Assessment of functional food and beverage consumption among the Balearic Islands population: gender, socio-demographic and lifestyle determinants

PhD Thesis

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ASSESSMENT OF FUNCTIONAL FOOD AND BEVERAGE CONSUMPTION AMONG THE BALEARIC ISLANDS POPULATION:

gender, socio-demographic and lifestyle determinants

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The person **with the approval of the Director**

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“Let food be your medicine and medicine be your food”

Hippocrates

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ABBREVIATIONS

ALA	α-Linolenic Acid
ANOVA	Analysis of Variance
BF	Body Fat
BMD	Bone Mineral Density
BMI	Body Mass Index
BP	Blood Pressure
CDV	Cardio Vascular Disease
CHD	Coronary Heart Disease
CLA	Conjugated Linoleic Acid
CNB	Caloric Nutritional Beverage
CSD	Carbonated Soft Drink
DHA	Docosahexaenoic Acid
EFSA	European Food Safety Authority
EPA	Eicosapentaenoic Acid
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FF	Functional Food
FFQ	Food Frequency Questionnaire
FOS	Fructo-oligosaccharides
FOSHU	Foods for Specific Health Use
FuFoSe	Functional Food Science in Europe
HDL-Cholesterol	High Density Lipoprotein-Cholesterol
ILSI	International Life Science Institute
IPAQ	International Physical Activity Questionnaire
IQS	Intake Quality Score
LDL-Cholesterol	Low Density Lipoprotein-Cholesterol
MD	The Mediterranean Diet
MEDLINE	Medlars Online International Literature
MET	Metabolic Equivalent of Task
MUFA	Mono-Unsaturated Fatty Acid
NQI	Nutrition Quality Index
OBEX	Obesity and Oxidative Stress (Obesidad y Estrés Oxidativo)
OBIB	Obesity in Children and Adolescents in the Balearic Islands (Obesitat Infantil i Juvenil a les Illes Balears)
OR	Odds Ratios

PUFA	Polyunsaturated Fatty Acid
RCSD	Regular Carbonated Soft Drink
RDI	Recommended Dietary Reference Intake
SD	Standard Deviation
SE	Standard Error
SES	Socio Economic Status
SFA	Saturated Fatty Acid
SSB	Sugar Sweetened Beverage
TEI	Total Energy Intake
UK	United Kingdom
US	United States

ASSESSMENT OF FUNCTIONAL FOOD AND BEVERAGE CONSUMPTION AMONG THE BALEARIC ISLANDS POPULATION: gender, socio-demographic and lifestyle determinants

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ABSTRACT

In our modern life burden of non-communicable diseases such as obesity, cancer, cardiovascular disease and type-2 diabetes has increased. By contrast, life expectancy and also cost of health care has increased. So, individuals search other ways to improve or maintain their well-being. In this regard, food and also the pharmaceutical industry offer functional foods (FFs) with health-promoting and disease-preventing properties. Besides, the traditional Mediterranean Diet (MD) is a good example of healthy diet, rich in FFs like olive oil, yogurt, wine, nuts, and spices.

Moreover, beverage consumption plays an important role in our health status and consumption of energy containing beverages like sugar sweetened beverages (SSBs) has linked with many diet-related diseases.

The objective of the present thesis was to examine the socio-demographic and lifestyle determinants of the FF consumption among adult (16-65 years old) and adolescent (13-18 years old) population in the Balearic Islands. Moreover, the aim was to assess the relation between FF consumption and MD. Additionally, this thesis presented the association between beverage consumption and demographic variables and several lifestyle characteristics.

Adult population preferred to consume FFs like low-fat milk (42%), coffee and tea (53%), probiotics (30%) and breakfast cereals (20%). Similarly, adolescent population also preferred to consume modified milk (low-fat or omega-3 enriched milk) (20%), probiotics (20%) and breakfast cereals (19%). However, instead of coffee and tea the young population preferred fruit juice (21%).

Consumption of FF was not found associated with gender in adult (OR=0.96, *P*=0.841) and also in adolescent population (OR=1.06, *P*=0.570); however, when we analyse the relation between gender and each of the FF separately, we observed that females were more likely to consume soy milk or tea, whereas males were more likely to consume breakfast cereals. Among adolescents, boys more preferred to consume breakfast cereals, while girls more likely to consume modified milk, soy milk and fibre-rich bakery products. We found that age was an important determinant and influenced the FF consumption, in both of the study populations consumption of FFs increased with increasing age.

Consumption of many FFs was positively associated with the intake of several functional components. Inadequate intake of functional components such as carotene, zinc, omega 3 and omega 6 fatty acids was found in adult and adolescent population.

Water was found the main fluid source in adolescent and adult population. While a higher proportion of adult population consumed beverages with low energy, like low-fat milk, coffee and tea, the majority of adolescents were preferred to consume beverages with high energy and some benefits like natural fruit juice or whole fat milk. Beverage intake contributed 6 to 13% of the daily total energy intake (TEI) in adolescents, while in adults beverage consumption provided 9 to 18% of the daily TEI. In adolescents the consumption of high energy beverages was inversely associated with the nutrition quality index (NQI), whereas no relation was found between the consumption of these beverages and body mass index (BMI).

Consumption of FFs such as low fat milk or probiotics which are successful products in the FF market was high among the Balearic Islands population; however, consumption of cholesterol lowering products was not common. Consumers' willingness to use foods and beverages highly depends on awareness toward FFs. Therefore, FF producers and also nutritional authorities promote the consumption of FFs by informing consumers about health-promoting effects of FFs.

Consumption of high energy beverages and the energy intake from these beverages of adolescents was not as high as in the US or other European countries. Whereas, adverse effect of high consumption of high energy beverages on nutrition intake was observed in adolescents, so the young population should be encouraged healthy beverage consumption.

EVALUACIÓN DE LOS ALIMENTOS FUNCIONALES Y CONSUMO DE BEBIDAS ENTRE LA POBLACIÓN DE LAS ISLAS BALEARES: género, determinantes socio-demográficos y de estilo de vida

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RESUMEN

En nuestra vida moderna, se ha incrementado la proporción de enfermedades no transmisibles como la obesidad, el cáncer, la enfermedad cardiovascular y la diabetes tipo 2. Por el contrario, ha aumentado la esperanza de vida y también los costes de atención sanitaria. Por tanto, los individuos buscan otras maneras de mejorar o mantener su bienestar. A este respecto, la industria de la alimentación y farmacéutica también ofrecen alimentos funcionales (AF) que poseen propiedades de promoción de la salud y prevención de enfermedades. Además, la Dieta Mediterránea tradicional (DM) es un buen ejemplo de dieta saludable, rica en alimentos funcionales, como aceite de oliva, yogur, vino, frutos secos y especias.

Por otra parte, el consumo de bebidas juega un papel importante en nuestro estado de salud y el consumo de energía que contienen bebidas como aquellas endulzadas con azúcar se ha relacionado con muchas enfermedades relacionadas con la dieta.

El objetivo de la presente tesis fue estudiar los determinantes socio-demográficos y de estilo de vida del consumo de alimentos funcionales entre los adultos (16-65 años) y adolescentes (13-18 años) de la población de las Islas Baleares. Además, el objetivo fue evaluar la relación entre el consumo de alimentos funcionales y DM. Además, esta tesis presenta la asociación entre el consumo de bebidas y las variables demográficas y varias características del estilo de vida.

La población adulta prefirió consumir alimentos funcionales como leche baja en grasa (42%), el café y el té (53%), probióticos (30%) y los cereales para el desayuno (20%). Del mismo modo, la población adolescente también prefirió consumir leche modificada (baja en grasas o leche enriquecida en omega-3) (20%), probióticos (20%) y los cereales para el desayuno (19%). Sin embargo, en lugar de café y té, la población joven prefirió el zumo de fruta (21%).

El consumo de alimentos funcionales no se asoció con el sexo en adultos (OR = 0.96, P = 0.841) y también en la población adolescente (OR = 1.06, P = 0.570), sin embargo, cuando se analizó la relación entre el género y por separado cada uno de los alimentos funcionales, se observó que las mujeres tenían más probabilidades de consumir leche de soja o té, mientras que los hombres eran más propensos a consumir cereales para el desayuno. Entre los adolescentes,

los chicos eran quienes más preferían consumir cereales de desayuno, mientras que las chicas fueron las más propensas a consumir leche modificada, leche de soja y productos de panadería ricos en fibra. Se encontró que la edad es un factor determinante que influía en el consumo de alimentos funcionales, pues el consumo de alimentos funcionales aumentó con la edad entre las poblaciones de estudio.

El consumo de muchos alimentos funcionales se asoció positivamente con la ingesta de determinados componentes funcionales. Tanto en población adulta como en adolescente se encontró una ingesta inadecuada de componentes funcionales tales como caroteno, zinc, y ácidos grasos ácidos grasos omega 3 y omega 6.

El agua es la principal fuente de fluido en la población adolescente y adulta. Mientras que una mayor proporción de la población adulta consume bebidas con bajo contenido en energía, como la leche baja en grasa, el café y el té, la mayoría de los adolescentes prefirieron consumir bebidas con alta energía y algunos beneficios, como el zumo de fruta natural o la leche entera. La ingesta de bebidas contribuye de un 6 a un 13% de la ingesta energética diaria total (TEI) en adolescentes, mientras que en los adultos el consumo de bebidas proporciona del 9 al 18% de la TEI diaria. En los adolescentes el consumo de bebidas de alta energía se asoció inversamente con el índice de calidad nutricional (NQI), mientras que no se encontró relación entre el consumo de estas bebidas y el índice de masa corporal (BMI).

El consumo de alimentos funcionales como la leche baja en grasa o los probióticos, que son productos de éxito en el mercado de los alimentos funcionales, es alta entre la población de las Islas Baleares, sin embargo, el consumo de los productos para reducir el colesterol no es común. La predisposición de los consumidores hacia el uso de alimentos funcionales y bebidas es altamente dependiente de su actitud hacia los alimentos funcionales. Por tanto, los productores de los alimentos funcionales y también las autoridades nutricionales si desean promover el consumo de los alimentos funcionales, deberían informar adecuadamente a los consumidores sobre los beneficios para salud que promueven los alimentos funcionales.

El consumo de bebidas de alta energía y el consumo de energía de estas bebidas entre los adolescentes no fue tan alto como en los Estados Unidos de América o en otros países europeos. Considerando que se han descrito efectos adversos entre los adolescentes debidos a un elevado consumo de bebidas de alta energía, debería alentarse el consumo de las bebidas saludables entre la población joven.

AVALUACIÓ DELS ALIMENTS FUNCIONALS I CONSUM DE BEGUDES ENTRE LA POBLACIÓ DE LES ILLES BALEARS: gènere, determinants socio-demogràfics i d'estil de vida

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RESUM

A la nostra vida moderna, s'ha incrementat la proporció de malalties no transmissibles com l'obesitat, el càncer, la malaltia cardiovascular i la diabetis tipus 2. Pel contrari, ha augmentat l'esperança de vida i també els costs d'atenció sanitària. Per tant, els individus busquen altres maneres de millorar o mantenir llur benestar. En aquest sentit, la indústria de l'alimentació i farmacèutica també ofereixen aliments funcionals (AF) que posseeixen propietats de promoció de la salut i prevenció de malalties. A més, la Dieta Mediterrània tradicional (DM) és un bon exemple de dieta saludable, rica en aliments funcionals, com oli d'oliva, iogurt, vi, fruits secs i espècies.

Per altra banda, el consum de begudes juga un paper important en el nostre estat de salut i el consum d'energia que contenen begudes com les endolçades amb sucre s'ha relacionat amb moltes malalties relacionades amb la dieta.

L'objectiu de la present tesi fou estudiar els determinants socio-demogràfics i d'estil de vida del consum d'aliments funcionals entre els adults (16-65 anys) i adolescents (13-18 anys) de la població de les Illes Balears. A més, l'objectiu fou avaluar la relació entre el consum d'aliments funcionals i DM. A més, aquesta tesi presenta l'associació entre el consum de begudes i les variables demogràfiques i vàries característiques de l'estil de vida.

La població adulta preferí consumir aliments funcionals com llet baixa en greix (42%), el cafè i el té (53%), probiòtics (30%) i els cereals per a l'esmorzar (20%). De la mateixa manera, la població adolescent també preferí consumir llet modificada (baixa en greixos o llet enriquida en omega-3) (20%), probiòtics (20%) i els cereals per a l'esmorzar (19%). Malgrat això, la població jove preferí el suc de fruita (21%)en lloc de cafè o té.

El consum d'aliments funcionals no s'associà amb el sexe als adults (OR = 0.96, P = 0.841) i com tampoc entre la població adolescent (OR = 1.06, P = 0.570), així i tot, quan s'analitzà la relació entre el gènere i a cadascun dels aliments funcionals per separat, s'observà que les dones tenien més probabilitats de consumir llet de soja o té, mentre que els homes eren més propensos a consumir cereals per a l'esmorzar. Entre els adolescents, els al·lots eren qui més preferien consumir cereals per a l'esmorzar, mentre que les al·lotes foren les més propenses a consumir

llet modificada, llet de soja i productes de panaderia rics en fibra. Es trobà que l'edat és un factor determinant que influeix sobre el consum d'aliments funcionals, ja que el consum d'aliments funcionals augmentà amb l'edat entre les poblacions estudiades.

El consum de molts aliments funcionals s'associà positivament amb la ingesta de certs components funcionals. Tant a la població adulta com a l'adolescent es trobà una ingesta inadequada de components funcionals tals com carotens, zinc i àcids grassos omega 3 i omega 6.

L'aigua és la principal font de fluid en la població adolescent i adulta. Mentre que una major proporció de la població adulta consumí begudes amb baix contingut d'energia, com la llet baixa en greix, el cafè i el té, la majoria dels adolescents preferiren consumir begudes amb alta energia i alguns beneficis, com el suc de fruita natural o la llet sencera. La ingesta de begudes contribueix d'un 6 a un 13% de la ingesta energètica diària total (TEI) en adolescents, mentre que en els adults el consumo de begudes proporciona del 9 al 18% de la TEI diària. En els adolescents el consum de begudes d'alta energia s'associà inversament amb l'índex de qualitat nutricional (NQI), mentre que no es trobà cap relació entre el consum d'aquestes begudes i l'índex de massa corporal (BMI).

El consum d'aliments funcionals com la llet baixa en greix o els probiòtics, que són productes d'èxit en el mercat dels aliments funcionals, és alt entre la població de les Illes Balears, el consum dels productes per a reduir el colesterol no és habitual. La predisposició dels consumidors cap a l'ús d'aliments funcionals i begudes és altament depenent de llur actitud cap els aliments funcionals. Per tant, els productors d'aliments funcionals i també les autoritats nutricionals si desitgen promoure el consum dels aliments funcionals, haurien d'informar adequadament els consumidors sobre els beneficis per a la salut que promouen els aliments funcionals.

El consum de begudes d'alta energia i el consum d'energia d'aquestes begudes entre els adolescents no fou tan alt com als Estats Units d'Amèrica o a altres països europeus. Considerant que s'han descrit efectes adversos entre els adolescents deguts a un elevat consum de begudes d'alta energia, s'hauria d'estimular el consum de begudes saludables entre la població jove.

LIST OF PAPERS

I. Ozen AE, Pons A, Tur JA, 2012. Worldwide consumption of functional foods: a systematic review. Nutrition Reviews, 70 (8): 472-481.

II. Ozen AE, Pons A, Tur JA. Differences in consumption of functional foods between European countries: a systematic review (submitted).

III. Ozen AE, Bibiloni MM, Pons A, Tur JA. Socio-demographic and lifestyle determinants of functional food consumption among a Mediterranean adult population (submitted).

IV. Ozen AE, Bibiloni MM, Pons A, Tur JA. Consumption of functional foods in the Balearic Islands: adolescent population (submitted).

V. Ozen AE, Bibiloni MM, Pons A, Tur JA. Adherence to the Mediterranean Diet: the perspective of functional food consumers in the Balearic Islands (submitted).

VI. Ozen AE, Bibiloni MM, Pons A, Tur JA. Adherence to the Mediterranean Diet and consumption of functional foods among the Balearic Islands adolescent population (submitted).

VII. Ozen AE, Pons A, Tur JA. Beverage consumption and energy intake from beverages across age groups worldwide: a systematic review (submitted).

VIII. Ozen AE, Bibiloni MM, Pons A, Tur JA. Beverage patterns of adult population in the Balearic Islands: association with socio-demographic characteristics, nutrient intakes, BMI and physical activity (submitted).

IX. Ozen AE, Bibiloni MM, Pons A, Tur JA. Beverage consumption among adolescents in the Balearic Islands: effects on nutrient and energy intake (submitted).

X. Ozen AE, Bibiloni MM, Pons A, Tur JA. Beverage patterns of the adolescent population in the Balearic Islands (submitted).

XI. Ozen AE, Bibiloni MM, Pons A, Tur JA. Beverage consumption and physical activity among the adult population in the Balearic Islands (submitted).

XII. Ozen AE, Bibiloni MM, Pons A, Tur JA. Association between beverage consumption and physical activity in the adolescent population (submitted).

Introduction

1. Functional Foods

Functional foods were first introduced in Japan in the mid-1980s. The government and health authorities in Japan focused to maintain and improve health status of Japanese and promoted the development of foods with health benefits [1] and called these foods as FOSHU (Foods for Specific Health Use) which refer to processed foods containing ingredients that beneficially influence the specific body functions, in addition to being nutritious [2].

In Europe the interest for functional foods started in the latter half of the 1990s. The European Commission generated an activity called Functional Food Science in Europe (FuFoSE) to explore the concept of functional foods in a science-based approach [3]. Nevertheless, legislation by the authorities in the European Union (EU) for functional food is missing, so several European countries have developed their own self-regulations on how the health effects can be communicated [3].

1.1. Definition of Functional Foods

There are several definitions for "functional foods"; however; a universally accepted definition is missing. Moreover, it is a concept rather than a well-defined group of food products [1,4]. The European Commission's Concerted Action on FuFoSE, coordinated by the International Life Science Institute (ILSI) Europe described functional foods as follows:

''A food can be regarded as 'functional' if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutritional effects, in a way that is relevant to either an improved state of health and well-being and/or reduction of risk of disease. Functional foods must remain foods and they must demonstrate their effects in amounts that can normally be expected to be consumed in the diet: they are not pills or capsules, but part of a normal food pattern'' [5].

Functional foods can be a natural as well as a processed food. The production of functional foods are often requires modern technology and different approaches such as [3,5,6];

- Elimination of a component known as causing a deleterious effect to the consumer
- Addition of a component that is not normally present
- Incensement of the concentration of a component naturally present in foods to produce beneficial effects
- Replacement of a component (potentially deleterious) with another for which beneficial effects have been demonstrated

As mentioned before some foods contain one or more functional components naturally and several researches have investigated the identification and understanding of the potential mechanisms of these functional components which could improve health and possibly reduce the risk of disease while enhancing our overall well-being, in food [1]. Some examples of functional components and their potential health benefits are presented in Table 1 [7,8]. In addition to natural functional foods industrially processed foods may become functional by the addition of a functional component in the formula [1].

While some functional food producers focus on niche markets and different kinds of functional foods which exert their actions on different systems, like the gastrointestinal, cardiovascular or immunological ones are produced for a particular group of people; some others prefer to develop products for the whole marketplace. The first example of the products in the functional foods' market were mineral or vitamin fortified foods, while various other food products fortified with many other micronutrients such as omega-3, plant sterol or dietary fibre has taken place in the market [9]. Moreover, functional foods which have more than one health benefit have been developed [9].

A wide spectrum of unmodified functional foods like tomato, walnut or fishes or produces functional foods like probiotic yogurt can be a part of daily diet of everybody and thereby beneficially affect people's health and well being. Another group of processed functional foods provide their health benefits for a special group of people. For example, foods fortified with stanol/sterol esters may reduce the total cholesterol and low density lipoprotein cholesterol level [10]. Moreover, these products may even have additive effects when combined with cholesterol lowering medicines [11]. So these kinds of products are used by people who have some health problems like high cholesterol and consumers should be cautious when using these kinds of functional foods. They need to know the nutritional components of functional foods in order to make healthful eating choices and decrease the incidence of chronic diseases.

Although functional foods offer potential health benefits, consumers should also consider the overall quality of their diet, since poor whole-diet quality is associated with diet-related diseases such as obesity, cancer, type 2 diabetes, and cardiovascular diseases (CVD) [12].

Table 1. Examples of functional components

Functional Components	Source	Potential Benefit
Carotenoids		
Beta-carotene	Carrot, pumpkin, sweet potato, cantaloupe	Neutralizes free radicals which may damage cells; bolsters cellular antioxidant defenses; can be made into vitamin A in the body
Lutein, zeaxanthin	Kale, collards, spinach, corn, eggs, citrus	May contribute to maintenance of healthy vision
Lycopene	Tomato and processed tomato products, watermelon, Red/pink grapefruit	May contribute to maintenance of prostate health
Dietary fibres		
Beta glucan	Oat bran, rolled oat, oat flour	May reduce risk of coronary heart disease (CHD)
Soluble fibres	Psyllium seed husk, pea, bean, apple, citrus fruit	May reduce risk of CHD and some types of cancer
Whole grains	Cereal grains, whole wheat bread, oatmeal, brown rice	May reduce risk of CHD and some types of cancer; may contribute to maintenance of healthy blood glucose levels
Insoluble fibre	Wheat bran, corn bran, fruit skins	May contribute to maintenance of a healthy digestive tract; may reduce the risk of some types of cancer
Fatty acids		
Monounsaturated fatty acids (MUFAs)	Tree nuts, olive oil, canola oil	May reduce risk of CHD
A-Linolenic Acid (ALA)	Walnut, flax	May contribute to maintenance of heart health; may contribute to maintenance of mental and visual function
Docosahexaenoic acid/ Eicosapentaenoic acid (DHA/EPA)	Salmon, tuna, marine, algae, krill, and other fish oils	May reduce risk of CHD; may contribute to maintenance of mental and visual function
Conjugated linoleic acid (CLA)	Beef, lamb and some cheese	May contribute to maintenance of desirable body composition and healthy immune function
Flavonoids		
Anthocyanins, cyanidin, delphinidin, malvidin	Berries, cherry, red grape	Bolsters cellular antioxidant defenses; may contribute to maintenance of brain function
Catechins, epicatechins, epigallocatechin, procyanidins	Tea, cocoa, chocolate, apple, grape	May contribute to maintenance of heart health
Hesperetin, naringenin	Citrus foods	Neutralize free radicals which may damage cells; bolster cellular antioxidant defenses
Quercetin, kaempferol, isorhamnetin, myricetin	Onion, apple, tea, broccoli	Neutralize free radicals which, may damage cells; bolster cellular antioxidant defenses
Proanthocyanidins	Cranberry, cocoa, apple, strawberry, grape, wine, peanut, cinnamon	May contribute to maintenance of urinary tract health and heart health

Table 1. Continued

Functional Components	Source	Potential Benefit
Plant stanols/sterols		
Free stanols/sterols	Corn, soy, wheat, wood oils, fortified foods and beverages	May reduce risk of CHD
Stanol/Sterol esters	Stanol ester dietary supplements, fortified foods and beverages, including table spreads	May reduce risk of CHD
Minerals		
Calcium	Sardine, spinach, yogurt, low-fat dairy products, fortified foods and beverages	May reduce the risk of osteoporosis
Magnesium	Spinach, pumpkin seed, whole grain breads and cereals, halibut, brazil nut	May contribute to maintenance of normal muscle and nerve function, healthy immune function, and bone health
Potassium	Potato, low-fat dairy products, whole grain breads and cereals, citrus juices, bean, banana	May reduce the risk of high blood pressure and stroke, in combination with a low sodium diet
Selenium	Fish, red meat, grains, garlic, liver, egg	Neutralizes free radicals which may damage cells; may contribute to healthy immune function
Probiotics		
Yeast, *Lactobacilli*, *Bifidobacteria*, and other specific strains of beneficial bacteria	Certain yogurts and other cultured dairy and non-dairy applications	May improve gastrointestinal health and systemic immunity; benefits are strain-specific
Prebiotics		
Inulin, Fructo-oligosaccharides (FOS), Polydextrose	Whole grains, onion, some fruits, garlic, honey, leek, fortified foods and beverages	May improve gastrointestinal health; may improve calcium absorption
Soy protein		
Soy protein	Soybean and soy-based foods	May reduce risk of CHD
Vitamins		
Vitamin A	Organ meats, milk, egg, carrot, sweet potato, spinach	May contribute to maintenance of healthy vision, immune function, and bone health; may contribute to cell integrity
Vitamin C	Guava, sweet red/green pepper, kiwi, citrus fruit, strawberry, fortified foods and beverages	Neutralizes free radicals which may damage cells; may contribute to maintenance of bone health and immune function
Vitamin E	Sunflower seed, almond, hazelnut, turnip green, fortified foods and beverages	Neutralizes free radicals, which may damage cells; may contribute to healthy immune function and maintenance of heart health

Source: IFIC, 2009; Tur *et al*., 2012.

