies[128–130].

In the SUVIMAX (Supplementation with Vitamins and Antioxidant Minerals) study, Kesse et al. found that, among 12,741 subjects between the ages of 35 and 60 who were followed for 8 years, an increase in daily servings of yoghurt could increase the risk of developing prostate cancer. When comparing the upper tercile of yoghurt consumers with non-consumers, the relationship was weak and the relative risk was not statistically significant. This relationship could be a possible threshold effect, although studies with a larger scope are needed to confirm these results[128].

Another prospective study (n=142,000 men followed for 8.7 years) also concluded that yoghurt consumption was associated with the risk of prostate cancer. When categorising the population into quintiles based on consumption, individuals in the top quintile had a higher incidence of prostate cancer than those in the bottom quintile [HR 0.17 (95% CI: 1.04–1.31); P-trend=0.02]. However, it is important to note that within the yoghurt category they included white cheese and petit-suisse, which can affect the association[129]. Likewise, a Japanese cohort (n=43,435 subjects followed for 7.5 years) evaluated baseline consumption and the risk of developing prostate cancer. The results of this study also showed that individuals with higher consumption had a 52% higher risk of developing this type of cancer [OR: 1.52 (1.10-2.12)][130]. It should be noted that a major limitation of this study was that it did not assess consumption over the seven years of follow-up.

On the other hand, there are other prospective studies that have not found a significant association between yoghurt consumption and prostate cancer. One such study

was conducted by Park et al. with a sample of 80,000 participants from different ethnic groups who were followed for 8 years[131]. Another study, conducted by Wright et al., had a sample of 27,111 Finnish male smokers between the ages of 50-69 who were followed for 21 years[132].

Therefore, the current evidence on the relationship between yoghurt consumption and prostate cancer is controversial, although many of the studies point towards a positive association. Nonetheless, more studies that control for the potential confounding factors are needed so that the evidence can be considered solid and recommendations can be established.

Another common type of cancer, both in industrialised and industrialising countries, is breast cancer (BC)[133]. Yoghurt consumption has not been associated with a significant increase in BC[127,134,135].

Furthermore, there is no sufficient evidence to link yoghurt consumption and gastric cancer. The majority of studies on this topic analysed the general consumption of dairy products, without categorising them, showing a possible protective effect against this tumour[136–140]. Only two studies specifically refer to the consumption of yoghurt. Moreover, they had conflicting results. A case-control study conducted in Turkey, with a total of 253 patients between the ages of 55.5-57 diagnosed with gastric cancer, found that yoghurt consumption was not associated with the risk of gastric cancer in those who consumed less[141]. Similarly, a Japanese cohort (n=110,792) of men and women aged 40-79 and followed for two years did not show an association between yoghurt consumption and the risk of gastric cancer[142].

There is very little epidemiological evidence for other types of cancer such as bladder cancer. Only one case-control study with a sample of 130 participants diagnosed with bladder cancer specifically studied the association between yoghurt consumption and bladder cancer. Yoghurt consumption was found to be inversely associated with its development [OR: 0.34 (0.12-0.97)][143]. Other prospective studies analysed the relationship between different dairy products like cream, various cheeses and other fermented milks, without showing specific results for yoghurt[144–146].

In conclusion, the current evidence on the consumption of yoghurt and the risk of developing cancer is limited, especially for some types of cancer. The lack of solid epidemiological evidence causes premature conclusions to be drawn, conclusions which are then conveyed to the general population. Furthermore, the possible benefits of yoghurt for the prevention of some types of cancer and other chronic diseases justifies the recommendation of a variety of dairy products as part of a healthy diet.

YOGHURT AND MORTALITY

In industrialised countries, non-communicable diseases are responsible for over 90% of the years of life lost. The three leading causes of premature death are coronary heart disease, lower respiratory tract infections, such as pneumonia, and cerebrovascular accidents. In 2012, three out of every ten deaths were attributed to cardiovascular diseases: 7.4 million were attributed to ischaemic heart disease and 6.7 million to cerebrovascular accidents. Worldwide, 17.5 million deaths are linked to this type of pathology[147].

There are very few epidemiological studies on the consumption of yoghurt and mortality rates. A total of three prospective studies[107,108,148] have evaluated yoghurt consumption and populations with a high risk of premature death. In a five-year study of 162 men with an average age of 80, a greater survival rate was observed in individuals who consumed yoghurt more than three times a week when compared to those who consumed yoghurt less than one time a week. Similarly, individuals that consumed at least 1 serving or more of yoghurt three times per week had a lower risk of premature death[148]. Other prospective studies evaluated the relationship between the consumption of different dairy products, like yoghurt, or the nutrients from them and the risk of mortality by CVD, cancer or any other causes. The study followed a sample of 1,529 Australian adults (aged 25-78) for 16 years and showed that there were no significant associations between the different categories of yoghurt consumption and the risk of mortality from cardiovascular disease [HR=0.65 (0.26-1.58) P-trend=0.52], or death from any cause [HR=1.22 (0.77-1.93)] P-trend=0.36][107]. In conclusion, the prospective study conducted by Praagman et al. also found no significant associations between yoghurt consumption and death from a myocardial infarction[108].

To date, two meta-analyses[117,149] have been published on the cause-effect of the consumption of dairy products or yoghurt and the risk of mortality. Soedamah-Muthu et al. collected the information from a total of 17 studies: 5 conducted in the United States, 2 in Japan and 10 in Europe. The average age of the subjects was 56±13 years and they were followed for between 6 and 14 years. Although they provided results for dairy products in general, no conclusion about yoghurt consumption could be drawn due to the lack of scientific studies and publications published so far[117].

In a separate meta-analysis, six cohort studies were evaluated for a relationship between dairy product consumption and death from any cause[149]. The results of the meta-analysis showed a significant inverse relationship between the frequency of yoghurt consumption and the overall death rate. The meta-analysis highlights that the evidence on dairy groups, in particular, is insufficient.

As a final conclusion, there are no publications to date that show the specific association between yoghurt consumption and overall death rate, the probability of death from a cardiovascular disease, or any other cause. However, there is some evidence from prospective studies that yoghurt consumption might reduce the risk of mortality from different kinds of cancer, including CRC[150].

MECHANISMS

Studies have proposed different hypotheses for the mechanisms through which yoghurt consumption may provide health benefits. As stated in this study, the consumption of yoghurt is inversely associated with the risk of diseases like general and abdominal obesity, DM2, MetS, HTN, different types of cancer and CVD, the disease that causes the most deaths in the world.

One of the mechanisms to highlight is directly related to total fat content. Recent evidence has shown that dairy fat, despite its concentration of saturated fats, appears to be more beneficial than harmful, and this fact may help to explain its different mechanisms that might be associated with different health benefits[151].

SFAs have been closely monitored by various organisations, entities and health professionals due to their supposedly harmful effects on cardiovascular health and increased risk of some diseases directly related to it. However, several recent publications have suggested that SFAs, especially those from dairy sources, might not be harmful to cardiovascular health[151,153]. The effects of SFA depend on intake and, above all, on the origin of the source[154].

As described in the "Macronutrients" section, the lipids found in yoghurt fat have different biological functions in the human body, such as the formation of membranes or the transport of certain nutrients, as in the case of some lipid-soluble vitamins. Furthermore, in recent years, new scientific publications have suggested that there are different lipid components in milk, like conjugated linolenic acid, unconjugated linolenic acid, arachidonic acid and sphingomyelin, which could play an important role in the prevention of cardiovascular disease[155]. Additionally, the trans-palmitoleic acid produced by gastric bacteria in ruminants has been directly associated with a lower risk of insulin resistance, atherogenic dyslipidaemia and DM2, which might explain the mechanism by which dairy fat is associated with the prevention of cardiovascular disease[27,156]. Some studies have also shown an inverse relationship between odd-chain saturated fatty acids, pentadecanoic acid (C15:0) and heptadecanoic acid (C17:0) with the incidence of DM[151,157]. These odd-chain fatty acids are primarily obtained from dairy products and are therefore considered important biomarkers of consumption. Recently, in more than 3,000 adults from two significant American cohorts, it was found that a higher serum concentration of these fatty acids was associated with a significantly lower risk of developing DM2 (around 40%)[151].