1.2. Functional Food's Market

Regarding to the health message of functional foods, the market for these products has been growing steadily [13,14]. Because of the inconsistence of an internationally accepted definition of functional foods, it is very challenging to access reliable numbers describing the world-wide functional food markets. The demand for functional foods varies from country to country, on the basis of the eating habits, the enforced legislation and the culture. The biggest functional food markets are in Japan and the US, whereas, the European markets far behind them [13,15]. The current market share of functional food in Europe is still below 1% of the total food and drink market [9]. Germany, France, the United Kingdom and the Netherlands have a higher consumption of functional foods than other European countries [13], and Germany had half of the companies in the European market for functional food in 2004 (Figure 1.1) [16].

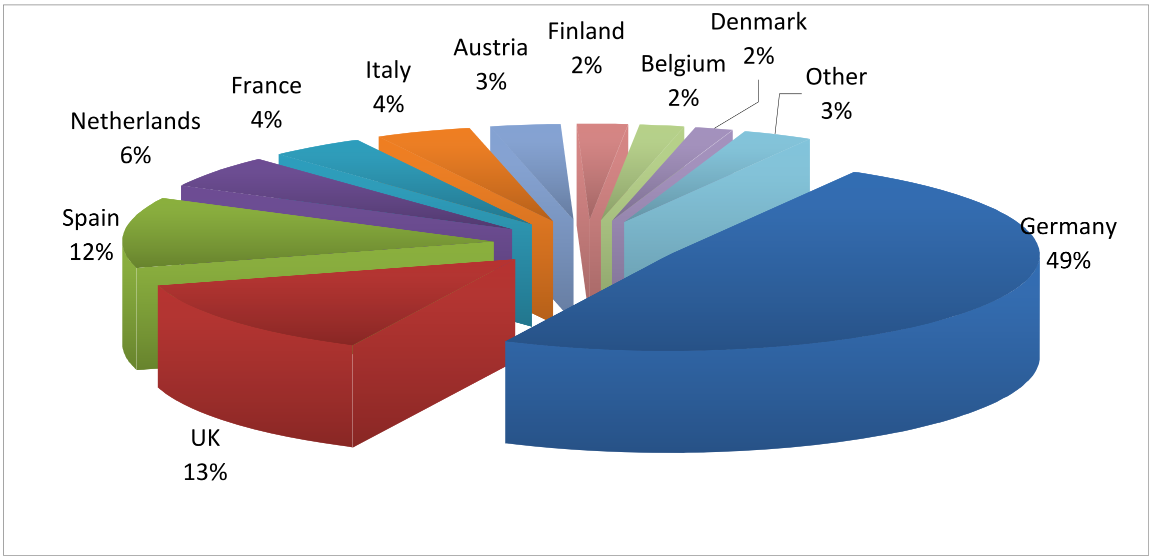

Figure 1.1. Percentage of companies in the European market for functional food in 2004 [Source: Stein and Rodriguez-Cerezo, 2008]

The markets for functional foods are increasing and new products are being launched continuously and competition is becoming more intense [13]. Developing and marketing a functional food is different than a conventional one, because development of a functional food needs scientific proves so different specialist like nutritionist, food technologist are involved to the development and production [17]. Moreover, marketing considers big importance to inform consumers about the health effect of functional foods.

The distribution of functional food products in the market is not homogeneously scattered over all food categories and the most prominent types of functional foods are mainly in the dairy and beverage market in the world. Similarly, we observed that high percentage of the populations of different countries in all over the world consume dairy products (low-fat/skimmed milk, probiotics), vitamin or mineral fortified juices, coffee and tea [12]. On the other hand, less than 10% of the populations of these countries consume cholesterol lowering products [12].

The European functional food market mainly focuses on gut and intestinal health and also cholesterol levels [16]. Moreover, beverages enriched with vitamin A, C or E are successful functional foods in the European market (Figure 1.2) [16].

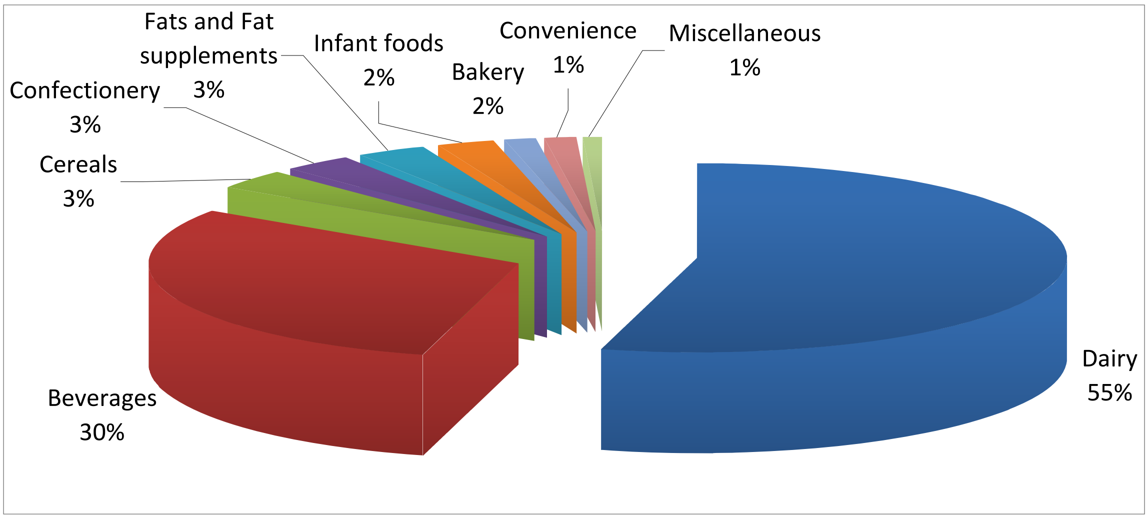

Figure 1.2. Functional food products in the European market in 2004, by sectors [Source: Stein and Rodriguez-Cerezo, 2008]

In Spain (the Canary Islands) the distribution of functional food consumption is different than in overall Europe (Figure 1.3.). In the Canary Islands functional beverages and condiments are the most popular functional foods [18]. More than 40% of the population in the Canary Islands consumes functional beverages and around 40% of the population consumes condiments [18]; whereas, only 30% of the population consumes functional milk products [18].

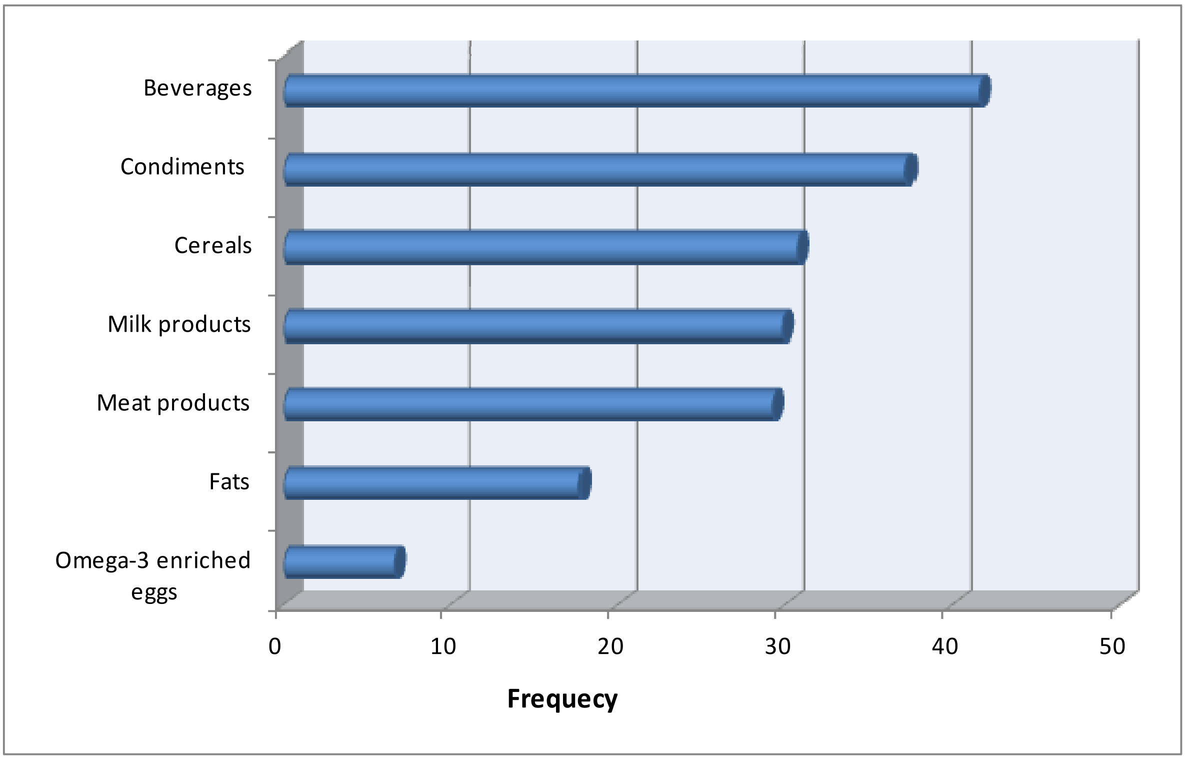

Figure 1.3. Functional food consumption in the Canary Islands [Source; Núñez-González *et al.*, 2011]

1.3. Acceptance of Functional Foods

Increase in life expectancy, desire for higher life quality, and rising costs of health care direct individuals to health-improving foods and beverages [5] and in this regard, functional foods play an important role and offer a new kind of health message by promising specific effects caused by particular food components [19].

For the food scientists and industry, it is important to understand consumer attitudes towards to functional foods to develop and offer functional foods which meet the consumer demands. Several studies carried out on functional foods have focused on consumer trends [10,11,20,21], consumer attitudes towards functional foods [9,22] and their possible health effects [23-26].

The socio-demographic variables such as gender [24,26,27], age [21], education [10] and health claim [21], influence the consumer attitudes towards functional foods. Generally females are more interested in functional foods than males [24,26,27] and different products can be attractive for one or the other gender [11,28].

Age is another important factor which influences the consumers' choice for functional foods. Older people prefer to consume functional foods due to their disease preventing effect because they are suffered from disease more frequently [21]. Education is another factor contributing to healthy eating and functional food users have a higher education level than the non-users [10].

Effects of functional foods on health and well-being are other significant predictors which are impacted on the willingness to use functional food. Diet related problems like high cholesterol, high blood pressure and diabetes cause an increase in the consumption of functional foods [24]. People with CVD also prefer to consume cholesterol lowering margarine to obtain a health effect [29]. In a study conducted in six European countries (France, Germany, Great Britain, Italy, Poland and Portugal), it was reported that almost half of the populations consume functional foods to obtain a cholesterol-lowering effects and blood sugar and weight reduction are the other most common reasons to use functional foods [29].

Consumers' acceptance and attitude towards functional foods determine the markets size and success. Especially in the early phases of the functional foods market, consumers have often been suspicious about 'unnaturalness' of functional foods because their production needs high technology to remove, add or modify bioactive components. This has brought the risk that functional foods are perceived as being less natural than conventional products and thus avoided by those who value naturalness in food choices [17]. However, the reactions of the consumers have changed in a positive way after their awareness towards functional foods has increased [30].

Acceptance of functional foods varies from country to country. While Americans accept and consume functional foods more easily; Europeans' approaches are more critical [31] and questioning of functional foods [23]. Furthermore, acceptance of functional foods in Europe is heterogeneous and there are large regional differences in use of them [9]. In general, the interest of consumers in functional food in the Central and Northern European countries is higher than in Mediterranean countries [13]. This can be true if we consider only processed functional food consumption. On the other hand, great richness and diversity of plants in the Mediterranean region provide numerous functional foods [32]. In addition to functional foods, the Mediterranean diet is rich in functional components like phenols, flavonoids, isoflavonoids, phytosterols, phytic acid and omega-3 fatty acids [32]. As a whole, the Mediterranean diet is a good example of functional diet [33].

In addition to consumer's acceptance, attitudes toward functional foods also differ from the US to Europe. Bech-Larsen and Grunert, [34] reported that Danish consumers have more negative attitudes toward functional foods than American and Finnish consumers. By contrast, the Finnish consumers have the most positive attitudes toward functional foods. Labrecque *et al.*, [22] reported that awareness of functional foods is lower among French consumers than those of American and Canadian consumers.

1.4. Functional Foods in the Mediterranean Diet

The Mediterranean diet describes the dietary pattern in the olive-growing areas of the Mediterranean region [35] and varies among different cultures, traditions and geographic locations [36,37]. High consumption of plant origin foods such as, cereals, legumes, fruits and vegetables in this dietary pattern provide protective effects on well being [38].

There are many standpoints to explain the health benefits of the Mediterranean diet such as high consumption of vegetables and fruits, high intake of olive oil or high intake of antioxidants [39,40]; although, it is clear that great varieties of foods in the Mediterranean diet improve the health status and also reduce the risk of many diseases [38-42]. Besides, numerous functional foods like olive oil, garlic, tomato, wine, herbs, spices and nuts are abundant in the Mediterranean diet and these foods inherently contain and functional components like phenols, flavonoids, isoflavonoids, phytosterols and phytic acid [33].

The traditional Balearic diet is one of the examples of Mediterranean diet [43] and offers several unprocessed functional foods and functional components like unrefined cereals and cereal products, fruits and vegetables rich in antioxidants, vitamins, minerals, and phytochemicals [44,45]. Whole grain cereals and cereal products contain a high amount of dietary fibre and both soluble and insoluble dietary fibres play an important role in satiety and energy metabolism [42], and a high intake of whole-grain foods may reduce the risk of heart disease, type 2 diabetes and various types of cancer [42,46-48]. Moreover, whole grains contain bran and germ which are rich in micronutrients and phytochemicals [46].

Other dietary fibre sources in the Mediterranean diet are fruits and vegetables which provide many kinds of vitamins. Diets rich in fruits and vegetables are associated with a reduced risk of heart disease and a lower risk of obesity [49,50]. Bes-Rastrollo *et al.*, [51] indicated that fruit and vegetable consumption helps to avoid weight gain due to the high fibre content of these foods. Also Food and Drug Administration (FDA) reported that consumption of fibre rich foods like cereals or fruits and vegetables with low fat diet might reduce the risk of some types of cancer, and furthermore, the intake of soluble fibre may reduce the risk of heart disease [52]. Moreover, fruits and vegetables provide micronutrients such as carotenoids, Vitamin E, ascorbic acid and polyphenols known for their antioxidant effect [45,48].

In the Mediterranean diet the main source of fat intake is olive oil which is low in saturated and n-6 fatty acids but high in monounsaturated fatty acids (MUFA) [53]. Oleic acid the major polyphenol and many other components of olive oil have beneficial health effects on the cardiovascular system [39]. Moreover, other phenolic compounds and also vitamin E prevent cancer via their antioxidant capacity [54].

Nuts like almond, walnut, hazelnut, cashew nut are parts of the Mediterranean diet and they provide phenols, phytosterols, vitamin E, which reduce the risk of several chronic diseases [55]. Nuts also contain a high amount of MUFA and a diet high in MUFA reduces the total and high density lipoprotein (HDL) cholesterol [56]. Moreover, walnut and walnut oil is a good source of alpha-linoleic acids (ALA) which improves the insulin sensitivity and has a hypotensive effect [8]

Herbs and spices have important roles in the traditional Mediterranean kitchen. Bioactive components in herbs and spices have an impact of oxidative modification of low-density lipoprotein (LDL) cholesterol in the development of atherosclerosis because of their antioxidant properties [57].

2. Beverages

2.1. Beverage Consumption

Nowadays, the food industry offers several kinds of beverages, while in our early ancestors' diet only water and breast milk were the main water sources [58]. Fluid intake, especially water is essential for human life, necessary for physical and mental function [59,60]. Furthermore, water loss causes some health problems (Figure 2.1). While mild dehydration defined as a 1 to 2% loss of body weight caused by fluid loss [61] may cause functional impairments, moderate dehydration may cause coronary heart disease (CHD) and CDV [62].

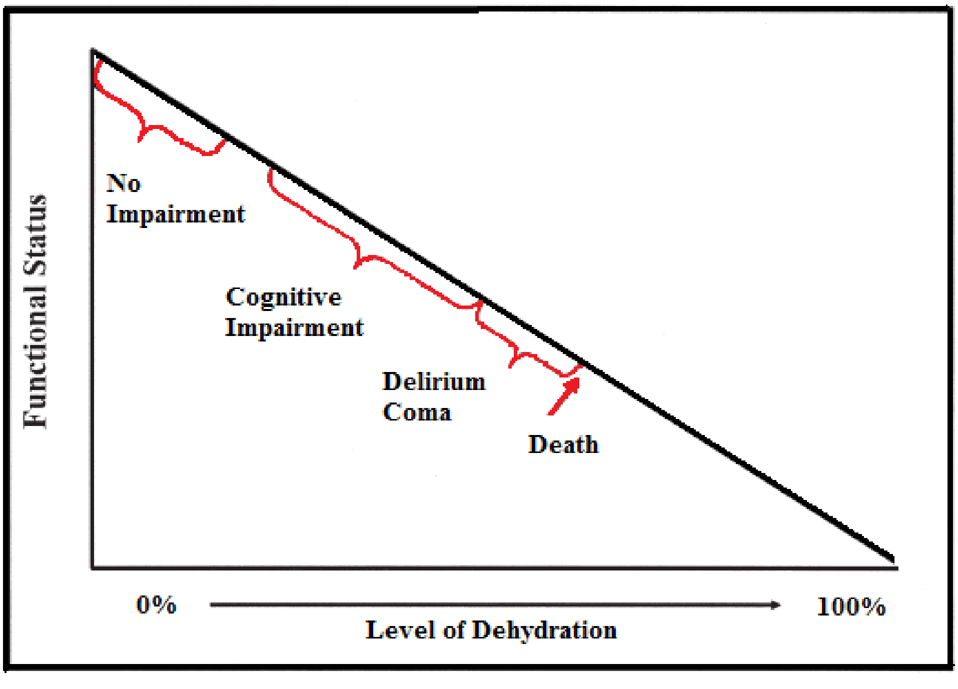

Figure 2.1. Effect of dehydration to functional status (Source: Lieberman, 2007)

Despite the importance of water, only a few countries consider water as a nutrition [59,62,63] and approaches to the estimation of water requirements are unclear [59,62,63]. Variability in total body water and dehydration prevents to generalize a recommended daily water intake. Several factors affect water needs such as, the thirst mechanism [64], gender, age, physical activity [64], body size [59], climate [63], food habits and the level of respiration [60].

A better understanding of the many factors that influence beverage consumption levels is needed. Total daily beverage consumption and beverage choices are strongly related with gender and age. Knowledge of differences in beverage intake is important for food and nutrition policymakers.

Previous studies showed that while the drinking water is still the main source of water in the diet of all age groups [65-70], the consumption of other beverages is varied according to age groups. Shifts in beverage consumption of children and adolescents with the age have been observed in many countries [65,66,68,69]. While children prefer to drink milk, adolescents prefer to consume soft drinks [65,67,68,71] and adults prefer to consume tea/coffee and alcoholic beverages [66,67,69].

The European Food Safety Authority (EFSA) determined an adequate intake (AI) of water for children as 1.3 L/day for boys and girls 2-3 years of age, 1.6 L/day for boys and girls 4-8 years of age, 2.1 L/day for boys 9-13 years of age, and 1.9 L/day for girls 9-13 years of age; for adolescent/adult (14 years and older) as 2.0 L/day for females and 2.5 L/day for males [72]. In the previous studies, total relative beverage intake varies between 0.8 L/d and 2.6 L/d among age groups [65-70] but they do not reach the recommended AI of fluids [72]. Beside this, the proportion of water in the average diet has diminished over time as individuals have shifted consumption patterns to a range of beverages that contain either one or many of the following: sugar, caffeine, natural and artificial flavourings, non-nutritive sweeteners, and carbonation [73].

2.2. Beverage Consumption and Nutrition Intake

Shifts in beverage consumption during the last decades have affected overall nutrition intake. Less nutritious beverages replaced nutrient dense drinks like milk or natural fruit juices [74-76] and the consumption of sugar sweetened beverages affects the intake of various nutrients adversely. The intake of many minerals such as calcium, magnesium, iron and vitamins such as vitamin A, K and riboflavin has decreased [77]. A cross-sectional study of Crete children aged 4-7 years, reported that the consumption of high amounts of sugar sweetened beverages caused a decrease in milk and yogurt consumption and also calcium and vitamin A intakes [78]. Moreover, a positive association between high intake of sugar sweetened beverages and poor eating habits, inadequate nutrient intake, and risk for developing childhood obesity is reported [78]. Another cross-sectional study found that consumption of milk is associated with adequate intakes of multiple nutrients, such as calcium and vitamin D, while consumption of sugar sweetened beverages and 100% fruit juice was negatively associated with adequate intakes of multiple nutrients and overall diet quality [79].

Consumption of milk is essential for calcium intake which is important for bone development in children and adolescents’ diet; however, replacing milk with sugar sweetened beverages results in a decrease in calcium intake and adverse effects on bone health [80-82]. In addition to the calcium intake, a high consumption of sugar sweetened beverages affects the intake of various nutrients and the diet quality of children and adolescents [77-79].

Furthermore, beverage consumption is related with dietary patterns. People with unhealthy dietary patterns like the Western diet engage to unhealthy beverage patterns like a high consumption of sugar sweetened beverages [75,83].

2.3. Energy Intake from Beverages

Several studies carried out beverage consumption have focused on sugar or energy intake from sugar sweetened beverages because of the potential negative health effects of high consumption of these beverages [84]. The World Health Organization (WHO) recommends a diet in which refined sugar contributed 10% of the total energy intake [85]; however, many studies have reported an increase in sugar sweetened beverage consumption [74,86]. Thus the energy intake from sugar has increased. In Germany 6% of the total energy intake is contributed by sugar added beverages [77] and in the USA the energy contribution of sugar added beverages and natural fruit juice to the total energy intake is 10.7% [87]. Similar to these results, the percentage of total energy intake from sugar added soft drinks is 7.5% in Australian adolescents [88]. In Mexico sugar sweetened beverages contribute 6.7% (at ages 1 to 4) and 9.4% (at ages 5 to 11) of the daily total energy intake of children [69], while beverages contribute 13% of the total energy intake of adolescents [69].

Moreover, several studies show that sugar sweetened beverage intake does not affect the food intake. Because of low satiety of these beverages the food consumption does not reduce [58]. Therefore, it appears that individuals consuming beverages before or during the meal take the same amount of calories as individuals consuming energy free beverages. The increase in energy intake may lead to the increase in prevalence of overweight. A cross-sectional study on Australian children and adolescents [88] found no association between sugar sweetened beverage consumption and overweight. Similarly, Libuda *et al.* [80], using data of DONALD study, found no association between sugar sweetened beverage consumption and BMI and also the percentage of body fat, and reported a positive association between sugar sweetened beverage consumption and BMI of adolescent girls [9]. No differences were observed between the BMI of heavy, medium or non-consumers of sugar sweetened beverages [89], and no association between sugar sweetened beverage consumption and BMI [89]. From NHANES data, an increase in consumption of milk, 100% fruit juice, fruit drinks and soda resulted in a higher total energy intake; however, no association between the consumption of these beverages and BMI of children was found [89]. One small cross-sectional study in London reported no association between sugar sweetened beverage consumption and BMI of children at ages 9 to 13 years [90] however, many other longitudinal or cross-sectional studies reported a significant positive association between the consumption of sugar sweetened beverages and overweight [91-93].