Total caloric value could be the key to another mechanism that could explain the benefits attributed to yoghurt consumption. Current scientific evidence suggests that products with a high caloric density could produce an increase in the sensation of fullness and satiety[158].

The hypothesis that yoghurt can control appetite is not based on the caloric density of the product, but on the set of physiological mechanisms that can provoke this effect due to protein concentration. Caseins and whey proteins differ in terms of how quickly they are digested. Whey protein appears to be more easily absorbed, and this may be why it can induce rapid changes in the feeling of fullness and quite possibly satiety. Furthermore, casein delays gastric emptying and steadily releases amino acids. It has also been found that the consumption of yoghurt increases the concentration of anorectic peptides like the peptide similar to glucagon (GLP)-1 and the peptide YY (PYY)[159,160]. The set of mechanisms designed to influence appetite control suggests that yoghurt is an ideal food to eat on a regular basis in order to prevent feeling hungry.

There is yet another positive health benefit associated with the protein in yoghurt: it is thought to reduce blood pressure. The bioactive peptides found in yoghurt are associated with the inhibition of the conversion of angiotensin I into angiotensin II, and at the same time, a reduction in aldosterone production. In addition, these peptides show an ever-increasing effect on the changes that regulate insulin control, the control of lipid metabolism and the accumulation of abdominal fat—all of which are key factors in preventing MetS and CVD[14].

Its high Ca content might explain other mechanisms regarding the benefits of yoghurt consumption for cardiovascular health. The mineral Ca is involved in lipid oxidation and fat mobilisation. Various studies have linked low Ca intake to an increase of

adipose tissue and a decrease in the utilisation of body fat. The suppression of 1,25-dihydroxyvitamin D formation and the secretion of parathormone are mechanisms by which it is thought that Ca may reduce lipogenesis and increase lipolysis[161,162]. The Ca from dairy products such as yoghurt, unlike supplements, reduces the triglyceride content of chylomicrons in a postprandial situation[163]. Additionally, the Ca from dairy promotes the formation of insoluble soaps (made of Ca and Mg with fatty acids) in the small intestine and increases the loss of fat via faeces[164–166].

Ca is also associated with insulin secretion and glucose uptake, which affect homeostasis[13]. Ca can also reduce blood pressure through various mechanisms: decreasing cell membrane permeability, reducing sympathetic nervous system activity, increasing the renal excretion of sodium, regulating the concentration of circulating hormones like parathormone and the activity of angiotensin-converting enzyme inhibitors. The decrease in the activity of the renin-angiotensin-aldosterone system induces vasoconstriction and lowers blood pressure[167–169]. There are not very many studies that directly examine the effects of yoghurt consumption on the risk of HTN, even though epidemiological evidence suggests an inverse association between dairy consumption and a lower incidence of HTN. As a result, more studies are needed to fully explain the mechanisms with regard to this association.

In summary, the importance of gastrointestinal microbiota should not be underestimated. It has been suggested that the bacteria in yoghurt can have beneficial interactions with the gastrointestinal microbiota of yoghurt consumers. They may also play an important role in the reduction of inflammation through lipopolysaccharides, which are products of the same gastrointestinal microbiota[170]. The addition of probiotic bacteria to yoghurt is also being studied in order to observe the possible effects on the human intestine. In a randomised double-blind clinical trial with a sample of 44 patients (aged 30-60) diagnosed with DM2, the consumption of probiotic yoghurt resulted in the reduction of various factors linked to oxidative stress, such as TNF-α, which was accompanied by a significant reduction in glycosylated haemoglobin[171]. On these lines, another double-blind randomised clinical trial of 60 diabetic individuals found an improvement in lipid profile, specifically in LDL-cholesterol levels in comparison with the control group[172].