In contrast to sugar sweetened beverages, water intake before or with the meal reduce the sensation of hunger and thus energy intake [73,84]. A high amount of whole milk consumption causes an increase in energy intake as well as cholesterol and dietary fat intake [84]. So the consumption of low fat or skimmed milk instead of whole milk is more beneficial.

2.4. Beverage Consumption and Health Effects

Milk

Milk and milk products are important components of the Western diet. Especially in children's diet, milk is the current key source of vitamin D and calcium. Moreover, milk is rich in magnesium, potassium, zinc, iron, vitamin A, riboflavin and high-quality proteins [94]. On the other hand, whole milk contains saturated fats and trans-fatty acids which may increase the risk of CVD [95,96]. Therefore, instead of whole fat milk, the consumption of low fat or skimmed milk should be promoted. Beside milk, fermented milk drinks are another nutritious dairy beverage in our diet. These beverages contain lower amounts of lactose than milk does and may be consumed by lactose intolerance individuals. Furthermore, fermented milk beverages contain probiotic microorganisms which may enhance the gut flora and the immune system [97].

In addition to provide many nutrients in our diet, the consumption of milk and milk products has many health benefits. Because of the high calcium content of milk, the consumption of milk is directly related with bone health [98]. Especially during childhood and adolescence milk consumption combined with physical activity is important for bone development [99]. Calcium and proteins in milk composition have also beneficial effects on blood pressure [95]. The consumption of dairy products may reduce the risk of type 2 diabetes and some cancers [98-101].

Coffee and Tea

The consumption of infusions such as coffee and tea is associated with a lower risk of type 2 diabetes and CHD [102]. Caffeine which causes alertness and mood change is another important component of coffee and tea [103]. A regular coffee consumption decreases the risk of type 2 diabetes [94], while regular tea consumption may cause a reduction in CVD risk [94]. Furthermore, coffee and tea contains phenolic compounds which show antioxidant properties in both in vitro and in vivo studies [50]. The consumption of coffee and tea without sugar does not affect the energy intake; however, the addition of sugar to the infusions may cause an increase in energy intake [82].

Fruit and Vegetable Juices

Fruits and vegetables are major dietary sources of vitamin C, A and folate and they contain phytochemical components which may have protective effects on CVD and some cancers [104]. Juices from fruits and vegetables are also containing numerous nutrients such as; vitamins and dietary fibres; however, a relatively high energy content of natural fruit juices may cause obesity in high consumptions [105]. On the other hand, vegetable juices provide a lower amount of energy than fruit juices do.

The abundance of citrus juices in the Mediterranean diet may provide one of the main antioxidant; vitamin C. Additionally citrus juices contain phytochemicals, mainly flavonoids which counteract oxidative damage and may modulate the activity of enzymes that detoxify carcinogens in the body that may lead to the formation of CVD and cancer [106].

Sugar Sweetened Beverages

Consumption of sugar sweetened beverages may cause an increase in energy intake and also body weight [107]. Additionally, a high consumption of sugar sweetened beverages is associated with other medical disorders. A higher consumption of these beverages has been found to be linked with the development of the metabolic syndrome and type 2 diabetes. A high consumption of these beverages may increase the risk of metabolic disorders not only through obesity, but also by increasing dietary glycemic load and insulin resistance [108]. Another study also confirmed that sugar-sweetened beverage consumption causes an increase in the risk of the metabolic syndrome and type 2 diabetes [109]. It affects inversely bone mineral density and causes an increase in systolic and diastolic blood pressure [109].

Alcoholic Beverages

A moderate level of alcohol consumption has been linked with some health benefits. Moderate alcohol intake is 30g/d for men and 20g/ for women and these values lower the risk of CHD [110,111].

Consumption of red wine is common in the traditional Mediterranean diet [38]. Compared to other alcoholic beverages red wine offers more health benefits. In the wine production during the fermentation process a variety of chemical changes occurs and aging alters the composition, so wine is more than an alcoholic beverage. Phenolic compounds in red wine may prevent the oxidation LDL and is linked with reduction of certain cancers [112].

Sport Drinks

Sport drinks are very beneficial beverages during or after vigorous exercise. Water and mineral loss during physical activity may be replaced by the consumption of isotonic beverages [113,114].

2.5. Beverage Consumption in Spain

According to an online survey of a market research company the average daily beverage intake for Spanish population aged 15-55 years, is 9 servings and drinking water is the premier water supply of the majority [115]. Soda is also consumed by a very high proportion of the population (Figure 2.2) like in Mexico [69] and the USA [116].

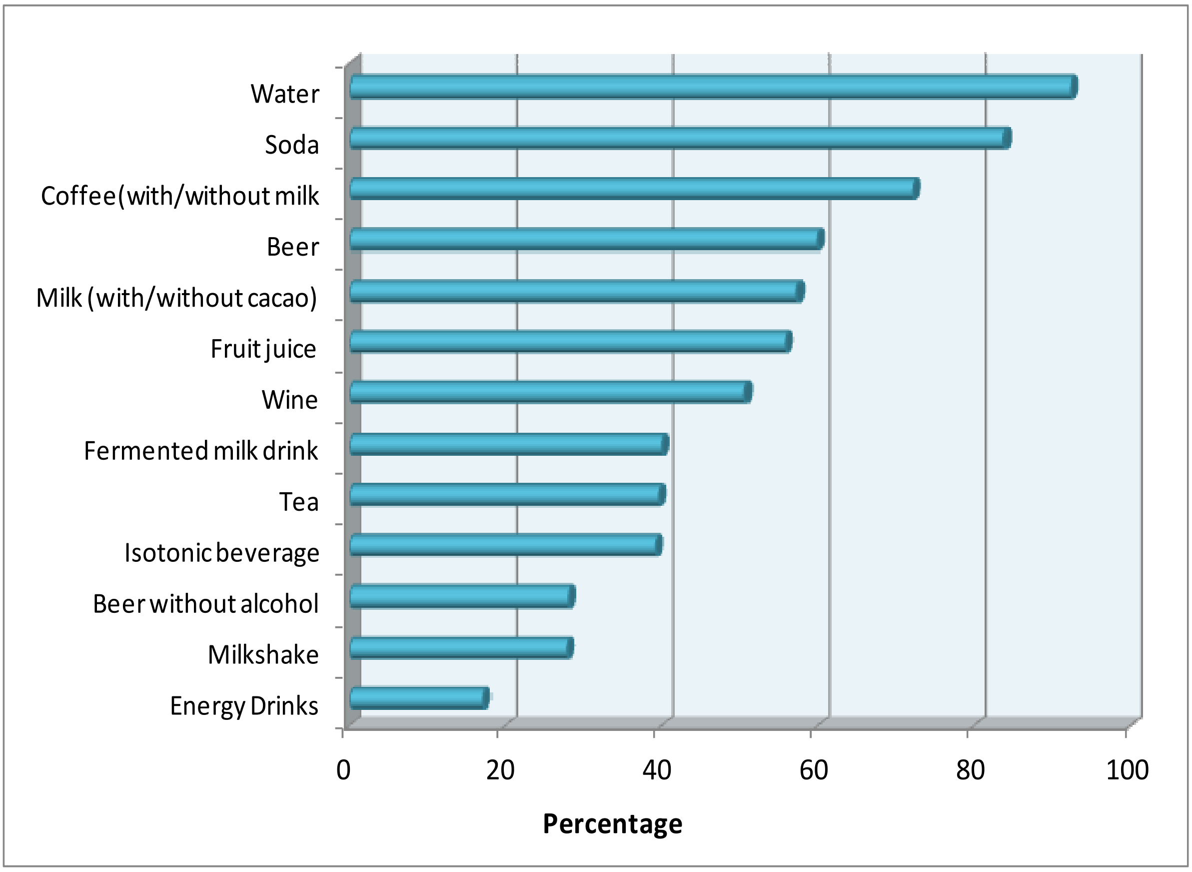

Figure 2.2. Beverage consumption in Spain [Source: Valero *et al.,* 2011]

In the Spanish population the consumption of soft drinks has risen and the consumption of sugar-sweetened soft drinks has grown by 21% from 1991 to 2001 [83,117]. Changes in beverage consumption are directly related with the transition in dietary habits. Consumers of sugar sweetened beverages follow a Western Dietary Pattern (WDP), whereas, Spanish people who have a high adherence to the Mediterranean diet prefer to consume beverages like natural fruit juices, low fat milk or decaffeinated coffee [83].

The alcoholic beverage consumption pattern has changed in Spain during the last decades. In the mid-1960s two third of the alcohol was consumed as wine in Spain; whereas, the consumption of distilled spirits has increased after 1960 [118]. Spain is a Mediterranean country and one of the characteristics of the traditional Mediterranean diet is moderate alcohol consumption, mainly wine and during meal [37]. While in other Mediterranean countries like France [119] and Italy [120,121] wine consumption is still high in Spain wine is consumed by only 39.5% of the population [122]. Beyond that drinking habit is moving away from the traditional Mediterranean norm to the drinking habits of Central European countries in where people consume alcohol through different contexts than meal [118].

OBJECTIVES

Food choice is a complex behaviour and influenced by many factors. Mainly it is driven by physiological and nutritional needs but also socio-demographic and lifestyle factors. So it is important to determine the relationship between dietary intake and socio-demographic and lifestyle factors. Beyond this, increase in the burden of diet related diseases such as obesity, cancer, type 2 diabetes and cardiovascular diseases has directed the scientists to find out the relation between food and beverage consumption and these diseases.

While consumption of energy dense, nutrient low foods and beverages is thought to be the main reason for diet related diseases, healthy eating has become prominent. Moreover, functional foods beyond basic nutrition may prevent some diseases or improve one's health status. It is important to find out the factors that affect the functional food consumption of different populations. So this study examined this issue by analysing socio-demographic and lifestyle differences in functional food consumption among both adults and adolescents in the Balearic Islands. The relation between functional food consumption and intake of functional components and nutrients intake was investigated.

Beverage consumption has become one of the popular study subjects and in the last decades many studies have focused on beverage consumption especially sugar sweetened beverage consumption. High intake of sugar sweetened beverages might be linked with overweight and also inadequate intake of macro and micronutrients. Examine the socio-demographic and lifestyle differences in beverage consumption and the association between beverage consumption and nutrient intake were other aims of this study.

1. Overall Aim

The overall aim of this thesis is to investigate demographic and lifestyle characteristics associated with the consumption of functional foods and beverages among the Balearic Islands population.

2. Sub-aims

The specific aim for each study was:

i. To explore the consumption of functional foods among a Mediterranean adult and adolescent population and assess differences between the socio-demographic and lifestyle determinants such as age, gender, economic level and physical activity.

ii. To investigate differences in the adherence to the Mediterranean diet between the consumers and non-consumers of functional foods among the adult population of the Balearic Islands and compare the consumption of functional foods and intake of functional components between functional food users with high adherence to the Mediterranean diet and low adherence to the Mediterranean diet.

iii. To identify beverage patterns of the adult population in the Balearic Islands by using cluster analysis and to assess the association among beverage patterns with socio-demographic characteristics and nutrient intake

iv. To determine the differences in the beverage consumption of adolescents according to sex and age.

- ♣ To assess whether beverage consumption was associated with gender, age, chronic diseases, body mass index (BMI) and physical activity
- ♣ To examine the effects of beverage consumption on nutrient intake and diet quality

v. To identify beverage patterns of the adolescent population in the Balearic Islands by using cluster analysis and to assess the association among beverage patterns with socio-demographic characteristics and nutrient intake

vi. To examine the determinants of physical activity level and assess the relation between beverage consumption and physical activity level among the adult and adolescent population.

Material and methods

1. Study design

The study was carried out as a part of the Obesity and oxidative stress / Obesidad y estrés oxidativo) and OBIB (Obesity in children and adolescents in the Balearic Islands / Obesidad Infantil y Juvenil en las Islas Baleares) projects which were population based cross-sectional nutritional surveys. In the OBEX project the data collection took place between 2009 and 2010 and in the OBIB project the data collection took place between 2007 and 2009 in the Balearic Islands.

2. Study population

2.1. Adult population

The target population were consist of all inhabitants living in the Balearic Islands, and the sample population derived from residents aged 16-65 years registered in the official population census of the Balearic Islands [123]. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomization into subgroups, with the Balearic Islands municipalities being the primary sampling units, and individuals within these municipalities comprising the final sample units. The theoretical sample size was set at 1500 individuals and the one specific relative precision of 5% (type I error = 0.05; type II error = 0.10), and the final sample was 1386 (92.4% participation). Pregnant women were not considered in this study.

2.2. Adolescent population

The data collection took place in the Balearic Islands and the sample population was derived from residents aged 11-18 years, registered in the scholar census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomization into subgroups, with the Balearic Islands municipalities being the primary sampling units, and individuals within the schools of these municipalities comprising the final sample units. The interviews were performed at schools. The final sample size was 1988 individuals (98% participation). The reasons not to participate were: the subject declined to be interviewed or the parents did not authorize the interview.

3. Global questionnaire

A global questionnaire incorporating questions related to demographics, socio-economic status, education level and lifestyle factors was utilized.

3.1. Adult population

A questionnaire incorporating the following questions was used: age group (16-25, 26-45 and 46-65 years old); marital status; educational level (grouped according to years and type of education: low, <6 years at school; medium, 6-12 years of education; high, >12 years of education) and socio-economic level (classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology) [124].

Information about smoking habits and alcohol consumption was collected and grouped as: non-smoker, ex-smoker, smoker, and non-drinker, occasional drinker, daily drinker and alcoholic.

3.2. Adolescent Population

A questionnaire incorporating the following questions was used: age group (11-13, 14-15 and 16-18 years old), father's and mother's education level (grouped according to years of education: low, <6 years at school; medium, 6-12 years of education; high, >12 years of education), father and mother socio-economic level, based on the occupation of parents and classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology [124].

Information about smoking habits, alcohol consumption and daily time spent watching TV was collected and grouped as: non-smoker, occasionally smoker and smoker; and non-drinker and drinker; less than 1 h, 1-2 h and more than 2 h.

4. Anthropometric measurements

Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France) with subjects wearing light clothes without shoes, respectively. BMI was computed as weight/height^2.

Adults were categorized as normal-weight (≤24.9 kg/m^2), overweight (≥25 kg/m^2 ≤29.9 kg/m^2) and obese (≥30 kg/m^2) according to SEEDO BMI standards [125].

Adolescents were categorized as underweight (≤5th percentile), normal-weight (>5th ≤85th percentile), overweight (>85th percentile) and obese (≥95th percentile) according to WHO BMI standards [126].

5. Physical Activity Assessment

5.1. Adult Population

Physical activity was evaluated according to guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [127] in the short form. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at work), vigorous-intensity activities (i.e. sport practice) and sitting time (used as an indicator variable of time spent in sedentary activity). Weekly minutes of walking, moderate-intensity and vigorous-intensity activity were calculated separately by multiplying the number of days/week by the duration on an average day. Reported minutes per week in each category were weighted by a metabolic equivalent (MET) and physical activity computed by multiplying METs by min/w and expressed in MET-min/w. MET-values for different level activities were established based on the Compendium of Physical Activities [128] and were set as 3.3 MET for walking, 4 MET for moderate-intensity physical activity and 8 MET for vigorous-intensity physical activity. On the basis of their total weekly time of physical activity, the subjects were divided into 3 groups: "low", "moderate" and "high" levels of physical activity.

- Low: Meets neither 'moderate' nor 'high' criteria.
- Moderate: Meets any of the following three criteria:

  (a) 3 or more days of vigorous-intensity activity of at least 20 min/day;

  (b) 5 or more days of moderate-intensity activity/walking of > 30 min/day;

  (c) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 600 MET-min/w.
- High: Meets either of two criteria:

  (a) vigorous-intensity activity on 3 or more days/week and accumulating at least 1500 MET-min/week;

  (b) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 3000 MET-min/w [127].

5.2. Adolescent population

Physical activity was evaluating according to the guidelines for data processing and analysis of the IPAQ [127] in the short form, and its specific modification for adolescents (IPAQ-A) [129]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice), and an additional question about sitting time was used as an indicator variable of time spent in sedentary activity. On the basis of their total weekly physical activity (at least 60 minutes of physical activity per day on at least 5 d/w), the subjects were divided into 2 groups: inactive (<300 min/w) and active (≥300 min/w), according to the current physical activity recommendations [130].

6. Assessment of food, beverage and energy intake

Dietary questionnaires included two non-consecutive 24-h diet recalls and a validated quantitative food frequency questionnaire (FFQ) [131] covering the 145-item (118 of the original validated FFQ plus the most characteristic Balearic Islands foods in order to make the interviewee answer easy) [132]. Frequency of food consumption was based on times that food items were consumed (per day, week or month). Consumption <1/month was considered no consumption. Daily consumption (g) was determined by dividing the reported amount of the intake by the frequency (d). To prevent seasonal variations 24-h dietary recalls administered in the warm season (May-September) and in the cold season (November-March). To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. Well-trained dieticians administered the recalls and verified and quantified the food records. Volumes and portion sizes were reported in natural units, household measures or with the aid of a manual of sets of photographs [133]. Total nutrition and energy intake (TEI) were calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [134,135] and European Food Composition Tables [134], and complemented with food composition data available for Balearic food items [137].

Functional foods, which were selected according to the functional food list reported by Hasler [52] were taken from the dietary questionnaires. Moreover, low/reduced fat milk, coffee, black tea, fruit juice and soy milk were considered as functional food in this review, because various studies reported that these foods might reduce the risk of some diseases [49-52,101,103,112,137-141].

The daily mean intake of functional components (selenium, zinc, vitamin E, vitamin C, carotene, omega-6, omega-3, fibre, calcium, magnesium, potassium, niacin, folic acid and pantothenic acid) was also calculated by using Spanish [134,135] and European Food Composition Tables [136]. The nutritional density of each functional component was calculated dividing the average intake of these nutrients by the total energy intake (MJ) in order to avoid bias caused by different intakes of energy. Adequacy for intakes of functional components was calculated as percentage of the age-specific Recommended Dietary Reference Intakes (RDIs) for Spanish population [142] and RDI for Europeans [141] when no reference data was given for Spanish population.

Beverages were categorized in ten groups; water (tap water, bottled water, and spring water), low fat milk (low-fat and skimmed milk), whole milk, fruit juice 100% (all kinds of natural fruit juice), fruit drinks (all kinds of fruit juice sweetened with sugar), soda (all kinds of carbonated soft drinks), diet soda (low calorie carbonated soft drinks), coffee/tea (coffee, black tea and herbal tea), alcoholic beverages (wine, beer, vodka, whisky, liquor), energy/sport beverages (energy drinks, isotonic drinks) and others (carrot juice, beer without alcohol, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink, kefir, horchata, chocolate milkshake, sugar added iced tea).

7. Mediterranean dietary pattern

The Mediterranean Diet (MD) has been defined according to a previously defined score indicating the degree of adherence to the traditional MD [38,43,144,145]. This Mediterranean dietary score was converted to relative percentage of adherence using a previously described method [146]. An energy-adjusted value was obtained for each individual for the daily consumption of legumes, cereals and roots (including bread and potatoes), fruits (including nuts), vegetables, fish, meat (and meat products) and milk (and milk products). In order to score 'moderate alcohol consumption', a transformation centred at the level of consuming 30 g/d for men (30–(30–absolute alcohol intake)), and 20 g/d for women (20–(20–absolute alcohol intake)) was used to obtain the highest value for men consuming 30 g/d or women consuming 20 g/d, and progressive lower values as the consumption was lower or higher than these values. These values were associated with the lowest coronary heart disease (CHD) risk in previous studies [110,111].The alcohol consumption in adolescents must be null, and values above the reference indicate the alcohol consumption of adolescents. Information about the consumption of all the food items was obtained from the FFQ.

All the values were standardised as a Z value. A Z score expresses the difference between the individual's measurement and the mean value of the reference population (in this case, the study population) as a proportion of the SD of the reference population ((observed intake–energy adjusted intake)/SD).

The total Mediterranean dietary score was computed by adding up all the Z scores obtained for the favourable or 'more Mediterranean' dietary components (legumes, cereals and roots, fruits, vegetables, fish, alcohol and MUFA:SFA ratio) and subtracting the Z value obtained from the consumption of meat and whole milk (mainly high in fat):

$$\sum Z_i = Z_{legume} + Z_{fruit} + Z_{vegetable} + Z_{cereal\ and\ root} + Z_{fish} + Z_{alcohol} + Z_{MUFA:SFA} - Z_{milk} - Z_{meat}$$

In adolescent, all the Z scores obtained for the more Mediterranean dietary components (legumes, cereals and roots, fruit, vegetables, fish and MUFA:SFA ratio) and subtracting the Z value obtained from the consumption of meat, whole milk (mainly high in fat) and alcohol (in adolescents):

$$\sum Z_i = Z_{legume} + Z_{fruit} + Z_{vegetable} + Z_{cereal\ and\ root} + Z_{fish} + Z_{MUFA:SFA} - Z_{milk} - Z_{meat} - Z_{alcohol}$$

The Mediterranean dietary score was converted to relative percentage of adherence using the range of values of the sample. This percentage ranged from 100 (maximum adherence) to 0 (minimum adherence):

$$Adherence(Percentage_i) = \frac{\left(\sum Z_i - \sum Z_{\min}\right)}{\left(\sum Z_{\max} - \sum Z_{\min}\right)} \times 100$$

Once the percentage of adherence to the MD was calculated, the variables that could determine a higher or lower adherence were assessed.

8. Nutrition Quality Index (NQI)

The intake quality score (IQS) [147,148] for macro and micro nutrients were calculated as percentage of the age-specific RDIs. Then the nutrition quality index (NQI) [147,148] was calculated from harmonic mean of each subject’s IQS for carbohydrate, protein, calcium, potassium, magnesium, phosphorous, iron, zinc, vitamin A, thiamine, riboflavin, vitamin B6, vitamin B12, vitamin C, vitamin D, vitamin E, niacin, folic acid, and pantothenic acid.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects and, when they were under 18 years old, also from their parents or legal tutors.

RESULT AND DISCUSSION

Manuscript I

Worldwide consumption of functional foods: a systematic review

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Manuscript II

Differences in consumption of functional foods between European countries: a systematic review

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Differences in consumption of functional foods between European countries: a systematic review

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ABSTRACT

Objective: To assess differences in functional food consumption between European countries.

Design: Systematic review. The literature search was conducted in Medlars Online International Literature (MEDLINE), via PubMed© and Scopus. Twenty two studies were identified to examine the differences in functional food consumption between European countries.

Results: There are disparities between functional food consumers' percentage across European countries. While functional foods are popular in most of the European countries like Finland, Sweden, the Netherlands, Poland, Spain and Cyprus, in some countries like Denmark, Italy and Belgium they are not popular. A high percentage of adolescents in the European Mediterranean countries (Spain and Cyprus) consumed functional foods. Evaluation of functional food consumption according to gender is difficult, because results varied from study to study.

Conclusions: Functional foods have become very popular in Europe in recent years Additional studies are necessary for a better understanding the differences between European countries and to find out reasons behind the differences.

Key words: Functional foods, Europe, Systematic review

INTRODUCTION

Diet-related diseases such as obesity, cancer, diabetes and cardiovascular diseases have been increasing [1] and in this view, functional foods play an important role by reducing or preventing the risk of diseases [2]. Regarding to the health message of functional foods, markets for these products have been growing steadily [3,4]. The biggest functional food markets are in Japan and the USA; however, European markets are far behind them [3,5], and in the European functional food market, Germany, France, the United Kingdom and the Netherlands have a higher consumption of functional foods than other European countries [3].

Consumer's acceptance and attitude towards functional foods determine the markets size and success. While Americans accept and consume functional foods more easily, Europeans' approaches are more critical [6] and questioning of functional foods [7]. It has been reported that Danish consumers have more negative attitudes toward functional foods than American and

Finnish consumers [8]. By contrast, Finnish consumers have the most positive attitudes toward functional foods [5]. In addition to consumer's acceptance, the study for comparison between European and American consumer's awareness of functional foods also shows the differences between Europe and the USA. Labrecque *et al.* [9] reported that awareness of functional foods among French consumers is lower than those of Americans and Canadians. In the literature, there are studies comparing consumers acceptance and awareness of functional foods between Europeans and Americans [5,9]; however, studies evaluating the differences in the functional food consumption of European countries are scarce. The aim of the present study is to systematically review the functional food consumption in European countries.

METHODS OF THIS REVIEW

The literature search was conducted through April 2012 in Medlars Online International Literature (MEDLINE), via PubMed© and Scopus. The MeSH dictionary in PubMed was used to identify search terms for this review. The keywords used in the search were "functional food"[Major] AND ("intake"[Mesh] OR "consumption"[Mesh] OR "food habits"[Mesh], OR "diet" [Mesh]) AND ("Mediterranean"[Mesh], OR "Europe"[Mesh], OR "adults"[Mesh], OR "child"[Mesh], OR "elder"[Mesh],OR "age groups"[Mesh], OR "demography"[Mesh], OR "socio-economic factors"[Mesh]).

The selection process for the articles is shown in Figure 1. In total, 424 articles (402 via PubMed, and 22 via Scorpus) were selected by reading the title or abstract (by AEO). Among the latter, review articles, systematic reviews, articles in other languages rather than English, articles that are not conducted in Europe, articles that are not included a validated method for assessing dietary intake at the individual level and articles which are not included the number and percentage of the functional food consumers in the population were excluded (n=402). Finally, a total of twenty-two articles were chosen for the present review. Author and year of publication, age range of the population, number and gender of participants, sampling size, country in which the study was carried out and methods were collected from these articles. In addition to these data, number and percentage of the functional food consumers in each study were found. Full-text articles were assessed by 2 authors (AEO and JAT). Any matter of doubt was discussed by at least two of the reviewers (AEO, AP, and JAT).

Eleven articles [10-20] represented the functional food consumption of the population; however other studies gave information about the food consumption [21-24] or dietary patterns [25] or consumption of specific food groups [26-32] of the study population. In these studies functional foods were determined according to the definition of Diplock *et al.* [2].

RESULTS

The characteristics of the studies selected for this systematic review are shown in Table 1. In these studies the number of the participants varied from 395 [30] to 48763 [26]. The range of the response rate was 33% [26]–99% [13]. In two studies the response rate [17,20] and in one study[17] the year of the study was not mentioned. While two studies involved only men [15], and one study involved only adolescents [25], most of the studies showed an age range of 2-91 years old.

Food consumption of respondents was determined by different questionnaires. In total, five food frequency questionnaires (FFQ), one of them was validated, three validated semi-quantitative food frequency questionnaires (s-FFQ), three self-administered questionnaires (two of them were validated), one cross-sectional study, one food questionnaire, three 24-h dietary recalls, four special questionnaires and one validated closed question questionnaire were used to assess food consumption. The functional food consumption was reported in eleven studies [10-20], and seven of them showed different functional food consumption [4,12,14-17,20], whereas two of them presented consumption of stanol-enriched margarines [10,13]. In one study low-fat food consumption was reported [19] and in another study fortified food consumption was presented [18]. Two studies showed functional food consumption only in men [15,19].

Nine articles reported different food group consumption like fruits and vegetables, whole grains, or alcohol. While two studies reported fruit and vegetable intake [27,32], one study reported tea and coffee consumption [30] and two studies reported alcohol consumption [28,36]. One study reported a relationship between body mass index and food choices [23]. One study assessed the association of whole-grain intake with BMI [31], and another one reported alcohol intake and BMI relation [29]. The rest of the studies reported food patterns of the study population [21,22,24,25].

Milk and milk products

Five studies reported the consumption of low-fat/skimmed milk, milk with omega-3 fatty acid or milk fortified with calcium. In Finland while 42.3% of the respondents consumed low-fat milk only 8.8% of them consumed skimmed milk [23]; however, in Belgium only 7.4% of the respondents consumed low-fat milk [19] (Table 2). Total percentage of the adults who consumed low-fat/skimmed milk in Finland was higher than those in Spain in where only 30% of the adults consumed functional milk products like milk low in lactose, milk products low in fat or milk enriched with vitamins and/or minerals [20]. In Italy functional milk products consumption (milk with omega-3 fatty acids) was lower than in Finland, Belgium and Spain, only 5% of the adults consumed milk with omega-3 fatty acids [17]. In one study, semi skimmed milk consumption of adolescents was investigated, and reported that 66% of the boys and 69.5% of the girls consumed low-fat milk in Cyprus [25].

Consumption of fermented milk products was reported in nine studies. Finland had the highest consumption percentage of fermented milk products, 91.6% of the respondents consumed sour milk [23]. Also in Sweden probiotic milk products were consumed in high ratio (55.9%), while yogurt with muesli was consumed by only 6.9% of the respondents [14]. De Jong *et al*. [12] reported that 32.4% of the Dutch respondents consumed yogurt enriched with lactic acid bacteria and Wadolowska *et al*. [16] reported that 20% of the Polish respondents consumed probiotic yogurt drinks; however in Italy [17] and Belgium [15], fermented dairy products were not popular. While in Italy 12% of the respondents consumed probiotic yogurt, in Belgium less than 5% of the respondents consumed these products. In Belgium, 17.3% of the respondents consumed low-fat yogurt [19]. Lazarou *et al*. [25] reported that 43.5% of the children consumed yogurt in Cyprus, while in Spain almost 50% of the children consumed yogurt [22,24].

Infusions

Coffee and/or tea consumption was reported in three studies. In Finland the coffee and tea consumption was higher than in other countries and no gender difference was reported [23]. Coffee consumption, especially decaffeinated coffee, also in Italy was high. Coffee with caffeine was consumed by 61% of Italian respondents; almost 92% of them consumed decaf coffee [30]. While almost 70% of the male respondents consumed tea in Italy [30], 29.8% of the male respondents in Belgium consumed black tea [15].

Cholesterol-lowering products

Consumption of cholesterol lowering products [phytosterol/-stanol-enriched foods] was reported in six studies. Cholesterol lowering margarine/drinks were a popular functional food in Belgium, Sweden, Poland and Spain where the percentage of consumption were 26.3% [15], 28.2% [14], 20% [16] and 17.7% [20] respectively; however, in Finland and the Netherlands cholesterol lowering products were consumed by 4.6% [10] and 6.6% [12] of the respondents. In Finland, 18% of the respondents consumed cholesterol lowering products [11].

Red wine

Five studies reported consumption of red wine. France had the highest proportion for red wine consumption with 83.4% of the respondents [29]. In Italy (62.2%) and Denmark (55%) more than half of the respondents consumed red wine [26,28], while in Spain 39.5% of the respondents consumed red wine [21]. In France and Spain there was a gender difference in the consumption of red wine, male respondents more likely to consume red wine in these countries; however, in Denmark and Italy no gender difference was observed. In Belgium red wine consumers were reported as 10.2% of the respondents [15]; since this study represented functional food consumption of military men, comparison of genders for red wine consumption was not possible.

Cereals

Breakfast cereals or fibre rich bread consumption was reported in six studies. In Cyprus and Spain breakfast cereal consumption of adolescents was investigated. In these two Mediterranean countries children had similar and high percentage of breakfast cereal consumption, 49.7% [25] and 49.5% [22,24] respectively, and boys had a slightly higher consumption proportion than girls.

Landström *et al.* [14] reported that 42.5% of Swedish respondents consumed fibre rich bread with omega-3 fatty acid, while 92.8% of the Dutch respondents consumed total brown, wholemeal or rye bread [31]. Whole and all grain consumption of Dutch respondents were also reported as 39.3% and 42.9% of the respondents, respectively [16,31]. Wadolowska *et al.* [16] reported that high fibre foods were consumed by 38% of the Polish respondents. In Italy only 15% of the respondents consumed enriched breakfast cereals [17].

Fruits and vegetables

Fruit and vegetable consumption was reported in three studies. In Austria 36.4% of the respondents consumed fruits and vegetables and it is clearly seen that females more likely to consume these products [32]. In Poland 83% of the respondents consumed fruits and vegetables [16]. In Belgium the consumption of fruits and vegetables were investigated separately. While 26.6% of the respondents consumed vegetables 19.1% of them preferred to consume fruits [15].

In five studies the consumption of fruit juice was investigated. In Sweden almost half of the respondents (48.7%) consumed juice with added vitamins or minerals [14]. Another study reported that 50% of the Swedish respondents consumed fruit juice [26]. Probiotic fruit drinks were another common functional food among Swedish respondents and were consumed by 45.8% of the respondents [14]. Consumption of vitamin enriched juices was not popular in Italy, only 7% of the respondents consumed these products [17]; however in Spain juices and enriched drinks were consumed by almost 42% of the respondents [20].

Other functional foods

Consumption of other functional foods like eggs with omega-3 fatty acids, spread with added calcium, low-fat mayonnaise, low-fat cheese, low-cholesterol butter, nuts, energy drinks, vitamin or mineral enriched foods, and weight loss products were also investigated among European citizens. While fatty fish was consumed by 12.3% of the Belgium respondents, nuts were consumed by 14% of them [15]. Low-fat products like mayonnaise and cheese were consumed by 5% of the Belgium respondents; however, low-fat meat was consumed by 22% of them [19]. Consumption of low-cholesterol butter and spread with added calcium in Italy was investigated and reported that less than 5% of the respondents consumed these products [17]. Consumption of different functional foods (yogurts fortified with vitamins or minerals, juice fortified with vitamins or minerals, ready-to-eat breakfast cereals fortified with vitamins or minerals, energy and wellness drinks fortified with vitamins or minerals, quarks fortified with vitamins or minerals) were investigated in Finland and it was reported that total 67.5% of the respondents consumed these products [18]. Probiotic juice and yogurt, products with added fibre and low-salt were also commonly consumed by Finns [11].

Consumption of functional eggs was mentioned in two studies. While in Sweden only 3.8% of respondents consumed eggs with omega-3 fatty acids [14], in Spain 6.7% of the respondents consumed eggs with omega-3 or low in cholesterol [20]. Vitamin enriched foods like lemonade or sweets were popular in the Netherlands, almost 40% of the respondents consumed these products [15]. In the same study it was reported that almost 30% of the study population consumed foods with extra calcium [15]. Products with added calcium were also popular in another northern European country, almost half of the study population consumed calcium fortified products in Finland [11]. However, in Poland 20% of the respondents consumed vitamin and/or mineral enriched foods, whereas energy drinks and weight loss products were consumed by only 7% and 4% of the respondents respectively [16].

DISCUSSION

While in most of the northern European countries like Finland, Sweden and the Netherlands, functional foods are consumed by a high percentage of the population [10,12,13,18,23,31], in Belgium the percentage of functional food consumers is not as high as in the northern European countries [15,19]. On the other hand, in most of the other European countries, fortified margarines were consumed by less than 10% of the populations [10,12,13,17], but in Belgium 26% of the study population consumed these products [15].

It is also surprising that fermented dairy products, one of the most popular functional foods [33], is consumed by less than 5% of the study population in Belgium. The studies conducted in Belgium represented only a specific group of the population, military men, it might be the reason that the results from this country differs from other European countries. Results from Mediterranean countries, like Spain, Italy and Cyprus, also show differences. Spaniards and Cypriots are more likely to consume functional foods than Italians. Functional foods, except coffee, tea and red wine, are not as popular in Italy as in other European countries [17,28,30]. When we investigated the functional food consumption of the young population in Mediterranean countries, results show that in Spain and Cyprus a high percentage of adolescents consumed functional foods [22,24,25].

It is clearly seen that there are differences between functional food consumers' percentage across the countries. Menrad [3] reported that functional foods are more popular in the Central and Northern European countries than in Mediterranean countries; however, it is not possible to make a generalization between northern and southern countries. Furthermore, in eastern Europe functional food consumption has become popular [16], and the functional food market has been growing in Poland [34]. European countries differ in their nutrition and health claims of functional foods [35] and also popularity of functional foods differs from country to country.

Bech-Larsen and Grunert [8] reported that Finnish consumers have positive attitudes toward functional foods, whereas Danish consumers have negative attitudes toward functional foods. High acceptability of functional foods in Finland might be the result of the government's support of functional foods [14].

It is difficult to evaluate functional food consumption according to gender, because results varied from study to study. In some studies, it was reported that females were more interested in functional food [14,36,37]; however, some studies reported that different products might be attractive for one or the other gender [12,38]. In fact, the results of some studies conducted in the same country represent different outcomes. According to Lathi-Koski *et al.* [23] females were more likely to consume functional foods than males in Finland; in contrast Anttolainen *et al.* [10] and Hirvonen *et al.* [18] reported that male consumers were more interested in functional foods than females. Similarly, Landström *et al.* [13] pointed out that Swedish women are more likely to consume functional foods than men, but another study conducted in Sweden reported that males consumed functional foods more than females did [27].

Functional foods offer a new kind of health message due to the specific effects of functional components [39], and consumer aspects of functional foods lay on the grey area between food and medicine [7].The lack of legal definition and regulation for functional foods could affect the consumer attitude towards functional foods [14].

CONCLUSIONS

Functional foods have become very popular in Europe in recent years, but still huge differences exist between Europeans regarding the consumption of functional foods. Further researches are necessary to find out reasons behind the differences and understand consumers' needs for functional foods.

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Authors' contributions

AEO and JAT contributed to the design of the strategy for the literature search, double screened and selected the retrieved documents. AP provided previous literature searches and analysis. AEO and JAT prepared the main outline of the manuscript and all authors contributed to the preparation of the manuscript.

Competing interests

The authors declare that they have no competing interests.

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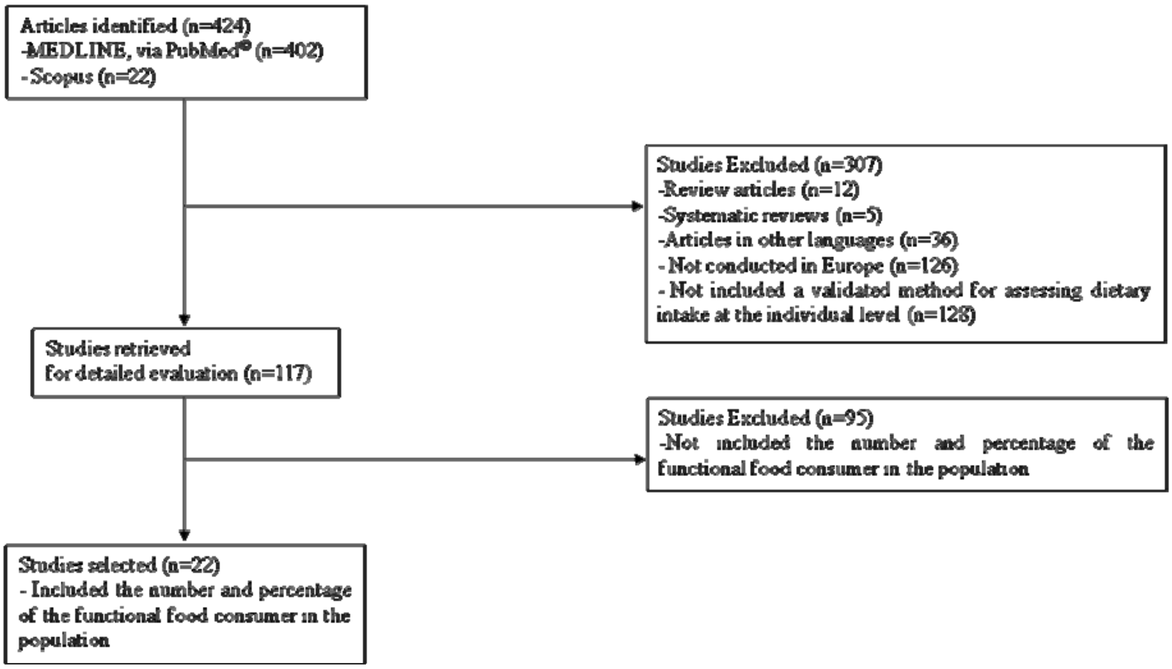

Figure 1. Flow chart for selection of articles for the present review

Table 1. Description of the studies included in this review

Author(s)	Method	Country	Study year	Sample size (Response rate, %)	Age range
Schätzer *et al.,* [32]	Self-administered questionnaire	Austria	2006	2704, (52.7)	19-64 y
Mullie *et al.*, [15]	Semi-quantitative food-frequency questionnaire (FFQ)	Belgium	2007	1852, (37)	20-59 y
Mullie *et al.*, [19]	Semi-quantitative food-frequency questionnaire (FFQ)	Belgium	2007	1852, (37)	20-59 y
Lazarou *et al.*, [25]	Semi-quantitative food-frequency questionnaire (FFQ)	Cyprus (The CYKIDS)	2004–2005	1140, (72)	9–13 y
Tjønneland *et al.*, [26]	Food frequency questionnaire (FFQ)	Denmark	1993-1997	48763, (33)	50-64 y
Lahti-Koski *et al*., [23]	Self-administered questionnaire	Finland (FINRISK)	1982-1997	24604, (79)	25-64 y
Anttolainen *et al*., [10]	Questionnaire (Health-lifestyle)	Finland	1996-1998	23657, (79)	35-84 y
Hirvonen e*t al*., [18]	24-hour dietary records	Finland (FINDIET)	2007	981, (90)	25-64 y
Urala et al., [11]	Special questionnaire	Finland	1999	958, (nd)	17-81 y
Lukasiewicz *et al*., [29]	24-hour dietary records	France	1994-2002	2323, (86)	35–60 y
Annunziata and Vecchio, [17]	Special questionnaire	Italy	nd	400, (nd)	18-75 y
Ferraroni *et al*., [30]	Food frequency questionnaire (FFQ)	Italy	1990-1991	395 (87%)	>35 y
Trevisan *et al*., [28]	Special questionnaire	Italy	1978-1987	15649 (83%)	30-59 y
de Jong *et al.*, [12]	Self-administered questionnaires	Netherlands	2000	1183, (76)	19–91 y
de Jong *et al*., [13]	Food frequency questionnaire (FFQ)	Netherlands	2003	2379, (99)	28-76 y
van de Vijver *et al*., [31]	Food frequency questionnaire (FFQ)	Netherlands	2006	4237, (85)	55–69 y
Aranceta *et al*., [21]	Food frequency questionnaire (FFQ)	Spain (Basque Country)	1990	2348, (73)	25-60 y
Serra-Majem *et al*., [22,24]	24-hour dietary records	Spain (EnKid)	1998–2000	3850, (70)	2–24 y
Núñez-González *et al*., [20]	Special questionnaire	Spain (Canary Islands)	2009-2010	1112, (nd)	>18 y
Landström *et al.*, [14]	Food questionnaire	Sweden	2005	972, (48)	17-75 y
Lindström *et al.*, [27]	Cross-sectional study	Sweden	1994	11834, (39)	45-64 y
Wadolowska *et al.*, [16]	Closed-question questionnaire	Poland	2005	1005	15-75 y

nd: no data.

Table 2. Number and percentage of the functional food consumers in different European countries

Country	Functional food	Men		Women		Total	
Austria [32]		n	%	n	%	n	%
	Fruits and vegetable	290	27.2	694	43.0	984	36.4
Belgium [15]							
	Fortified margarines	488	26.3	nd	nd	488	26.3
	Fermented dairy products	87	4.7	nd	nd	87	4.7
	Nuts	259	14.0	nd	nd	259	14.0
	Black tea	551	29.8	nd	nd	551	29.8
	Red wine	190	10.2	nd	nd	190	10.2
	Fatty fish	228	12.3	nd	nd	228	12.3
	Fruits	354	19.1	nd	nd	354	19.1
	Vegetables	492	26.6	nd	nd	492	26.6
Belgium [19]							
	Low-fat mayonnaise	93	5.0	nd	nd	93	5.0
	Low-fat yogurt	320	17.3	nd	nd	320	17.3
	Low-fat milk	137	7.4	nd	nd	137	7.4
	Low-fat cheese	65	3.5	nd	nd	65	3.5
	Low-fat cottage cheese	95	5.1	nd	nd	95	5.1
	Low-fat meat	401	21.7	nd	nd	401	21.7
Cyprus (The CYKIDS) [25]							
	Semi skimmed milk	352	66.0	422	69.5	774	67.9
	Yogurt	240	45.1	256	42.2	496	43.5
	Whole grain bread	113	21.2	118	19.5	231	20.3
	Breakfast cereals	273	51.2	293	48.2	566	49.7
Denmark [26]							
	Red wine	12973	55.7	13891	55.5	26864	55.1
Finland (FINRISK) [23]							
	Low-fat milk	5065	42.7	5339	41.9	10404	42.3
	Skimmed milk	875	7.4	1287	10.1	2162	8.8
	Sour milk	10697	90.2	11846	92.9	22543	91.6
	Coffee	11740	99.0	12675	99.4	24415	99.2
	Tea	10455	88.2	11573	90.8	22028	89.5
Finland [10]							
	Plant sterol ester margarine	577	5.1	518	4.2	1095	4.6
Finland (FINDIET) [18]							
	Voluntarily fortified foods[1]	305	74	315	65	620	67.5
Finland [10]							
	Probiotic juice and yoghurt	nd	nd	nd	nd	287	30.0
	Cholesterol lowering products	nd	nd	nd	nd	169	18.0
	Products with added calcium	nd	nd	nd	nd	451	47.0
	Products with added fibre	nd	nd	nd	nd	465	49.0
	Low-salt products	nd	nd	nd	nd	670	70.0
France [29]							
	Wine	954	90.4	984	77.6	1938	83.4
Italy [17]							
	Milk with n-3 fatty acids	nd	nd	nd	nd	20	5
	Probiotic yoghurt	nd	nd	nd	nd	48	12
	Vitamin enriched juices	nd	nd	nd	nd	21	7
	Enriched breakfast cereals	nd	nd	nd	nd	60	15
	Low cholesterol butter	nd	nd	nd	nd	12	3
	Spread with added calcium	nd	nd	nd	nd	16	4
Italy [30]							
	Coffee	80	61.5	161	60.8	241	61.0
	Decaffeinated coffee	120	92.3	243	91.7	363	91.9
	Tea	93	71.5	183	69.1	276	69.9

Table 2. Continued

Country	Functional food	Men		Women		Total	
Italy [28]							
	Red wine	5650	62.9	4090	61.3	9740	62.2
Netherlands [12]							
	Yogurt with lactic acid bacteria	nd	nd	nd	nd	383	32.4
	Cholesterol lowering margarine	nd	nd	nd	nd	78	6.6
	Lemonade or sweets with extra vitamins and minerals	nd	nd	nd	nd	435	36.8
	Foods with extra calcium	nd	nd	nd	nd	324	27.4
Netherlands [31]							
	Whole grain (all grain without bran and germs)	727	35.0	938	43.5	1665	39.3
	Total brawn bread (sum of brown, wholemeal and rye bread)	1913	92.1	2018	93.5	3931	92.8
	All grain (bran, germs, muesli, porridge, brown rice and cooked grains)	765	36.8	1051	48.7	1816	42.9
Netherlands [13]							
	Phytosterol/-stanol-enriched margarines	48	4.0	67	5.7	115	4.8
Spain (Basque Country) [21]							
	Red wine	793	69.4	470	39.0	1263	39.5
Spain (EnKid) [22,24]							
	Cereal or cereal product for breakfast	1380	84.7	1669	87.6	3049	86.3
	Two yoghurts and/or 40 g cheese	850	52.2	0897	47.1	1748	49.5
Spain (Canary islands) [20]							
	Milk products[2]	nd	nd	nd	nd	331	29.8
	Cereals[3]	nd	nd	nd	nd	341	30.7
	Drinks[4]	nd	nd	nd	nd	463	41.6
	Eggs[5]	nd	nd	nd	nd	75	6.7
	Fats[6]	nd	nd	nd	nd	197	17.7
Sweden [14]							
	Probiotic fruit-drinks	169	39.5	276	50.7	445	45.8
	Probiotic milk-products	217	50.8	326	59.9	543	55.9
	Portion-sized yoghurt with muesli	20	4.7	47	8.6	67	6. 9
	Juice with added vitamins or minerals	208	48.6	265	48.7	473	48.7
	Cholesterol-lowering products	112	26.3	162	29.7	274	28.2
	Fibre-rich bread with n-3 fatty acids	157	36.7	256	47.1	413	42.5
	Egg with n-3 fatty acids	14	3.3	23	4.2	37	3.8
Sweden [27]							
	Fruit Juice	2987	55.5	2925	45.3	5912	50.0
Poland [16]							
	Cholesterol lowering spreads or drinks	nd	nd	nd	nd	201	20.0
	Energy drinks	nd	nd	nd	nd	70	7.0
	Food with added vitamins and/or minerals	nd	nd	nd	nd	201	20.0
	Fruit and/or vegetables	nd	nd	nd	nd	834	83.0
	High fibre foods	nd	nd	nd	nd	382	38.0
	Probiotic yoghurt drinks	nd	nd	nd	nd	372	37.0
	Weight loss products	nd	nd	nd	nd	40	4.0

nd: no data.
[1]Yogurts fortified with vitamins or minerals, juice fortified with vitamins or minerals, Ready-to-eat breakfast cereals fortified with vitamins or minerals, Energy and wellness drinks fortified with vitamins or minerals, Quarks fortified with vitamins or minerals
[2]Milk products: easily digestible milk (or milk low in lactose), milk enriched with vitamins and/or minerals, skimmed milk with soluble fiber, milk with royal jelly, milk with modified fatty acids (omega 3), milk products low in fat, pro-biotic foods (yoghurt and fermented milk) and yoghurt with phytosterols.
[3]Cereals: fortified breakfast cereals, whole-meal cereals and energy bars.
[4]Drinks: juices and enriched drinks, stimulating drinks and isotonic drinks.
[5]Eggs: Docosahexanoic acid-enriched (DHA), low in cholesterol eggs.
[6]Fats: enriched margarine, margarine rich in phytosterols and sun flower oil rich in oleic acid.