The study of the potential role of gastrointestinal microbiota and yoghurt bacteria in the prevention of obesity, CVD and cancer is a new approach. This field is considerably unexplored[170]. Probiotics such as *Lactobacillus* and *Bifidobacterium*, which are found in dairy products, might play an important modulatory role in the gastrointestinal microbiota and in the prevention of different chronic diseases[173,174].

The large majority of mechanisms described make it very difficult to explain with certainty the reasons why yoghurt consumption protects against various diseases. Another mechanism could be the sum of the effects of the different components in yoghurt, the interaction between nutrients themselves after consumption, the effect of different metabolic reactions and the possible effect of the interaction of probiotics with gastrointestinal microbiota.

CONCLUSIONS

Yoghurt is a food with unique nutritional characteristics. Many publications analyse yoghurt as part of a group of dairy products and/or as a subgroup of fermented milks, along with butter or different types of cheese, for example. Grouped in this way, the results of the analyses cannot be directly extrapolated for yoghurt.

So far, the results of these studies point to a beneficial relationship between yoghurt consumption and a reduced risk of developing various chronic diseases like obesity and/or overweight, MetS, DM2, CVD and cancer. However, further properly designed interventional studies are needed in order to establish a causal relationship between yoghurt consumption and the emergence of the aforementioned diseases. Both the complexity of the diseases, as well as the ability to study the potential nutritional properties of a specific food, make it difficult to carry out such studies. However, as can be seen in this publication, most studies suggest that yoghurt consumption is associated with health benefits and not with damage to health.

Dietary guidelines continue to recommend the moderate consumption of dairy products and low-fat yoghurt. Considering the high divergence from previous beliefs on the subject of dairy fat in the results of recent publications, it is imperative to review and reconsider the dietary recommendations from various institutions. The revision of dietary recommendations should focus on the number of daily servings for each of the products in question, differentiating yoghurt from milk and above all from cheese. Daily yoghurt consumption as a way to satisfy the nutritional requirements of various nutrients, and not just Ca, should be recommended to both the general population and specific populations.

Yoghurt is a food that has become part of diets around the globe. In some cases, as in certain Mediterranean areas, it is an ancestral dietary component. It is a product that has been studied for over a decade, and its distinct nutritional properties make it superior and unmatched, especially in scientific terms. Therefore, the daily consumption of yoghurt, along with a variety of other dairy products, should be recommended as part of a healthy and nutritionally adequate diet.

KEY MESSAGES FOR THE GENERAL POPULATION

- Yoghurt contains high-quality proteins which may explain its various health benefits.
- The consumption of 2 servings of yoghurt a day covers 32-44% of the daily recommendations of Ca, with respect to different life stages, and a high percentage of other micronutrients (vitamins B2, B12, D and phosphorus).
- From a nutritional point of view, yoghurt can be considered equivalent to milk. Nevertheless, the microorganisms found in yoghurt and the products resulting from its subsequent fermentation give it the nutritional value it is recognised for.
- In lactose-intolerant patients, yoghurt reduces levels of exhaled hydrogen due to lactose overload and improves lactose digestion as well as other symptoms of intolerance.
- Epidemiological studies suggest that yoghurt consumption is associated with less weight gain and a decreased risk of obesity.
- Current evidence suggests that yoghurt consumption, regardless of its fat or sugar content, protects against the risk of diabetes and metabolic syndrome.
- The consumption of whole-milk yoghurt is thought to play an important role in preventing metabolic syndrome and lowering the incidence of cardiovascular diseases.
- The odd-chain saturated fatty acids and the trans-palmitoleic acid in dairy products are significantly associated with a lower incidence of diabetes.
- To date, there are no epidemiological studies that link yoghurt consumption to an increased risk of mortality by cardiovascular disease or any other cause.
- Until now, there is no sufficent evidence between yoghurt consumption and the risk of developing cancer.
- The set of mechanisms that influence appetite control suggests that yoghurt can be considered as the perfect food to include regularly in a diet in order to keep from feeling hungry.

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