Manuscript III

Socio-demographic and lifestyle determinants of functional food consumption among a Mediterranean adult population

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Socio-demographic and lifestyle determinants of functional food consumption among a Mediterranean adult population

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ABSTRACT

Background and aims: Functional foods are offering a new kind of health message. Studies about functional food consumption among the southern European countries are scarce. The aim of this work is to assess socio-demographic and lifestyle determinants of the functional food consumption among a Mediterranean adult population.

Methods: This study was a population based cross-sectional nutritional survey. Data were obtained from a global questionnaire and two non-consecutive 24-h recalls. Functional foods were selected from the recalls. The target population was consisting of all inhabitants living in the Balearic Islands (Spain) aged 16-65 years.

Results: A high percentage of the study population consumed most of the functional foods (coffee, low-fat/skimmed milk, fibre-rich bread/cookies, probiotics, breakfast cereals, and tea). Females had a higher interest for the consumption of infusions, and males had a higher interest in breakfast cereals, fibre rich bread/cookies and low fat/skimmed milk. The consumption of most of the functional foods was associated with increasing age. Married participants were found more likely to consume coffee than not married ones. The consumption of fibre-rich bread/cookies was related to middle education level, as well as consumption of coffee was related with higher education level. Medium level employment status was related to consumption of breakfast cereals. The consumption of breakfast cereals and fibre-rich bread/cookies was inversely related to BMI. Physical activity was associated with the consumption of soy milk, breakfast cereals, probiotics, and red wine.

Conclusions: A high percentage of the study population consumed most of the functional foods. Socio-demographic determinants and lifestyle characteristics are significant factors of consumption of functional foods. The importance of these factors depends on each functional food.

Keywords: Functional food, food consumption, the Balearic Islands, lifestyle, socio-demographic determinants.

INTRODUCTION

Changes in lifestyle and diet may increase the burden of diet-related diseases such as obesity, cancer, diabetes and cardiovascular diseases [1]. Over the last decades demands for health-improving foods and beverages have increased related with the rising cost of health care, increase in life expectancy and desire for a higher life quality [2].

A functional food can be a natural food or it can contain one or more specific components which have functional influence on the health and well-being of the consumer. This component can be added to food, removed from food or modified to provide health benefits [2,3]. In this regard, functional foods may play an important role and offer a new kind of health message by promising specific effects caused by particular food components [3].

For the food scientists and industry, it is important to understand consumer attitudes towards to functional foods to develop and offer functional foods which meet the consumer demands. In the literature it is reported that gender [4-9], age [10], education [9,11] and health claims [12] influence the consumer attitudes towards functional foods. Females are more interested in functional foods than males [4-8] and different products can be attractive for one or the other gender [4,14]. Age may also influence the consumption of some functional foods; according to Wadolowska *et al.* [10] disease-preventing effects of foods are more important for older people than for younger, because they get sick more frequently. Education is another factor contributing to healthy eating, and functional food users are more educated than the non-users [11].

There are several studies reporting the functional food consumption in different countries which are northern European countries like Sweden [5], Poland [10], Belgium [12], the Netherlands [14], or Finland [15,16]; however, in the literature studies about functional food consumption among southern European countries are missing. It is important to find out the factors that affect the functional food consumption of different populations.

The present paper is aimed to assess socio-demographic and lifestyle determinants of functional food consumption among a Mediterranean adult population.

METHODS

Study population

This study is a population based cross-sectional nutritional survey. The data collection took place in the Balearic Islands, Spain (2009-2010). The target population was consist of all inhabitants living in the Balearic Islands, and the sample population derived from residents aged 16-65 years registered in the official population census [17]. The theoretical sample size was set at 1500 individuals and the one specific relative precision of 5% (type I error = 0.05; type II error = 0.10), and the final sample was 1386 (92.4% participation). Pregnant women were not considered in this study. The participants were interviewed at their household. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects and, when they were under 18 years old, also from their parents or legal tutors.

Assessment of functional food consumption

Dietary questionnaires included non-consecutive 24-h diet recalls and a validated quantitative food frequency questionnaire (FFQ) [18] covering the 145-item (118 of the original validated FFQ plus the most characteristic Balearic Islands foods in order to make easy the interviewee answer) [19]. Frequency of food consumption was based on times that food items were consumed (per day, week or month). Consumption <1/month was considered no consumption. Daily consumption (g) was determined by dividing the reported amount of the intake by the frequency (d). To prevent seasonal variations 24-h dietary recalls administered in the warm season (May-September) and in the cold season (November-March). To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. Well-trained dieticians administered the recalls and verified and quantified the food records. Volumes and portion sizes were reported in natural units, household measures or with the aid of a manual of sets of photographs [20]. Functional foods were first selected according to functional food list reported by Hasler [21], but also potential candidate functional foods were searched through the literature for evidence on potential health benefits [22-32]. According to this study, considered functional foods were: cholesterol lowering products (margarine, milk, yoghurt and mini yoghurt enriched with sterols or stanols), soy milk, enriched breakfast cereals (fibre, minerals, and/or vitamins), fibre-rich bread/cookies, low-fat/skimmed milk, black tea, coffee, probiotics (yoghurt and mini yoghurt derived from milk fermented with lactic-acid bacteria), and red wine.

Assessment of Overweight and Socio-demographic Characteristics

Height was determined to the nearest millimetre using a mobile anthropometer (Kawe 44444, Asperg, Germany), with the subject's head in the Frankfurt plane. Body weight was determined to the nearest 100 g using a digital scale (Tefal, sc9210, Rumilly, France). The subjects were weighed in bare feet and light underwear, which was accounted by subtracting 300 g from the measured weight. BMI was computed as weight/height^2 (kg/m^2) and study participants were categorized as ≤24.9, 25-29.9 and ≥30 kg/m^2. A questionnaire incorporating the following questions was used: age, marital status, educational level (grouped according to years and type of education: low, <6 years at school; medium, 6-12 years of education; high, >12 years of education), and economic level (based on the occupation and classified as low, medium and high; when respondents were under 18 years old, economic status of the head of the household was considered), according to the methodology described by the Spanish Society of Epidemiology (33).

Physical Activity Assessment

Physical activity (PA) was evaluated according to guide-lines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [34] in the short form. The specific types of activity assessed were walking, moderate-intensity activities (i.e. PA at work), vigorous-intensity activities (i.e. sport practice) and sitting time (used as an indicator variable of time spent in sedentary activity). Weekly minutes of walking, moderate-intensity and vigorous-intensity activity were calculated separately by multiplying the number of days/week by the duration on an average day. Reported minutes per week in each category were weighted by a metabolic equivalent (MET) and PA computed by multiplying METs by min/w and expressed in MET-min/w. MET-values for different level activities were established based on the Compendium of Physical Activities [35] and were set as 3.3 MET for walking, 4 MET for moderate-intensity PA and 8 MET for vigorous-intensity PA. On the basis of their total weekly time of PA, the subjects were divided into 3 groups: "low", "moderate" and "high" levels of PA.

• Low: Meets neither 'moderate' nor 'high' criteria.

• Moderate: Meets any of the following three criteria:

(a) 3 or more days of vigorous-intensity activity of at least 20 min/day;

(b) 5 or more days of moderate-intensity activity/walking of > 30 min/day;

(c) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 600 MET-min/w.

• High: Meets either of two criteria:

(a) vigorous-intensity activity on 3 or more days/week and accumulating at least 1500 MET-min/week;

(b) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 3000 MET-min/w [34].

Statistics

Statistical analyses were performed using SPSS for windows, version 19.0 (SPSS Inc., Chicago, IL, USA). For descriptive purposes absolute numbers and percentages of the participants were calculated for demographic and lifestyle characteristics. Functional food consumers were compared with non-consumers by using logistic regression methods. Crude and adjusted odds ratios (OR; and 95% CI) were calculated to examine the effects of the demographic and lifestyle variables on use (=1) or non-use (=0) of functional foods. To adjust the OR all variables were entered simultaneously into the model in order to account for the effects of all other covariates. The number of respondents included in the analyses may differ according to the food or because of missing data.

RESULTS

The demographic and lifestyle characteristics of the study participants are presented in Table 1. Age and education level was found statistically determine the likelihood of functional food consumption.

Consumption of functional foods is showed in Table 2. Female respondents consumed a significantly higher amount of infusions than males did; males consumed a significantly higher amount of breakfast cereals, fibre rich bread/cookies and low-fat/skimmed milk than females did. Half of the respondents (male and female) consumed coffee and low-fat/skimmed milk; around a third of the respondents (male and female) consumed fibre-rich bread/cookies, probiotics, and breakfast cereals; approximately 20% of women and 10% of men consumed tea; 15% of men and 5% of women consumed red wine; around 5% of women and men consumed soy milk; and ≤5% of the respondents consumed cholesterol lowering products (data not shown).

The consumption of each functional food in relation to demographic and lifestyle characteristics (adjusted OR for gender, age, marital status, education level, employment status of the respondent, work status of the household head, BMI and physical activity) are shown in Table 3. Consumption of soy milk, fibre-rich bread/cookies and tea was directly related to males, and breakfast cereals inversely related to females. While cholesterol lowering products were not consumed by young respondents, a direct association was observed between consumption of cholesterol lowering drinks and elder ages. Other direct associations between increasing age and consumption of fibre-rich bread/cookies, tea, coffee, and red wine were also found. Married participants were found more likely to consume coffee than not married ones. A direct association between the consumption of fibre-rich bread/cookies and middle education level and between the consumption of coffee and higher education level were found. Medium level employment status was directly related to the consumption of breakfast cereals. Increasing BMI was inversely related to the consumption of breakfast cereals and fibre-rich bread/cookies. Consumption of soy milk, breakfast cereals, probiotics, and red wine were associated with increasing physical activity.

DISCUSSION

The aim of the present study was to determine the association between functional food consumption and socio-demographic and lifestyle determinants among the Balearic Islands' population.

A high percentage of the study population consumed most of the functional foods (low-fat/skimmed milk, fibre-rich bread/cookies, probiotics, breakfast cereals, and infusions), which is in agreement with the consumption of these functional foods worldwide [36]. Soy products were more commonly consumed in Australia and Asian countries like Japan and China; however, the consumption of these functional foods among the Balearic Islands' inhabitants is low and similar to those of most European citizens [36]. Red wine consumption among the Balearic Islands' population is similar to the observed one in other regions of Spain; also the proportion of males who consume red wine is significantly higher than those of females [37]. The low consumption of cholesterol-lowering products is similar to the observed in the Netherlands and Finland, but lower than the consumption among Swedish, Polish, and Belgian citizens [36]. In any case, our study offers a first and global view of functional food consumption among the southern European inhabitants.

In the literature it was reported that females [7,8,15,38], older [10,38] or high educated people [5,15] were more likely to consume functional foods. In this study we also observed that age and education level were the significant determinants of functional food consumption. And when we analysed the determinants for each functional food separately we found that gender, age, marital status, education level, BMI and physical activity all proved to be significant predictors of functional food consumption; however, the significance of these factors differs according to the products. This relation was reported in another study among the Dutch population by means of a self-administered questionnaire [14].

According to crude logistic regression (data not shown) a positive and statistically significant association was found between females and most of the functional foods. It was found that females had a higher interest for consumption of some of the functional foods, like soy milk, fibre-rich bread/cookies and tea, and males had a higher interest to cholesterol lowering products. Similar to our findings, other studies have reported that females were more likely to consume probiotics [5,14,15], while males were more likely to consume cholesterol lowering products [14]. After adjustment for gender, age, marital status, education level, employment status of the respondent, work status of the household head, BMI and physical activity, females had a higher interest to consume functional foods, and males were more likely to consume breakfast cereals.

We found a positive and statistically significant association between an increasing age and a greater consumption of cholesterol lowering products. Our findings about a higher consumption of cholesterol lowering products in the elders are consistent with previous studies [8,39]. Furthermore, consumers of these products tended to be married, have a higher income and have a higher BMI. Additionally to cholesterol lowering products, the consumption of fibre-rich bread/cookies, tea, coffee and red wine increased with age. Similar to our findings it was reported that older people were more likely to consume functional foods [7,38].

An inverse association between BMI and fibre intake which helps in weight management, was reported [40]; however we found an inverse and significant relation between the consumption of breakfast cereals and fibre-rich bread/cookies and high BMI.

Physical activity was found positively and significantly associated with the consumption of tea, low-fat/skimmed milk and probiotics. Our findings are in agreement with Mullie *et al.* [12] that previously reported a positive relation between the consumption of probiotics and physical activity.

CONCLUSIONS

In this study, the socio-demographic and lifestyle determinants of functional food consumption in the Balearic Islands were investigated. A high percentage of the study population consumed most of the functional foods. Socio-demographic determinants and lifestyle characteristics like gender, age, marital status, education level, BMI and physical activity are significant factors of functional food consumption. Nevertheless, the importance of these factors depends on the functional foods. Additional to socio-demographic determinants, knowledge and beliefs play an important role in consumers' choices. To understand consumers' acceptance, concerns and needs for functional foods further research is needed.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Conflict of interests

The authors state that there are no conflicts of interest.

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Table 1. Characteristics of the study population and likelihood to consume functional food

Characteristics	**Respondents**		**Likelihood to consume functional food**	
	n	**%**	**OR[1] (95% CI)**	***P* Value**
Gender				
Male	578	41.7	1.00	
Female	808	58.3	1.09 (0.71,1.68)	0.687
Age (Years)				
16-25	598	43.1	1.00	
26-45	560	40.4	1.94 (1.05, 3.57)	0.035
46-65	228	16.5	10.31 (2.16, 20.87)	0.001
Marital Status				
Not married[2]	978	70.6	1.00	
Married	400	28.9	1.21 (0.62, 2.37)	0.584
Education Level[3]				
Low level	447	32.3	1.00	
Medium level	475	34.3	1.84 (1.20, 2.84)	0.005
High level	453	32.7	3.68 (1.99, 6.79)	>0.0001
Economic level				
Low level	549	39.6	1.00	
Medium level	151	10.9	1.64 (0.85, 3.14)	0.140
High level	665	48.0	1.32 (0.76, 2.29)	0.332
BMI				
Normal (≤24.9 kg/m^2)	797	57.5	1.00	
Overweight (25-29.9 kg/m^2)	380	27.4	0.94 (0.59, 1.48)	0.785
Obese (≥30 kg/m^2)	12	00.9	0.19 (0.06, 0.58)	0.004
PA score				
Low	788	58.3	1.00	
Moderate	378	28.0	1.01 (0.64, 1.60)	0.956
Intensive	185	13.7	1.46 (0.80, 2.66)	0.218
Chronic Disease[4]				
No	416	31.4	1.00	
Yes	907	68.6	0.81 (0.52, 1.24)	0.805

[1]Odds ratios (ORs) adjusted for all variables
[2]Not married includes: single, divorced, widowed, and separated.
[3]Education level: low less than 6y, medium 6-12y, high: higher than 12 y.
[4]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases.

Table 2. Consumption frequencies and daily mean intake of functional foods among respondents

Functional Foods	**Male**		**Female**		***P* value**[1]
	N (%)	**Consumption (g) Mean SD**	**N (%)**	**Consumption (g) Mean SD**	
Cholesterol lowering products	5 (0.9)	120.00 ± 11.18	6 (0.7)	108.33 ± 12.91	0.148
Soy milk	16 (2.7)	242.19 ± 96.49	53 (6.5)	214.43 ± 92.52	0.301
Breakfast Cereals	141 (24.0)	52.58 ± 26.07	133 (16.3)	41.29 ± 16.22	>0.0001
Fibre-rich bread/cookies	76 (12.9)	83.67 ± 61.28	181 (22.2)	64.49 ± 41.39	0.004
Infusions	258 (43.9)	121.22 ± 106.42	487 (59.6)	159.81 ± 173.28	0.001
Low-fat milk	226 (38.4)	250.07 ± 162.82	364 (44.6)	215.14 ± 92.93	0.001
Probiotics	169 (28.7)	159.73 ± 75.36	255 (31.2)	159.96 ± 71.75	0.975
Red wine	45 (7.7)	168.89 ± 100.16	53 (6.7)	161.32 ± 121.55	0.740

[1]Differences between mean values were tested by ANOVA

Table 3. Functional food consumption in relation to demographic and lifestyle characteristics

	Cholesterol lowering products	Soy Milk	Breakfast Cereals	Fibre-rich bread/cookies	Tea	Coffee	Low-fat/Skimmed milk	Probiotics	Red wine
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Gender									
Male	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female	0.62 (0.13, 2.98)	2.86 (1.25,6.56)*	0.52 (0.36, 0.76)*	1.35 (0.97, 1.90)*	2.48 (1.47, 4.23)*	1.42 (1.05, 1.90)*	1.56 (1.19, 2.06)*	1.19 (0.86, 1.64)	0.56 (0.29, 1.09)
Age (years)									
16-25	nc	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26-45	1.00	3.21 (0.91, 5.41)	0.87 (0.42, 1.82)	2.24 (1.40, 3.60)*	3.76 (1.58, 4.50)*	2.20 (1.39, 3.48)*	1.08 (0.64, 1.54)	0.79 (0.49, 1.26)	4.37 (1.39, 13.72)*
46-65	7.94 (1.25, 50.58)*	2.79 (0.54, 4.34)	1.04 (0.37, 2.92)	3.98 (2.68, 5.14)*	4.57 (1.60, 7.97)*	4.77 (2.44, 9.34)*	1.94 (0.96, 3.24)*	0.98 (0.52, 1.85)	5.33 (1.41, 20.13)*
Marital Status									
Not married[1]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Married	1.10 (0.16, 7.49)	1.90 (0.70, 4.87)	0.62 (0.30, 1.30)	0.58 (0.32, 1.05)	0.75 (0.38, 1.48)	1.48 (1.01, 2.05)*	1.23 (0.68, 1.57)	1.49 (0.94, 2.24)	1.74 (0.77, 3.93)
Education level									
Low (<6 y)	nc	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium (6-12 y)	1.00	1.53 (0.59, 3.98)	1.27 (0.66, 2.42)	1.81 (1.16, 2.83)*	1.21 (0.71, 2.07)	1.24 (0.87, 1.76)	1.37 (1.00, 1.89)	1.42 (1.00, 1.99)*	0.89 (0.37, 2.11)
High (>12 y)	4.35 (0.28, 6.70)	2.41 (0.91, 6.44)	1.40 (0.69, 2.84)	1.84 (1.15, 2.95)*	1.86 (1.09, 3.18)*	1.61 (1.10, 2.33)*	1.28 (0.90, 1.82)	1.53 (1.05, 2.22)*	1.05 (0.43, 2.53)
Economic level									
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.15 (0.07, 20.28)	1.14 (0.36, 3.65)	1.97 (1.17, 3.32)*	1.04 (0.47, 1.41)	0.81 (0. 29, 2.28)	1.73 (1.10, 2.73)*	1.21 (0.77, 1.92)	0.65 (0.39, 1.10)	2.07 (0.58, 7.34)
High	0.33 (0.05, 2.45)	1.17 (0.46, 2.96)	0.86 (0.51, 1.43)	1.41 (0.75, 2.12)	0.72 (0.78, 2.20)	1.59 (1.11, 2.28)*	1.42 (0.95, 2.12)	1.01 (0.66, 1.55)	1.87 (0.69, 5.06)

Table 3. Continued

	Cholesterol lowering products	Soy Milk	Breakfast Cereals	Fibre-rich bread/cookies	Tea	Coffee	Low-fat/Skimmed milk	Probiotics	Red wine
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
BMI (kg/m^2)									
≤24.9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
25-29.9	0.72 (0.10, 5.03)	0.60 (0.22, 1.43)	1.27 (0.73, 3.68)	0.68 (0.40, 1. 15)	1.12 (0.58, 1.50)	1.12 (0.77, 1.63)	1.14 (0.86, 1.51)	1.15 (0.81, 1.62)	1.35 (0.65, 2.78)
>30	1.47 (0.20, 11.10)	0.12 (0.02, 0.98)*	0.49 (0.21, 1.18)*	0.43 (0.21, 0.87)*	1.68 (0.78, 3.21)	1.29 (0.77, 2.15)	0.91 (0.37, 2.27)	0.95 (0.58, 1.55)	1.59 (0.63, 4.01)
Physical Activity									
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Moderate	0.45 (0.05, 4.04)	1.08 (0.59, 1.97)	1.38 (0.97, 1.96)	1.09 (0.63, 1.32)	1.11 (0.71, 1.72)	0.96 (0.70, 1.32)	1.46 (1.09, 1.96)*	1.18 (0.86, 1.60)	0.88 (0.52, 1.50)
Intensive	4.12 (0.54, 31.20)	0.72 (0.24, 1.18)	1.39 (0.89, 2.18)	1.10 (0.64, 1.84)	1.92 (1.07, 3.43)*	0.75 (0.49, 1.16)	1.89 (1.28, 2.79)*	1.73 (1.16, 2.59)*	1.20 (0.61, 2.37)
Chronis Diseases[2]									
Yes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
No	0.75 (0.17, 3.30)	0.90 (0.50, 1.59)	1.03 (0.73, 1.44)	1.10 (0.77, 1.55)	1.18 (0.78, 1.78)	1.13 (0.84, 1.52)	0.94 (0.72, 1.23)	0.95 (0.71, 1.26)	0.99 (0.61, 1.60)

Odds ratios (ORs) were adjusted for all other variables in the model and 95% confidence intervals).
*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (P<0.05).
[1]Not married includes: single, divorced, widowed, and separated.
[2]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases.
nc: no consumption

Manuscript IV

Consumption of functional foods in the Balearic Islands: adolescent population

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ABSTRACT

Objective: The aim of our study was to examine socio-demographic determinants in the functional food consumption in the Balearic Islands, adolescent population, and to determine whether functional foods are associated with demographic and lifestyle characteristics.

Design: The study is a population-based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2009. Data were obtained from a semi-quantitative food frequency questionnaire (FFQ) and a general questionnaire. Functional foods were selected from the FFQ. The target population was consisting of all residents living in the Balearic Islands aged 11-18 years.

Results: Breakfast cereals, modified milk, and probiotics were the common functional food consumed by adolescents in the Balearic Islands, whereas soy milk and cereal bars were consumed by less than 1% of the adolescent population. With the exception of breakfast cereals, girls were more likely to consume functional foods than boys did. Age was found positively associated with the consumption of fibre-rich bread/cookies, modified milk, and probiotics while the consumption of breakfast cereals and cereal bars was negatively associated with age. BMI and physical activity was found positively related with the consumption of a few functional foods.

Conclusions: Consumption of functional foods, as a part of a healthy diet, in early and also late periods of life may prevent some diseases. Further researches are needed to find out young consumers' acceptance and needs for functional foods.

Keywords: Functional food, adolescent, consumption, the Balearic Islands

INTRODUCTION

Adolescence is an important transition time in human growth and maturation. This period covers significant developments of secondary sexual characteristics, somatic growth and psychology [1]. Energy and nutrient requirements increase [2] and healthy eating gains more important in this period of life [3].

Eating pattern develops in adolescence [3] and moreover, eating behaviours during this period have long term effects on health [4] and influence the risk of diet-related diseases such as obesity, cancer, diabetes and cardiovascular disease [5].

In the last decades obesity in youth has been increasing [1,6] because of changes in dietary patterns [7,8] and the increase in the consumption of sweets, sugar-sweetened drinks and fast foods [9]. An adequate intake of nutrients and energy is critical for the healthy development in adolescence. Thus, a high quality diet, including lower saturated fat and cholesterol and higher fibre and micronutrients, plays an important role [4]. In this regard, the consumption of functional foods may help to intake vitamins and minerals adequately via enriched or enhanced foods and reduce the risk of diseases in adolescence and also in the latter life. A functional food can be a natural food or it can contain one or more specific components which have functional influence on the health and well-being of consumers [10,11]. This component can be added to food, removed from food or modified to provide benefits [10,11].

Previous studies focused on functional food consumption in adulthood [12-18]; however, studies about the consumption of functional foods in adolescence are missing. The present paper is aimed to examine socio-demographic determinants in the functional food consumption among the Balearic Islands' adolescent population and to determine whether functional foods are associated with demographic and lifestyle characteristics.

METHODS

Study design

The study is a population-based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2009.

Study population

The data collection took place in the Balearic Islands and the sample population was derived from residents aged 11–18 years, registered in the scholar census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomisation into subgroups, with the Balearic Islands municipalities being the primary sampling units, and individuals within the schools of these municipalities comprising the final sample units. The interviews were performed at schools. The final sample size was 1988 individuals (98% participation). The reasons to not participate were: the subject declined to be interviewed or the parents did not authorise the interview.

General questionnaire

A questionnaire incorporating the following questions was used: age group and father's and mother's education level (grouped according to years of education: low, <6 years at school; medium, 6-12 years of education; high, >12 years of education). Anthropometric measurements were also obtained. Body mass index (BMI) was calculated from body weight and height (kg/m^2). Study participants were categorized as normal-weight (<85th percentile), overweight (≥85th ≤95th percentile) and obese (>95th percentile) according to BMI.

Physical activity was evaluating according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [19] in the short form, and its specific modification for adolescents (IPAQ A) [20]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice), and an additional question about sitting time was used as an indicator variable of time spent in sedentary activity. On the basis of their total weekly physical activity (at least 60 minutes of physical activity per day on at least 5 d/w), the subjects were divided into 2 groups: inactive (<300 min/w) and active (≥300 min/w), according to the current physical activity recommendations [21].

Assessment of functional food consumption

Dietary questionnaires included non-consecutive 24-h diet recalls and a validated quantitative food frequency questionnaire (FFQ) covering the 145-item [22]. To prevent seasonal variations 24-h dietary recalls administered in the warm season (May-September) and in the cold season (November-March). Furthermore, to account for day-to-day intake variability, the two 24-hour recalls were administered from Monday to Sunday. Functional foods, which were selected according to functional food list, reported by Hasler, [23] were taken from the dietary questionnaires. Moreover, modified milk (low/reduced fat milk, n-3 added milk), infusions (coffee and tea), and soy milk were considered as functional foods in this study, due to various studies which were reported these foods might reduce the risk of some diseases [7,24-28].

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). For descriptive purposes absolute numbers and percentages of participants were calculated for demographic and lifestyle characteristics. Functional food consumers were compared with non-consumers by using logistic regression methods. Crude and adjusted odds ratios (OR and 95% CI) were calculated to examine the effects of the demographic and lifestyle variables on use (=1) or non-use (=0) of functional foods. To adjust the OR all variables were entered simultaneously into the model in order to account for the effects of all other covariates. The number of respondents included in the analyses may differ according to the food or because of missing data.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands

Ethics Committee. Written informed consent was obtained from all subjects and their parents or legal tutors.

RESULTS

The characteristics of the study population and likelihood to consume functional foods are presented in Table 1. Differences between boys and girls regarding the consumption of functional foods are presented in Table 2. Functional foods like probiotics, modified milk, fruit juice and breakfast cereals were the most preferable functional foods among the study population. The proportion of girls who consumed functional foods like modified milk and fibre-rich bread/cookies, was higher than those of boys, whereas the proportion of boys who consumed other functional foods was higher than those of girls. On the other hand, daily mean intake of boys was higher than those of girls for all functional foods.

The crude and adjusted OR were presented in Tables 3 and 4 respectively for consumption of the functional foods relative to non-consumption of the functional foods in relation to demographic and lifestyle characteristics. With the exception of breakfast cereals, girls were more likely to consume functional foods than boys. There were a positive and significant association between girls and the consumption of fibre-rich bread/cookies, modified milk and soy milk. A negative and statistically significant association was found between girls and breakfast cereals consumption. After adjustment for gender, age, education level of the father, education level of the mother, chronic disease, BMI and physical activity the positive association between girls and the consumption of fibre-rich bread/cookies and modified milk remained, while the strong relation between soy milk and girls was lost. Furthermore, new statistically significant associations were found between girls and the consumption of cereal bars. A negative association between the consumption of breakfast cereals and girls also remained.

While consumption of fibre-rich bread/cookies, modified milk, and probiotics was positively associated with age, consumption of breakfast cereals and cereal bars was negatively associated with age. There was a positive association between the education level of the father and the consumption of breakfast cereals; however, after adjustment this association was lost. Consumption of probiotics was found significantly associated with a high level educated father. Similarly, after adjustment this association was also lost.

Education level of the mother was found associated with the consumption of cereal bars, modified milk, soy milk and probiotics. A high level educated mother was found significantly associated with the consumption of breakfast cereals and fibre-rich bread/cookies, after adjustment this significant relation was lost.

Before and after adjustment, a positive and strong association was observed between the consumption of soy milk and chronic disease. BMI was positively related with the consumption of modified milk before and after adjustment and also BMI was found positively correlated with the consumption of fibre-rich bread/cookies after adjustment. Physical activity was positively associated with the consumption of breakfast cereals and soy milks but after adjustment this relation was lost.

DISCUSSION

Breakfast cereals, modified milk, and probiotics were the common functional foods consumed by adolescents in the Balearic Islands, whereas soy milk and cereal bars were consumed by less than 1% of the adolescent population. Girls were more likely to consume soy milk and cereal bars. Consumption of soy products is important especially for girls during adolescence, because soy is rich in iso-flavones which may prevent or reduce the breast cancer risk in adulthood [24,25,30]. In adolescence the development of mammary gland starts and the intake of genistein, the main iso-flavones in soy, in this period might affect the growth of breasts or might reduce the endogenous estrogen level in this period [25,31].

Consumption of breakfast cereals was high; however, fibre-rich bread/cookies consumption was not common as breakfast cereals. Both of these functional foods are important sources of whole grains which contain high amounts of dietary fibres, B-group vitamins, vitamin E, minerals, and phytochemicals [32,33,34]. Studies reported that the consumption of whole grains might reduce the risk of heart diseases, type 2 diabetes and various types of cancer in adults [35,36]. Whole grains intake also plays an important role in disease prevention in adolescence. Greater insulin sensitivity and lower BMI were found associated with the consumption of whole grain foods in adolescents [8,32,34]. Su *et al.*, [37] reported that dietary intake of fibre during adolescence influenced the subsequent risk of breast disease and might prevent breast cancer. Furthermore, whole grains consumption, due to high dietary fibre content, might treat constipation during childhood and adolescence by increasing faces volume, bacterial growth, and bacterial degradation products [38].

Milk plays an essential role as the primary source of dietary calcium and vitamin D and an important source of protein, phosphorous, riboflavin, potassium, magnesium, vitamin B-12 and vitamin B-6 in adolescents diets [7,39,40]. Adolescence is an important period for bone mass development and an adequate intake of calcium in these ages might reduce the risk of osteoporosis in the adulthood [39,41,42]. Furthermore Kalkwarf *et al.*, [42] reported that consumption of milk during childhood and adolescence was related with higher bone mass and density in adulthood. Beside osteoporosis, the intake of calcium might reduce the risk of overweight, insulin resistance and hypertension [39]. In addition to all above, modified milks, included low-fat/skimmed milk and omega-3 enriched milk in this study, offer other benefits to consumers. Consumption of low-fat or skimmed milk instead of whole milk was important because consumers of low-fat milk had a lower low density lipoprotein (LDL)-cholesterol level [43], which is related with coronary heart disease (CHD) [44] in their plasma. For normal growth and development omega-3 fatty acids play an essential role and these fatty acids were reported to reduce the risk of coronary heart disease [45], reduce triglycerides, cardiac deaths and fatal and non-fatal myocardial infarction [46].

Another dairy product which was mentioned in this study was probiotics. Various species of lactobacilli and bifidobacteria are used in the production of fermented milk products. These live microorganisms have beneficial effects like preventing cancer, hypertension or therapeutic effects on intestinal tract function, immune function, and stomach health [23]. Moreover, studies showed that the consumption of probiotics had beneficial effects on symptoms of constipation and they might prevent constipation in childhood and adolescence [47,48].

In this study tea and coffee grouped as infusions. In the literature an association between consumption of coffee and tea and reduced risk of type 2 diabetes and coronary heart disease were reported [28,29]. Furthermore coffee and tea contains phenolic compounds which have antioxidant effects in both in vitro and in vivo studies [23]. It was reported that consumption of coffee and tea reduced the iron bioavailability due to polyphenolic components especially in children, pregnant women and those with low iron stores; however, consumption of coffee and tea didn't affect the iron status of people who had adequate iron stores [28,49].

Our results showed that around 30% of the study population was overweight. Likewise, around 40% of them were found have less than 60 min daily activity. Overweight in adolescence is considered as a result of several factors, such as long/term imbalance between energy intake and energy expenditure [50,51], lack of physical activity [1,6,7], and genetic factors [50]. Like in adulthoods, obesity in adolescence is associated with several health problems like hypertension, the risk of cardiovascular disease, dyslipidaemia [8,50]. Furthermore, obesity tends to persist into adulthood [50].

Food choices of the youth are affected by many factors such as, influence of peers, parents, convenience, cost, hunger, availability, and health concerns [52]. In the present study we found that gender was an important predictor of consumption of functional foods among adolescents in the Balearic Islands. Similarly, it was reported that women were more interested in functional foods than men [13,53]. Croll *et al*, [4] reported that there was no big difference of awareness of healthy eating between girls and boys, while healthy eating was related with energy and taste for boys, for girls it was related with weight lost and appearance.

Age was found another important factor for consumption of functional foods in adolescent. Except breakfast cereals and cereal bars, consumption of other functional foods was increased with age. In contrast to our findings, it was reported that whole grains intake increased with age in adolescent [33] and milk intake of adolescent declined as they grew older [7].

Patrick and Nicklas, [54] reported that a higher parental education was related with healthy food choices in adolescent. We found also a positive association with the education level of the parents and consumption of some functional foods. Anttolainen *et al*., [44] reported that functional foods were consumed by more educated people.

A positive and strong association was observed between the consumption of soy milk and chronic disease. This might be related with the lactose free composition of soy milk so lactose intolerance individuals prefer to consume soy milk instead of cow milk.

We found that BMI was positively associated with whole grain foods like fibre-rich bread/cookies; however, in previous studies it was reported that whole grain intakes were related with lower BMI [32,55]. Consumption of modified milk was found significantly associated with BMI. Estrone hormone in milk might be a reason for weight gain [7]. Similar to our result, Berkey *et al*., [7] reported that high consumption of low-fat or skimmed milk caused an increase in body weight.

We found no association between physical activity and consumption of some functional foods. Ottevaere *et al*., [56] reported that physical activity was associated with the consumption of milk in adolescent. Furthermore, they found that girls with low physical activity consumed a higher amount of cereal products than girls with high physical activity did, but they didn't found any difference between boys.

Adolescents have knowledge about nutrition and awareness of healthy eating; however, they have little concern about healthy eating [4] or they don't know how to practice healthy eating in their daily life [52]. To improve the dietary behaviours of adolescents, parents should take more responsibility for their children's' diets and also school food environment should offer the students healthy foods by considering nutritional requirements of adolescents [57].

In conclusion, healthy eating becomes more important in adolescence for their development and also for their latter life. Consumption of functional foods, as a part of a healthy diet, in early periods of life may prevent some diseases. Further researches are needed to find out young consumers' acceptance and needs for functional foods.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Table 1. Characteristics and likelihood to consume functional foods of the study population

Characteristics	**Respondents**		**Likelihood to consume functional food**	
	n	**%**	**OR[1] (95% CI)**	***P* Value**
Gender				
Boy	950	47.8	1.00	
Girl	1038	52.2	1.15 (0.94, 1.42)	0.174
Age (Years)				
11-13	498	25.1	1.00	
14-15	939	47.2	1.25 (0.97, 1.60)	0.084
16-18	551	27.7	1.31 (0.99, 1.72)	0.056
Education level of father[2]				
Low	297	15.2	1.00	
Medium	817	41.9	0.96 (0.73, 1.26)	0.780
High	526	27.0	1.06 (0.76, 1.46)	0.749
Education level of mother[3]				
Low	275	14.0	1.00	
Medium	883	44.8	1.26 (0.96, 1.66)	0.099
High	530	26.9	1.43 (1.02, 1.99)	0.036
Chronic Disease[4]				
No	1634	84.1	1.00	
Yes	310	15.9	0.88 (0.68, 1.15)	0.362
BMI (kg/m^2)				
Normal	1341	70.7	1.00	
Overweight	365	19.2	1.32 (1.02, 1.70)	0.035
Obese	191	10.1	1.25 (0.89, 1.75)	0.198
Physical activity[5]				
Inactive	729	37.8	1.00	
Active	1201	62.2	1.21 (0.98, 1.50)	0.074

[1]Odds ratios (ORs) adjusted for all variables
[2]Education level of mother: low less than 6y, medium 6-12y, high: higher than 12 y.
[3]Education level of mother: low less than 6y, medium 6-12y, high: higher than 12 y.
[4]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases
[5]Physical activity: Inactive less than 300min/week, Active more than 300min/week

Table 2. Percentage of functional food consumers and mean daily intake of functional foods

	Boy		Girl		***P***
Functional Foods	**N (%)**	**Mean ± SD (g)**	**N (%)**	**Mean ± SD (g)**	**value[1]**
Soy milk	61 (6.3)	231.25 ± 23.94	47 (4.5)	180.20 ± 100.18	0.358
Probiotics	206 (21.3)	167.56 ± 134.91	188 (17.9)	138.97 ± 47.91	0.016
Modified milk	186 (19.2)	241.09 ± 73.12	223 (21.2)	227.12 ± 53.07	0.052
Infusions	93 (9.6)	79.67 ± 61.04	88 (8.4)	72.07 ± 62.49	0.582
Fruit juice	205 (21.2)	310.98 ± 183.25	209 (19.8)	262.56 ± 137.39	0.008
Fibre-rich bread/cookies	77 (8.0)	79.70 ± 42.50	86 (8.2)	64.91 ± 36.26	0.157
Cereal bars	61 (6.3)	16.75 ± 31.50	46 (4.4)	11.50 ± 12.12	0.766
Breakfast Cereals	209 (21.6)	35.15 ± 16.19	180 (17.1)	32.73 ± 10.73	0.139

[1]Differences between mean values were tested by ANOVA

Table 3. Use of functional foods in relation to demographic and lifestyle characteristics (Crude Odds ratios (ORs) and 95% confidence intervals)

	Breakfast Cereals	**Cereal bars**	**Fibre-rich bread/cookies**	**Modified milk**	**Infusions**	**Soy Milk**	**Probiotics**
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Gender							
Boy	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Girl	0.73 (0.59, 0.90)*	2.96 (0.96, 9.11)	1.43 (1.05, 1.95)*	1.39 (1.13, 1.71)*	1.20 (0.87, 1.68)	3.19 (1.05, 9.73)*	1.00 (0.82, 1.22)
Age (years)							
11-13	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14-15	0.81 (0.63, 1.04)	0.66 (0.23, 1.91)	1.72 (1.12, 2.62)*	1.09 (0.84, 1.42)	1.42 (0.88, 2.29)	3.26 (0.73, 14.50)	1.03 (0.80, 1.32)
16-18	0.80 (0.60, 1.07)	0.42 (0.10, 1.68)	1.51 (0.94, 2.40)	1.22 (0.92, 1.62)	2.20 (1.34, 3.59)*	1.26 (0.21, 7.58)	1.04 (0.79, 1.37)
Education level of father[1]							
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.37 (1.06, 1.77)*	1.48 (0.44, 4.92)	0.89 (0.61, 1.31)	1.16 (0.91, 1.48)	0.93 (0.63, 1.37)	0.61 (0.19, 2.01)	1.03 (0.81, 1.31)
High	1.33 (1.00, 1.77)*	1.46 (0.39, 5.48)	1.29 (0.87, 1.91)	1.21 (0.92, 1.59)	1.00, (0.65, 1.54)	0.97 (0.30, 3.20)	1.43 (1.10, 1.85)*
Education level of mother[2]							
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.11 (0.86, 1.45)	1.48 (0.38, 5.75)	0.90 (0.61, 1.33)	1.07 (0.83, 1.37)	0.77 (0.52, 1.14)	1.11 (0.32, 3.80)	1.08 (0.85, 1.37)
High	1.55 (1.17, 2.06)*	2.52 (0.65, 9.79)	1.56 (1.05, 2.33)*	1.39 (1.05, 1.82)	0.98 (0.64, 1.50)	1.88 (0.55, 6.48)	1.21 (0.92, 1.58)
Chronic diseases[3]							
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.82 (0.61, 1.11)	0.75 (0.17, 3.34)	1.34 (0.90, 1.98)	1.03 (0.78, 1.36)	0.75 (0.46, 1.24)	4.32 (1.69, 11.05)*	0.85 (0.65, 1.13)
BMI (kg/m^2)							
Normal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Overweight	0.94 (0.69, 1.27)	1.15 (0.67, 1.97)	1.43 (0.95, 2.16)	1.32 (1.00, 1.74)	0.87 (0.56, 1.34)	1.01 (0.58, 1.75)	1.32 (1.00, 1.75)
Obese	1.04 (0.71, 1.54)	1.09 (0.53, 2.25)	1.36 (0.79, 2.34)	1.44 (1.01, 2.06)*	0.93 (0.53, 1.62)	0.90 (0.43, 1.91)	0.95 (0.64, 1.42)
Physical activity							
Inactive	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.53 (1.19, 1.96)*	1.35 (0.84, 2.16)	0.93 (0.65, 1.32)	1.15 (0.91, 1.46)	0.90 (0.64, 1.26)	1.64 (1.01, 2.68)*	1.20 (0.45, 1.53)

Odds ratios within a column, for a characteristic, were statistically significant from 1·00 ($P<0.05$).
[1]Education level of father: Low less than 6y, medium 6-12y, high: higher than 12 y.
[2]Education level of mother: Low less than 6y, medium 6-12y, high: higher than 12 y.
[3]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases.

Table 4. Use of functional foods in relation to demographic and lifestyle characteristics (Adjusted Odds ratios (ORs) and 95% confidence inter

	Breakfast Cereals	Cereal bars	Fibre-rich bread/cookies	Modified milk	Infusions	Soy Milk	Probiotics
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender							
Boy	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Girl	0.78 (0.62, 0.98)*	3.90 (1.08, 14.12)*	1.47 (1.05, 2.06)*	1.50 (1.2, 1.88)*	1.16 (0.80, 1.68)	2.51 (0.78, 8.06)	1.06 (0.85, 1.31)
Age (years)							
11-13	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14-15	0.80 (0.61, 1.06)	0.97 (0.29, 3.26)	1.78 (1.21, 2.81)*	1.11 (0.84, 1.46)	1.70 (0.97, 2.96)	2.73 (0.59, 12.57)	1.06 (0.81, 1.38)
16-18	0.82 (0.60, 1.12)	0.60 (0.13, 2.75)	1.56 (0.94, 2.59)	1.20 (0.89, 1.63)	2.64 (1.50, 4.66)*	1.16 (1.22, 9.76)	1.06 (0.79, 1.43)
Education level of father[1]							
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium	1.30 (0.94, 1.79)	1.35 (0.33, 5.47)	0.85 (0.53, 1.36)	1.18 (0.87, 1.61)	0.87 (0.52, 1.45)	0.52 (0.13, 2.09)	1.06 (0.79, 1.43)
High	1.04 (0.71, 1.51)	0.66 (0.11, 3.94)	1.07 (0.63, 1.83)	1.19 (0.83, 1.71)	0.99 (0.56, 1.79)	0.53 (0.12, 2.46)	1.44 (1.02, 2.04)
Education level of mother[2]							
Low	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Medium	0.94 (0.68, 1.30)	1.41 (0.29, 6.73)	1.02 (0.63, 1.66)	1.10 (0.80, 1.50)	0.73 (0.44, 1.21)	1.06 (0.24, 4.75)	1.06 (0.78, 1.43)
High	1.43 (0.98, 2.09)	2.45 (0.44, 13.62)	1.74 (1.01, 3.00)	1.42 (0.98, 2.05)	0.98 (0.54, 1.77)	2.77 (0.58, 13.27)	1.03 (0.72, 1.48)
Chronic diseases[3]							
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.81 (0.59, 1.12)	0.66 (0.15, 2.99)	1.19 (0.79, 1.81)	0.96 (0.72, 1.29)	0.71 (0.41, 1.22)	3.45 (1.22, 9.76)*	0.86 (0.64, 1.15)
BMI (kg/m^2)							
Normal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Overweight	0.93 (0.66, 1.30)	1.31 (0.68, 2.52)	1.91 (1.20, 3.06)*	1.43 (1.05, 1.93)*	0.94 (0.57, 1.54)	1.07 (0.55, 2.09)	1.34 (0.99, 1.83)
Obese	1.07 (0.69, 1.68)	0.39 (0.09, 1.64)	1.18 (0.56, 2.48)	1.43 (0.95, 2.16)*	0.61 (0.27, 1.36)	0.16 (0.02, 1.19)	0.92 (0.58, 1.46)
Physical activity							
Inactive	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Active	1.28 (0.96, 1.71)	0.87 (0.47, 1.61)	0.78 (0.50, 1.20)	1.20 (0.92, 1.57)	0.69 (0.46, 1.04)	1.20 (0.64, 2.26)	1.05 (0.80, 1.39)

*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (P<0.05).
[1]Education level of father: Low less than 6y, medium 6-12y, high: higher than 12 y.
[2]Education level of mother: Low less than 6y, medium 6-12y, high: higher than 12 y.
[3]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases.

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Manuscript V

Adherence to the Mediterranean Diet: the perspective of functional food consumers in the Balearic Islands

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ABSTRACT

Objective: The aim of our study was to assess differences in the adherence to the Mediterranean diet (MD) between the consumers and non-consumers of functional food (FF) among the adult population of the Balearic Islands and to compare the consumption of FF and intake of functional components between FF users with high and low adherence to the MD.

Design: The study was a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2009 and 2010. Data were obtained from a semi-quantitative food frequency questionnaire (FFQ), two non-consecutive 24-h recalls and a global questionnaire. The target population was consisting of all inhabitants living in the Balearic Islands aged 16-65 years.

Results: The mean adherence of FF users to the MD was 51.23 (SD 14.25) %, while the mean adherence of FFs non-users' to the MD was 49.63 (SD 11.85) %. Gender, age and education level were found important determinants of adherence to the MD. Consumption of probiotics, fibre rich bread/cookies, infusions, fish, soy milk and cholesterol lowering products was higher in adults with high adherence to the MD, whereas consumption of breakfast cereals, fruit juice, infusions and red wine was higher in adults with low adherence to the MD. Moreover, daily mean intake of functional components which are from plant origin foods, like dietary fibre, vitamin C, vitamin E, carotene, folic acid was significantly higher in adults with high adherence to the MD.

Conclusions: A moderate adherence to the MD was observed among the adult population of the Balearic Islands; however, the mean adherence was on the border to the low adherence. Furthermore, intake of many functional components like zinc, n-6 fatty acids, magnesium, potassium, folic acid and dietary fibre were inadequate. Consumption of MD components like fruits, vegetables and whole grain cereals should be increased to obtain high adherence to the MD, thus the intake of inadequate nutrients in the diet will increase.

Keywords: Functional food, functional component, the Mediterranean diet, adult, the Balearic Islands

INTRODUCTION

The Mediterranean diet (MD) describes the dietary pattern in the olive-growing areas of the Mediterranean region [1] and varies among different cultures, traditions and geographic locations [2,3]. High consumption of plant origin foods such as, cereals, legumes, fruits and vegetables in this dietary pattern provide protective effects on well being [4].

Health benefits of the 'traditional' MD have been well documented in several studies [4-9]. Reduction in the risk of cardiovascular disease, certain cancers and overall mortality [4,7,8] and protective effect on weight gain [10,11] and the development of type 2 diabetes [5,11,12] are some of the findings which have showed the protective and preventing role of the MD.

There are many standpoints to explain the health benefits of the MD such as high consumption of vegetables and fruits, high intake of olive oil or high intake of antioxidants [13,14]; although, it is clear that great varieties of foods in the MD improve the health status and also reduce the risk of many diseases [4,7,11]. Besides, numerous functional foods like olive oil, yogurt, garlic, tomato, wine, herbs, spices and nuts [15] and functional components like phenols, flavonoids, isoflavonoids, phytosterols and phytic acid are abundant in the MD [15].

Several studies have reported that adherence of the Mediterranean population to the MD has decreased [12,16-18] and dietary patterns in the Mediterranean areas have been switching to unhealthy diets [12,16,19]. While prevalence of diet related diseases have increased [20], FFs offer a new kind of health message to the consumers with their functional components [21] and more health-oriented consumers choose them to obtain health benefits [22]. In the literature, studies that examine the interest of FFs users to the healthy MD do not exist. In the present study we aimed to assess differences in the adherence to the MD between the consumers and non-consumers of FF among the adult population of the Balearic Islands and compare the consumption of FF and intake of functional components between FF users with high adherence to the MD and low adherence to the MD.

METHODS

Study design

The study was a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2009 and 2010.

Study population

The data collection took place in the Balearic Islands and the sample population was derived from residents aged 16-65 years, registered in the official population census of the Balearic Islands [23]. The theoretical sample size was set at 1500 individuals and the one specific relative precision of 5% (type I error = 0.05; type II error = 0.10), and the final sample was 1386

(92.4% participation). Pregnant women were not considered in this study. Written informed consent was obtained from all subjects and when they were under 18 years old, also from their parents or legal tutors.

General questionnaire

A questionnaire incorporating the following questions was used: age group, education level (grouped according to years of education: low, <6 years at school; medium, 6-12 years of education; high, >12 years of education) and socio-economic level classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology [24].

Anthropometric measurements were also obtained. Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France) with subjects wearing light clothes without shoes, respectively. Body mass index (BMI) was computed as weight/height^2 and study participants were categorized as normal weight (≤24.9 kg/m^2), overweight (≥25 kg/m^2 ≤29.9 kg/m^2) and obese (≥30 kg/m^2) according to BMI.

Physical activity (PA) was evaluating according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire [25] in the short form. The specific types of activity assessed were walking, moderate-intensity activities (i.e. PA at work), vigorous-intensity activities (i.e. sport practice) and sitting time (used as an indicator variable of time spent in sedentary activity). On the basis of their total weekly time of physical activity, the subjects were divided into 3 groups: 0-149, 150-499, and ≥500 min/wk.

Dietary questionnaire

Dietary intake was assessed with the dietary questionnaires included two non-consecutive 24-h recalls and a validated semi-quantitative food frequency questionnaire (FFQ) covering the 145-item [16]. Frequency of food consumption was based on times that food items were consumed (per day, week or month). Consumption <1/month was considered no consumption. Daily consumption (g) was determined by dividing the reported amount of the intake by the frequency (d). The period of consumption of seasonal items was also considered. To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. Well-trained dieticians administered the recalls and verified and quantified the food records. To estimate volumes and portion sizes, the household measures found in the subjects' own homes were used. Total nutrition and energy intake (TEI) were calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [26,27] and European Food Composition Tables [28], and complemented with food composition data available for Balearic food items [29]. Daily mean intake of functional components (selenium, zinc, vitamin E, vitamin C, carotene, omega-6, omega-3, fibre, calcium, magnesium, potassium, niacin, folic acid and pantothenic acid) was calculated. The nutritional density of each functional component was calculated dividing the average intake of these nutrients by the total energy intake (MJ) in order to avoid bias caused by different intakes of energy. Adequacy for intakes of functional components were calculated as percentage of the age-specific Recommended Dietary Reference Intakes (RDIs) for Spanish people [30] and RDI for Europeans [31] when no reference data was given for Spanish people.

Assessment of functional foods consumption

Functional foods, which were selected according to functional food list, reported by Hasler, [32] were taken from the dietary questionnaires. Moreover, modified milk (low/skimmed fat milk, omega-3 added milk), infusions (coffee and tea), and soy milk were considered as functional food in this review, due to various studies which reported these foods might reduce the risk of some diseases [33-39].

Mediterranean dietary pattern

The MD has been defined according to a previously defined score indicating the degree of adherence to the traditional MD [1,4,16,18,40]. This Mediterranean dietary score was converted to relative percentage of adherence using a previously described method [41]. An energy-adjusted value was obtained for each individual for the daily consumption of legumes, cereals and roots (including bread and potatoes), fruits (including nuts), vegetables, fish, meat (and meat products) and milk (and milk products). In order to score ‘moderate alcohol consumption’, a transformation centred at the level of consuming 30 g/d for men (30–(30–absolute alcohol intake)), and 20 g/d for women (20–(20–absolute alcohol intake)) was used to obtain the highest value for men consuming 30 g/d or women consuming 20 g/d, and progressive lower values as the consumption was lower or higher than these values. These values were associated with the lowest coronary heart disease (CHD) risk in previous studies [42,43].

All the values were standardised as a Z value. A Z score expresses the difference between the individual’s measurement and the mean value of the reference population (in this case, the study population) as a proportion of the SD of the reference population ((observed intake–energy adjusted intake)/SD).

The total Mediterranean dietary score was computed by adding up all the Z scores obtained for the favourable or ‘more Mediterranean’ dietary components (legumes, cereals and roots, fruits, vegetables, fish, alcohol and MUFA:SFA ratio) and subtracting the Z value obtained from the consumption of meat and whole milk (mainly high in fat):

$$\sum Z_i = Z_{legume} + Z_{fruit} + Z_{vegetable} + Z_{cereal\ and\ root} + Z_{fish} + Z_{alcohol} + Z_{MUFA:SFA} - Z_{milk} - Z_{meat}$$

The Mediterranean dietary score was converted to relative percentage of adherence using the range of values of the sample. This percentage ranged from 100 (maximum adherence) to 0 (minimum adherence):

$$Adherence(Percentage_i) = \frac{\left(\sum Z_i - \sum Z_{\min}\right)}{\left(\sum Z_{\max} - \sum Z_{\min}\right)} \times 100$$

Once the percentage of adherence to the MD was calculated, the variables that could determine a higher or lower adherence were assessed.

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). Mean adherence and SD were calculated. Quartile values of adherence to the MD were calculated in order to find the group of the population with the lowest adherence percentage (percentage below the lower quartile value) and those with the highest adherence (percentage of adherence above the upper quartile value). Differences between mean adherence of FF users and non-users and mean intake of FFs and functional components by FF users according to low and high adherence to the MD were tested by ANOVA. Logistic regression models were used to calculate the differences between the socio-demographic and lifestyle differences of the lowest and highest adherence (in order to assess which variables better determined a high or low adherence), among users and non-users of FF. Crude and adjusted odds ratios (OR; and 95% CI) were calculated. ORs for all variables were adjusted for sex and age. Spearman's rank correlation coefficient (r) was used to study the correlation between consumption of FFs and functional component intakes. The level of significance was established for P values, 0.05.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee.

RESULTS

A total of 1191 individuals reported FF consumption, whereas total 195 respondents consumed none of the FF. Figure 1a and b show the distribution of percentage of FF users and non-users adherence to the MD. While the mean and median adherence of FF users was 51.23% (SD 14.25) and 50.20%, the mean and median adherence of FF non-users was 49.63% (SD 11.85) and 49.71% respectively, slightly lower than those of FF users.

Means and standard deviations of the percentage of adherence of FF users and non-users to the MD according to socio-demographic and lifestyle factors are shown in Table 1. We observed gender was significantly associated with adherence to the MD and in both groups females had a higher risk to have a lower adherence to the MD than males did. In the comparison of FF users and non users, female FF users had a significantly higher mean adherence to the MD than non-users did. Age was found another important determinant for risk of low adherence and strongly associated with adherence to the MD in FF users and also in non-users. Younger adults had a significantly higher risk to have a low adherence to the MD than older did.

Marital status, employment status, BMI, physical activity, smoking and alcohol status were not statistically associated with adherence to the MD in FF users and non-users, while education level was found inversely associated with risk of low adherence to the MD. Having a chronic disease was also significantly associated with low risk of adherence to the MD in FF users.

FF consumption (g/d) and intake of functional components of FF users according to low and high adherence to the MD is shown in Table 2. Consumption of probiotics, fibre rich bread/cookies, infusions, fish, soy milk and cholesterol lowering products was higher in adults with high adherence to the MD, while consumption of modified milk, breakfast cereals, fruit juice, infusions and red wine was higher in adults with low adherence to the MD. Moreover, daily mean intake of functional components which are from plant origin foods, like dietary fibre, vitamin C, vitamin E, carotene, folic acid was significantly higher in adults with high adherence to the MD. The average intakes of selenium, vitamin C, omega-3 fatty acid, calcium, niacin and pantothenic acid met the RDI in both groups; whereas, intakes of vitamin E and carotene met the RDI only in FF users who had a high adherence to the MD. Intake of other functional components was lower than the RDI value in both groups.

The Spearman correlation analysis between the consumption of FFs and intake of functional components is shown in Table 3. Consumption of FFs except fruit juice, fish, red wine and cholesterol lowering products was found positively associated with the intake of many functional components. As expected there was a positive correlation between consumption of modified milk, probiotics and calcium intake. Intakes of dietary fibre were found positively associated with the consumption of breakfast cereals and fibre rich bread/cookies.

DISCUSSION

Health benefits of the MD are reported in several studies in the literature [4-9]. Moreover, consumers choose FF to improve the healthiness of their diet [44]. In the present adult population, FF users and non-users had moderate adherence to the MD; however, adherence of FF users and non-users indicated a borderline to low adherence to the MD. Another study, carried out in the Balearic Islands was reported that mean adherence of the adult population to the MD was around 43% [45], which shows that the adherence of the adult population to the MD increased in the last ten years in the Balearic Islands. Nevertheless, moving away from the

MD and switching to more westernised diets in the Mediterranean areas has been reported in many studies [12,19].

Socio-demographic characteristics such as gender, age, education level and the presence of chronic diseases were found significantly associated with the risk of low adherence to the MD. To be female, younger and have a lower education level had a higher risk to have low adherence to the MD. In general, female adults were more interested in healthy eating [46]; however, we observed males were more likely to follow a healthy MD. It was also reported in other studies that younger adults had a higher risk to have a low adherence to the MD [16,41,47]. A higher education level was associated with healthy eating [48] and in this study we also observed that respondents with a high education level had a lower risk to have a low adherence to the MD.

In many studies it was reported that smoking status was associated with unhealthy diet, and heavy smokers consumed less vegetables, fruits and olive oil [49,50]. In contrast to these studies, we observed no relation between smoking status and risk of low adherence to the MD in FF users and also non-users. While alcohol consumption increased, diet quality decreased [51] but, moderate consumption of wine during the meal was one of the characteristics of the traditional MD [4]; however, we didn't find any association between alcohol consumption and the risk of low adherence to the MD.

The Mediterranean area not only provides numerous foods, but also the climate in this area makes outdoor leisure activities possible [2,52]. In addition to the healthy diet, physical activity has been referred as an important part of a healthy lifestyle [52], but in this study, no association was found between physical activity and the risk of low adherence to the MD.

The presence of chronic diseases was found linked to have a lower risk to the MD in FF users. This might be explained that subjects with chronic disease were more focused on healthy eating due to their health status; therefore they were consuming FFs and following a healthy MD.

Consumption of FFs which are components of the MD such as fermented milk products and fish were higher in FF users with high adherence to the MD. Fish consumption in Spain is one of the highest in Europe [53] and we observed also high fish consumption among FF users with high adherence to the MD.

The intake of functional components such as vitamin E and C, carotene, dietary fibre, magnesium, potassium and folic acid was higher in FF users with high adherence to the MD than those of with low adherence. A high consumption of vegetables, fruits, cereals, legumes, nuts, and olive oil provides a high amount of these nutrients [11]. Tur *et al.*, [54] reported that intake of β-carotene, zinc and vitamin E was inadequate in adult population of the Balearic Islands in 2000. We observed inadequate intake of functional components like zinc, omega-6 fatty acid, dietary fibre, magnesium, potassium and folic acid among FF users with high and low adherence to the MD; however, intake of carotene and vitamin E increased in the last 10 years among Balearic adults and met the RDI value in FF users with high adherence to the MD. On the other hand, the intake of vitamin E and carotene was still inadequate among FF users with low adherence to the MD.

Consumption of FFs such as modified milk, probiotics, fibre-rich bread/cookies, breakfast cereals, infusions and soy milk had a positive association with the intake of many functional components. Studies showed that consumption of foods and food components in the diet has an additive or synergistic effect in the human body [6]. The MD which is rich in FFs and functional components [55,56] provides a large variety of food choice and the combination of the healthy MD diet with regular physical activity provides a protective effect against many diseases [2,51].

CONCLUSIONS

Moderate adherence to the MD was observed among the adult population of the Balearic Islands; however, the mean adherence was on the border to the low adherence. Furthermore, the intake of many functional components like zinc, n-6 fatty acids, magnesium, potassium, folic acid and dietary fibre were inadequate. Consumption of MD components like fruits, vegetables and whole grain cereals should be increased to obtain a high adherence to the MD, thus the intake of these inadequate nutrients will increase.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Conflict of interests

The authors state that there are no conflicts of interest.

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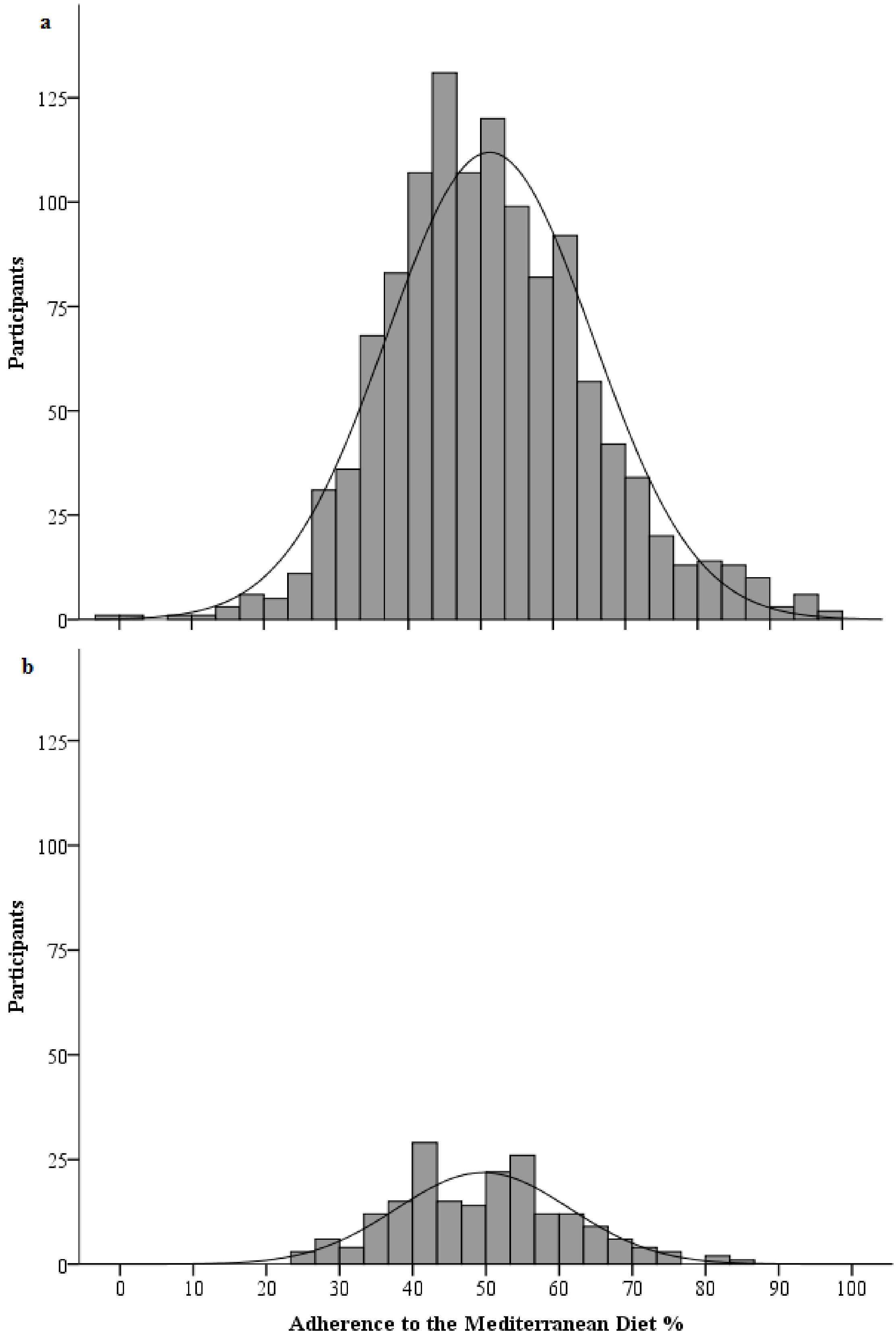

Figure 1. Percentage distribution of functional food consumers' (a) and non-consumers' (b) adherence to the Mediterranean dietary pattern (N=1191 and N=195)

Table 1. Percentage of adherence and risk of a low adherence according to socio-demographic and lifestyle variables of functional food users and non-users (Mean values and standard deviations; OR and 95% CI)

Socio-demographic and lifestyle variables	Functional food users			Functional food non-users		
	Percentage of adherence		Risk of low adherence[1]	Percentage of adherence		Risk of low adherence[2]
	Mean	SD	OR (95% CI)	Mean	SD	OR (95% CI)
Gender						
Male	52.13	15.60	0.69 (0.50, 0.95)*	48.57	12.66	0.89 (0.65, 1.02)
Female	50.86†	13.07	1.00	47.45	10.63	1.00
Age (years)						
16-25	48.23	13.66	4.12 (2.58, 6.57)***	45.84	10.92	3.13 (2.00, 4.88)***
26-45	53.10	13.91	1.28 (0.81, 2.02)	50.09	11.33	1.24 (0.78, 1.95)
46-65	54.40	14.70	1.00	54.99	12.13	1.00
Marital Status						
Not married[3]	50.32††	13.96	1.35 (0.89, 2.04)	46.56	11.36	1.37 (0.90, 2.09)
Married	53.89	14.38	1.00	54.58	12.48	1.00
Education level						
Low (<6 y)	49.40	13.97	1.53 (1.00, 2.35)*	47.24	12.04	1.34 (0.84, 2.14)
Medium (6-12 y)	50.69†	13.95	1.38 (0.93, 2.05)	46.19	8.55	1.79 (0.64, 0.97)*
High (>12 y)	53.73	14.29	1.00	52.09	14.76	1.00
Employment status						
Low	48.29	13.37	1.42 (0.91, 2.21	46.65	11.20	1.56 (1.03, 2.35)*
Medium	51.00	15.74	1.13 (0.67, 1.90)	45.05	10.29	1.37 (0.83, 2.26)
High	53.78	13.99	1.00	51.11	11.33	1.00
BMI (kg/m^2)						
>25	50.80†	13.31	1.52 (0.54, 1.55)	47.80	10.49	2.74 (0.44, 2.24)
25-29.9	51.89	15.65	0.87 0.50, 1.49)	47.38	12.24	2.91 (0.53, 2.56)
>30	51.80	14.36	1.00	52.21	17.10	1.00
Smoking status						
Non-smoker	51.30	14.18	0.77 (0.53, 1.12)	49.54	12.30	0.86 (0.61, 1.22)
Ex-smoker	54.50	15.37	0.62 (0.36, 1.07)	45.22	8.78	0.68 (0.39, 1.20)
Smoker	50.22††	13.37	1.00	44.25	9.17	1.00
Alcohol status						
Non-drinker	50.36	14.23	1.04 (0.49, 2.20)	51.01	12.77	1.57 (0.12, 1.67)
Occasional drinker	51.86	14.62	0.82 (0.40, 1.69)	48.89	12.08	2.85 (0.22, 3.22)
Daily drinker	50.83	13.72	1.02 (0.48, 2.19)	48.07	11.21	3.38 (0.24, 4.23)
Alcoholic	53.30	14.62	1.00	52.65	11.91	1.00
Physical activity						
0-149 min/w	50.96†††	13.55	1.16 (0.76, 1.77)	45.03	10.95	1.21 (0.82, 1.80)
150-499 min/w	52.56	13.96	0.84 (0.53, 1.32)	50.54	10.60	0.93 (0.60, 1.45)
≥500 min/w	51.37	15.08	1.00	51.53	12.47	1.00
Chronic Disease						
Have disease	52.49†	14.02	0.66 (0.46, 0.95)*	48.05	10.76	0.99 (0.33, 3.02)
No disease	50.45	14.04	1.00	49.58	12.04	1.00

[1]Low adherence was defined as a percentage of adherence below the lower quartile (41.4%); high adherence was defined as a percentage of adherence above the upper quartile (60.2%)
[2]Low adherence was defined as a percentage of adherence below the lower quartile (41.0%); high adherence was defined as a percentage of adherence above the upper quartile (57.2%)
[3]Not married includes: single, divorced, widowed, and separated
†Mean values were significantly different than those of functional food non-users (one-way ANOVA), $P<0.05$
Odds ratios (ORs) adjusted for all other variables in the model
*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 ($P<0.05$)
***Odds ratios within a column, for a characteristic, were statistically significant from 1·00 ($P<0.0001$)

Table 2. Average daily intake of functional foods and functional components by functional food users according to low and high adherence to the Mediterranean diet

Functional food	High Adherence to the MD[1]		Low Adherence to the MD[2]	
	Mean ± SD	**RDI%[3]**	**Mean ± SD**	**RDI%[3]**
Modified milk[4] (g)	109.64 ± 144.44	-	126.29 ± 160.54	-
Probiotics (g)	61.44 ± 91.37*	-	44.87 ± 78.04	-
Fibre-rich bread/cookies (g)	17.74 ± 42.80	-	13.05 ± 35.01	-
Breakfast cereals (g)	10.05 ± 21.81	-	11.75 ± 22.34	-
Fruit Juice (g)	60.29 ± 148.92	-	63.78 ± 131.87	-
Infusions[5] (g)	112.13 ± 165.23**	-	77.08 ± 133.75	-
Fish (g)	95.08 ± 124.67***	-	6.43 ± 23.30	-
Soy milk (g)	12.24 ± 50.37	-	11.87 ± 54.31	-
Red wine (g)	23.39 ± 67.73		41.97 ± 580.73	
Cholesterol lowering product (g)	1.53 ± 13.11		0.33 ± 5.78	
Functional components				
Antioxidants				
Selenium (µg/MJ)	13.46 ± 6.15	188.99 ± 96.27	13.18 ± 5.23	184.93 ± 87.99
Zinc (mg/ MJ)	1.26 ± 0.56**	81.80 ± 45.02*	1.39 ± 0.77	88.89 ± 47.88
Vitamin E (mg/ MJ)	1.10 ± 0.55***	105.05 ± 55.62***	0.88 ± 0.55	85.16 ± 57.92
Vitamin C (mg/MJ)	19.83 ± 15.30***	266.79 ± 185.07***	14.30 ± 12.02	192.68 ± 153.68
Carotene (µg / MJ)	664.42 ± 1019.79***	103.43 ± 145.68***	390.05 ± 593.56	59.56 ± 85.34
Fatty Acids				
Omega-6 (Linoleic acid) (g/ MJ)	1.12 ± 0.71	70.26 ± 45.92	1.04 ± 0.66	67.37 ± 48.17
Omega-3 (Linolenic acid) (g/ MJ)	0.21 ± 0.21	142.91 ± 140.92	0.23 ± 0.26	147.35 ± 154.83
Others				
Dietary fibre (g/MJ)	2.30 ± 1.05***	65.79 ± 34.02**	1.99 ± 0.92	57.25 ± 31.37
Calcium (mg/ MJ)	97.79 ± 42.21	118.56 ± 56.00	104.16 ± 45.01	126.10 ± 58.30
Magnesium (mg/ MJ)	35.63 ± 13.00**	96.68 ± 38.28*	32.96 ± 11.88	88.98 ± 34.78
Potassium (mg/ MJ)	385.65 ± 144.41***	68.51 ± 24.47***	334.53 ± 115.06	59.85 ± 21.47
Niacin (mg/ MJ)	2.63 ± 1.22	148.90 ± 75.81	2.55 ± 1.57	143.65 ± 99.44
Folic acid (µg/ MJ)	42.74 ± 31.02***	87.28 ± 47.42***	34.01 ± 20.13	69.98 ± 38.53
Pantothenic acid (mg/ MJ)	0.68 ± 0.40	112.16 ± 54.32***	0.65 ± 0.45	111.30 ± 85.36

[1]Above the upper quartile (60.2%)
[2]Below the lower quartile (41.4%)
[3]RDI Recommended Dietary Intake
[4]Skimmed/semi-skimmed milk, omega-3 added milk
[5]Coffee and tea
Mean values were significantly different than those of functional food users with low adherence to the Mediterranean diet (one-way ANOVA), $^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$.

Table 3. Spearman correlation coefficients (r) between the intakes of functional foods and functional components

	Modified Milk	Probiotics	Fibre-rich bread/cookies	Breakfast cereals	Fruit Juice	Infusions	Fish	Soy milk	Red wine	Cholesterol lowering product
Dietary fibre	0.034	0.130**	0.262**	0.095**	0.032	0.100**	-0.015	0.121**	-0.030	0.016
Selenium	0.060	0.005	0.069**	0.017	0.013	-0.019	0.072**	-0.037	-0.023	-0.019
Zinc	0.173**	0.037	0.105**	0.067*	0.047	-0.028	-0.023	-0.040	0.010	-0.051
Vitamin E	0.021	0.089**	0.097**	0.040	0.007	0.109**	0.036	0.078**	0.034	0.008
Vitamin C	0.058*	0.192**	0.124**	0.149**	0.268**	0.089**	0.019	0.055*	0.036	0.072**
Carotene	0.044	0.161**	0.092*	0.001	-0.010	0.167**	-0.010	0.095**	0.020	0.017
Linoleic acid	-0.027	0.041	0.104**	0.064*	0.030	0.068*	0.006	0.316**	-0.030	-0.006
Linolenic acid	0.036	0.120**	0.074**	0.076**	0.015	0.085**	0.009	0.218**	-0.056*	0.016
Calcium	0.257**	0.247**	0.107**	0.179**	-0.050	0.066*	-0.013	-0.010	-0.004	0.030
Magnesium	0.199**	0.172**	0.242**	0.156**	0.026	0.088**	0.034	0.181**	-0.007	0.017
Potassium	0.147**	0.231**	0.111**	0.081**	0.084**	0.108**	0.026	0.093**	0.005	0.008
Niacin	0.097**	0.164**	0.112**	0.386**	0.007	0.22	0.049	0.020	0.006	-0.003
Folic acid	0.104**	0.229**	0.189**	0.343**	0.013	0.116**	0.028	0.115**	0.025	0.041
Pantothenic acid	0.175**	0.196**	0.096**	0.122**	0.012	0.097**	0.019	-0.010	0.009	-0.011

* Indicates a significant difference by *P*-value < 0.05
** Indicates a significant difference by *P*-value < 0.01

Manuscript VI

Adherence to the Mediterranean Diet and consumption of functional foods among the Balearic Islands adolescent population

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Adherence to the Mediterranean Diet and consumption of functional foods among the Balearic Islands adolescent population

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ABSTRACT

Objective: The aim of our study was to assess differences in the adherence to the Mediterranean diet (MD) between the consumers and non-consumers of functional food (FF) among the adolescent population of the Balearic Islands.

Design: The study is a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2009. The target population was consisting of all inhabitants living in the Balearic Islands aged 11-18 years. Dietary intakes were obtained from a semi-quantitative food frequency questionnaire (FFQ), two non-consecutive 24-h recalls and a global questionnaire.

Results: The mean adherence of FF users to the MD is 56.42% (SD 6.05), while the mean adherence of FF non-users' to the MD is 55.76% (SD 5.41). Gender, age, education and socio-economic levels of parents are important factors which affected adherence to the MD. Consumption of fruit juice, fibre rich bread/cookies, cereal bars, fish and soy milk was higher in adolescents with high adherence to the MD, whereas consumption of modified milk, probiotics, breakfast cereals and infusion consumption was higher in adolescents with low adherence to the MD. Moreover, daily mean intake of functional components which are from plant origin foods, like dietary fibre, vitamin C, vitamin E, carotene, folic acid was significantly higher in adolescents with high adherence to the MD.

Conclusions: Moderate adherence to the MD was observed among the adolescent population of the Balearic Islands; however, inadequate intake of many functional components like carotene, zinc, omega-6 and omega-3 fatty acids and dietary fibre was found. High adherence of adolescents to the MD might cause an increase of the intake of these inadequate nutrients. Parents should be aware of this and follow the MD to serve as a model for their children.

Keywords: Functional food, functional component, the Mediterranean diet, adolescent, the Balearic Islands

INTRODUCTION

The Mediterranean diet (MD) was defined as a dietary pattern found in the olive oil growing areas of the Mediterranean region in the late 1950s and early 1960s by Ancel Keys [1]. This dietary pattern varies between coasts and inland of the Mediterranean, depends on cultural differences, traditions, geographic location and food availability [2,3], but generally the traditional MD is characterised by high consumption of legumes, cereals (in the past unrefined), fruits and vegetables, moderate to high consumption of fish (depending on the proximity of the sea), moderate consumption of milk and dairy products (mainly in form of yogurt and cheese), moderate consumption of alcohol (mainly wine and preferably during meals), and low consumption of meat and meat products [4]. High monosaturated/saturated dietary fat ration is another characteristic of the MD, because of the abundant use of oil olive and low intake of saturated dietary fats [1]. In addition to their healthy diet, Mediterranean people had regular physical activity, usually required for field or kitchen work and outdoor leisure activities [2,5].

Great richness and diversity of plants in the Mediterranean region provide numerous functional foods (FFs), which improve the state of health and/or provide reduction in risk of disease [6], like olive oil, yogurt, garlic, tomato, wine, herbs, spices and nuts [7]. In addition to functional foods, the MD is rich in functional components like phenols, flavonoids, isoflavonoids, phytosterols, phytic acid and omega 3 (n-3) fatty acids [7]. As a whole, the MD is a good example of a functional diet [5].

Functionality and disease preventing effect of the 'traditional' MD has been proven by several studies in the literature [4,8-12]. The MD has been related to reduce the risk of cardiovascular diseases, certain cancers and overall mortality [4,10,11]. Furthermore, this dietary pattern has a protective effect on weight gain [13,14] and the development of type 2 diabetes [8,14,15].

Despite the health benefits of the MD, several studies have reported that dietary patterns in the Mediterranean areas have been changing and switching to more westernised diets [15-17]. Increased prevalence of diet-related diseases such as overweight and obesity among children in Greece [18,19], Spain [13,15,20], and Italy [21,22] support the findings of these studies.

Adherence to the MD among Mediterranean population was examined by several studies [15,16,18,23]; however, studies that are evaluating the interest of FF consumers who are more health-oriented than non-consumers [24] to the MD are missing. Thus, in the present study we aimed to assess differences in the adherence to the MD between the consumers and non-consumers of FF among the adolescent population of the Balearic Islands.

METHODS

Study design

The study is a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2009.

Study population

The data collection took place in the Balearic Islands and the sample population was derived from residents aged 11-18 years, registered in the scholar census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomisation into subgroups, with Balearic Islands municipalities being the primary sampling units, and individuals within the schools of these municipalities comprising the final sample units. The interviews were performed at schools. The final sample size was 1988 individuals (98% participation). The reasons to not participate were: the subject declined to be interviewed; the parents did not authorise the interview.

General questionnaire

A questionnaire incorporating the following questions was used: age group, father's and mother's education level (grouped according to years of education: low, <6 years at school; medium, 6–12 years of education; high, >12 years of education), father's and mother's socio-economic level, based on the occupation of parents and classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology [25].

Anthropometric measurements were also obtained. Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France) with adolescents wearing light clothes without shoes, respectively. BMI was computed as weight/height^2. Study participants were categorized as underweight ($\leq 5^{th}$ percentile), normal-weight ($>5^{th}$ $\leq 85^{th}$ percentile), overweight ($>85^{th}$ percentile) and obese ($\geq 95^{th}$ percentile) according to BMI.

Physical activity was evaluating according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [26] in the short form, and its specific modification for adolescents (IPAQ A) [27]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice), and an additional question about sitting time was used as an indicator variable of time spent in sedentary activity. On the basis of their total daily time of physical activity, the subjects were divided into 2 groups: <60 and ≥60 min/day, according to the current physical activity recommendations [28].

Dietary questionnaire

Dietary intake was assessed with the dietary questionnaires included two non-consecutive 24-h recalls and a validated semi-quantitative food frequency questionnaire (FFQ) covering the 145-item [16]. Frequency of food consumption was based on times that food items were consumed (per day, week or month). Consumption <1/month was considered no consumption. Daily consumption (g) was determined by dividing the reported amount of the intake by the frequency (d). The period of consumption of seasonal items was also considered. To avoid bias brought on by day-to-day intake variability, the questionnaires were administered homogeneously from Monday to Sunday. Well-trained dieticians administered the recalls and verified and quantified the food records. To estimate volumes and portion sizes, the household measures found in the subjects' own homes were used. Total nutrition and energy intake (TEI) were calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [29,30] and European Food Composition Tables [31], and complemented with food composition data available for Balearic food items [32]. Daily mean intake of functional components (selenium, zinc, vitamin E, vitamin C, carotene, omega-6, omega-3, fibre, calcium, magnesium, potassium, niacin, folic acid and pantothenic acid) was calculated. The nutritional density of each functional component was calculated dividing the average intake of these nutrients by the total energy intake (MJ) in order to avoid bias caused by different intakes of energy. Adequacy for intakes of functional components was calculated as percentage of the age-specific Recommended Dietary Reference Intakes (RDIs) for Spanish adolescents [33] and RDI for Europeans [34] when no reference data was given for Spanish adolescents.

Assessment of functional food consumption

Functional foods, which were selected according to functional food list, reported by Hasler, [35] were taken from the FFQ. Moreover, modified milk (low/reduced fat milk, omega-3 (n-3) added milk), infusions (coffee and tea), and soy milk were considered as functional food in this review, due to various studies which reported these foods might reduce the risk of some diseases [36-42].

Mediterranean dietary pattern

The MD has been defined according to a previously defined score indicating the degree of adherence to the traditional MD [4,16,23,43]. This Mediterranean dietary score was converted to relative percentage of adherence using a previously described method [44]. An energy-adjusted value was obtained for each individual for the daily consumption of legumes, cereals and roots (including bread and potatoes), fruit (including nuts), vegetables, fish, meat (and meat products) and milk (and milk products). The alcohol consumption in adolescents must be null, and values above the reference indicate the alcohol consumption of adolescents. Information about the consumption of all the food items was obtained from the FFQ.

All the values were standardised as a Z value. A Z score expresses the difference between the individual's measurement and the mean value of the reference population (in this case, the study population) as a proportion of the SD of the reference population ((observed intake–energy adjusted intake)/SD).

The total Mediterranean dietary score was computed by adding up all the Z scores obtained for the favourable or 'more Mediterranean' dietary components (legumes, cereals and roots, fruits, vegetables, fish and MUFA:SFA ratio) and subtracting the Z value obtained from the consumption of meat, whole milk (mainly high in fat) and alcohol (in adolescents):

$$\sum Z_i = Z_{legume} + Z_{fruit} + Z_{vegetable} + Z_{cereal\ and\ root} + Z_{fish} + Z_{MUFA:SFA} - Z_{milk} - Z_{meat} - Z_{alcohol}$$

The Mediterranean dietary score was converted to relative percentage of adherence using the range of values of the sample. This percentage ranged from 100 (maximum adherence) to 0 (minimum adherence):

$$Adherence(Percentage_i) = \frac{\left(\sum Z_i - \sum Z_{\min}\right)}{\left(\sum Z_{\max} - \sum Z_{\min}\right)} \times 100$$

Once the percentage of adherence to the MD was calculated, the variables that could determine a higher or lower adherence were assessed.

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). Mean adherence and SD were calculated. Quartile values of adherence to the MD were calculated in order to find the group of the population with the lowest adherence percentage (percentage below the lower quartile value) and those with the highest adherence (percentage of adherence above the upper quartile value). Differences between mean adherence of FF consumers and non-consumers and mean intake of functional foods and components by FF consumers according to low and high adherence to the MD were tested by ANOVA. Logistic regression models were used to calculate the differences between socio-demographic and lifestyle of the lowest and highest adherence (in order to assess which variables better determined a high or low adherence), among consumers and non-consumers of FF. Crude and adjusted odds ratios (OR; and 95% CI) were calculated. To adjust the OR all variables were entered simultaneously into the model in order to account for the effects of all other covariates. Spearman's rank correlation coefficient (r) was used to study the correlation between consumption of functional food and functional component intakes. The level of significance was established for *P* values, 0.05.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands

Ethics Committee. Written informed consent was obtained from all subjects and their parents or legal tutors.

RESULTS

A total of 1018 individuals reported FF consumption in the present study (53.2% participation) and a total of 888 respondents consumed none of the FFs. Under-reporters were excluded from the analysis of dietary patterns in order to avoid respondent bias usually present in dietary recall methods. Fig. 1a shows the distribution of percentage of FF users' adherence to the MD. The mean adherence of FF users is 56.42% (SD 6.05) and the median adherence of FF users is 56.07%. Fig. 1b shows the distribution of percentage of FFs non-users' adherence to the MD and the mean adherence of FF non-users is 55.76% (SD 5.41) and the median adherence of FF non-users is 55.17%.

Means and standard deviations of the percentage of adherence to the MD according to socio-demographic and lifestyle factors of FF users and non-users are shown in Table 1. Among FF users and also non-users girls had a significantly higher percentage of adherence to the MD than boys did. In the comparison of girls, girls who consumed FFs had a statistically higher percentage of adherence to the MD than non-user girls did. While the percentage of adherence to the MD statistically increased with age among FF users, among non-user adherence to the MD was not statistically associated with age.

Education level of the mother was found associated with low adherence in FF users and non-users. Moreover non-users of FF whose mother had a low level of education, had a significantly higher risk to have low adherence to the MD. Percentage of adherence to the MD of FF users whose father had a medium education level was statistically higher than those of non-users.

Lower work status of father and mother was associated with lower adherence to the MD among FF non-users. FF users whose father had a medium level of education had a higher adherence to the MD than those of non-users.

While underweight adolescents who consumed FFs had a higher risk to have low adherence, the opposite trend was observed among FF non-users. High physical activity and having a chronic disease were not significantly associated with low risk of adherence to the MD in FF users and non-users.

Functional food consumption (g/d) and intake of functional components of FF users according to low and high adherence to the MD is shown in Table 2. As expected consumption of fruit juice, fibre rich bread/cookies, cereal bars, fish and soy milk was higher in adolescents with high adherence to the MD, while consumption of modified milk, probiotics, breakfast cereals and infusion was higher in adolescents with low adherence to the MD. Moreover, daily mean intake of functional components which are from plant origin foods, like dietary fibre, vitamin C, vitamin E, carotene, folic acid was significantly higher in adolescents with high adherence to the MD. The average intakes of selenium, vitamin C, potassium, niacin and pantothenic acid were met the RDI in both groups whereas intake of vitamin E met the RDI only in FF users who had high adherence to the MD. While adequate intake of zinc and n-3 fatty acid was observed among FF users with low adherence to the MD, intake other functional components were lower than the RDI value in both groups.

The Spearman correlation analysis between the consumption of FFs and intake of functional components is shown in Table 3. Consumption of FFs except modified milk, infusions, cereal bars and soy milk were found positively associated with the intake of many functional components. Especially statistically significant positive associations were observed between consumption of fruit juice and intake of dietary fibre, selenium, vitamin E, vitamin C, carotene, n-3 and n-6 fatty acids and potassium.

As expected there was a positive correlation between consumption of modified milk, probiotics and calcium intake. Beside this, consumption of modified milk was negatively associated with intake of n-3 and n-6 fatty acids, whereas consumption of probiotics was positively related with intake of these fatty acids. Intakes of dietary fibre were found inversely associated with consumption of breakfast cereals and also cereal bars, while consumption of fibre rich bread/cookies was positively associated with intake of dietary fibre.

DISCUSSION

In this study we examined the difference in adherence to the MD between FF users and non-users and then represented the functional foods and functional components intake by FF users according to low and high adherence to the MD. Traditional MD has been identified as a healthy diet [45] and consumption of FFs is related with a healthy diet. So we observed adherence to the MD of FF users was slightly higher than those of non-users and both populations had moderate adherence to the MD. Similar to our findings, Martinez *et al*., [23] also reported that adolescents in the Balearic Islands had moderate adherence to the MD (around 58%) [23]. In contrast to moderate adherence of Balearic adolescents, Greek children and adolescents had low adherence to the MD [18].

We found that gender was a significant factor which affected the risk of low adherence to the MD and boys had a higher risk to have low adherence to the MD than girls did. Previous studies also reported that girls had a higher adherence to the MD than boys did [18,23]. In general, female adults were more interested in healthy eating [46]; however, the meaning of healthy eating for female adolescents (weight lost and appearance) should be considered [47].

Age was found another important factor for adherence to the MD in FF users, the youngest adolescents had a significantly higher risk to have lower adherence to the MD than older did.

Similarly, Kontogianni *et al*., [18] reported that Greek children had a lower KIDMED index than Greek adolescents did.

Education level of parents was found not associated with adherence to the MD in FF users, while low education level of parents, especially of the mother was related with low adherence to the MD in non-users. A positive association between parents' education level and diet quality of children and adolescents were reported in many studies [48,49]. Similarly, socio-economic status of parents was also an important parameter which affected the diet quality [49]. While in FF users socio-economic status of parents were not associated with adherence to the MD, in non-users low adherence to the MD was associated with medium and low level of socio-economic status. Moreover, many of the MD components cost more than Western diet components which caused Spanish university students to switch to a westernized diet [50].

We found that underweight adolescents who consumed FFs had lower adherence to the MD; however, in non-FF users overweight adolescents were more likely to have lower adherence to the MD. Normal weight, overweight or obese adolescents who consumed FFs had similar adherence to the MD. Similar to our results Farajian *et al*., [19] observed no difference between adherence of normal weight and overweight children to the MD; however, other studies reported inverse association between BMI and adherence to the MD in children [51] and also adults [13,52]. Schröder *et al*. [13] reported that a higher BMI was associated with a lower adherence to the MD in adults. On the other hand, because the Mediterranean diet is a carbohydrate rich diet, researches questioning it might be a reason for obesity, the metabolic syndrome and its complications [53]; however, the important point is that in the traditional MD unrefined cereals and cereal products rich in dietary fibre were the main source of carbohydrate and sugar consumption was very low [4]. Moreover many studies reported that the Mediterranean dietary pattern was not associated with overweight and weight gain [13,52].

Physical activity with healthy diet plays an important role on health status [54] and physically active Greek children had a higher adherence to the MD [19,51]; however we didn't observe any association between physical activity level and adherence to the MD.

Average daily intake of many functional foods and functional components of adolescents with high adherence to the MD was found significantly higher than those of with low adherence to the MD. The traditional Balearic diet is one of the examples of a Mediterranean diet [16] and offers several unprocessed FFs and functional components like unrefined cereals and cereal products, fruits and vegetables rich in antioxidants, vitamins, minerals, and phytochemicals [55,56]. Whole grain cereals and cereal products were considered as FFs in this study due to a high amount of dietary fibre content of whole grain cereals [14]. Both soluble and insoluble dietary fibre play an important role in satiety and energy metabolism [14], and high intake of whole-grain foods might reduce the risk of heart diseases, type 2 diabetes and various types of cancer [14,57-59]. Moreover whole grains contain bran and germ which are rich in micronutrients and phytochemicals [57]. Fruit juices were also considered as FFs due to their high content of vitamins and also dietary fibre. Diets rich in fruits and vegetables are associated with a reduced risk of heart diseases and a lower risk of obesity [60,61]. Bes-Rastrollo *et al.*, [62] indicated that fruit and vegetable consumption helped to avoid weight gain due to the high fibre content of these foods. Also FDA reported that consumption of fibre rich foods like cereals or fruits and vegetables with low fat diet might reduce the risk of some types of cancer, and furthermore intake of soluble fibre might reduce the risk of heart diseases [35]. Moreover fruits and vegetables provide micronutrients such as carotenoids, Vitamin E, ascorbic acid and polyphenols known for their antioxidant effect [56,59].

As expected, consumption of FFs such as low fat or skimmed milk, probiotics was higher among adolescents with low adherence to the MD, because low to moderate intake of milk and milk products is characteristic of the traditional MD [4].

Intake of functional components like vitamin E, vitamin C, carotene and dietary fibre was significantly higher among adolescents with high adherence to the MD. Similarly, Bach-Faig *et al.*, [63] reported that higher adherence to the MD was positively associated with plasma concentrations of β-carotene, folates, vitamin C and α-tocopherol. On the other hand, inadequate intakes of many functional components were observed among young FF users with low and high adherence to the MD in the Balearic Islands. Inadequate intake of zinc and carotene also among adults population in the Balearic Islands was reported [64]. Nevertheless, intakes of selenium, vitamin E and vitamin C which act as antioxidant were above recommendations.

In the MD the main source of fat intake is olive oil which is low in saturated and n-6 fatty acids but high in plant monounsaturated fat [65]. In line with this we found that intake of n-6 fatty acid was low in FF users with low and also high adherence to the MD; however, intake was lower than RDI value. In addition to n-6 fatty acids, intake of n-3 fatty acids was inadequate in FF users with high adherence to the MD. It should be considered that, in this study the intake of n-3 fatty acids represented only intake of linolenic acid which is an “essential fatty acid” due to human body cannot synthesize it [35,59] and we didn’t represent intake of other n-3 fatty acids (eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)) of which fishes are the main source. Daily amount of fish consumption in Spain is one of the highest in Europe [66] and in this study we observed that adolescents consumed daily around 30g fish. So, total n-3 intake might meet the RDI value by accounting daily fish consumption.

While most of the FF consumption had a positive association with intake of many functional components, consumption of cereal bars and soy milk was found inversely associated with intake of many functional components. Cereal bars are sweetened with sugar and also contain a high amount of fat [67] and they might be consumed as a snack and energy intake might increase.

As seen in the correlation between consumption of FFs and intake of functional components food and nutrient intakes have complex interactions and instead of examining the role of single nutrients or food in disease risk, investigation of whole diet accounts the synergistic and antagonistic effects of foods and nutrients on health [9]. Although, FFs offer a new kind of health message by promising specific effects caused by particular food components [68], the MD as complex dietary patterns with large variety of food choice provides several FFs without recurring to food industry.

CONCLUSION

Adolescent population of the Balearic Islands had moderate adherence to the MD and a higher adherence was observed among FF users; however, intake of many functional components like carotene, zinc, n-6 and n-3 fatty acids and dietary fibre which are important components of the MD was found inadequate. High adherence of adolescents to the MD might cause an increase in the intake of these inadequate nutrients. Parents should be aware of this and follow the MD to serve as a model for their children.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Conflict of interests

The authors state that there are no conflicts of interest.

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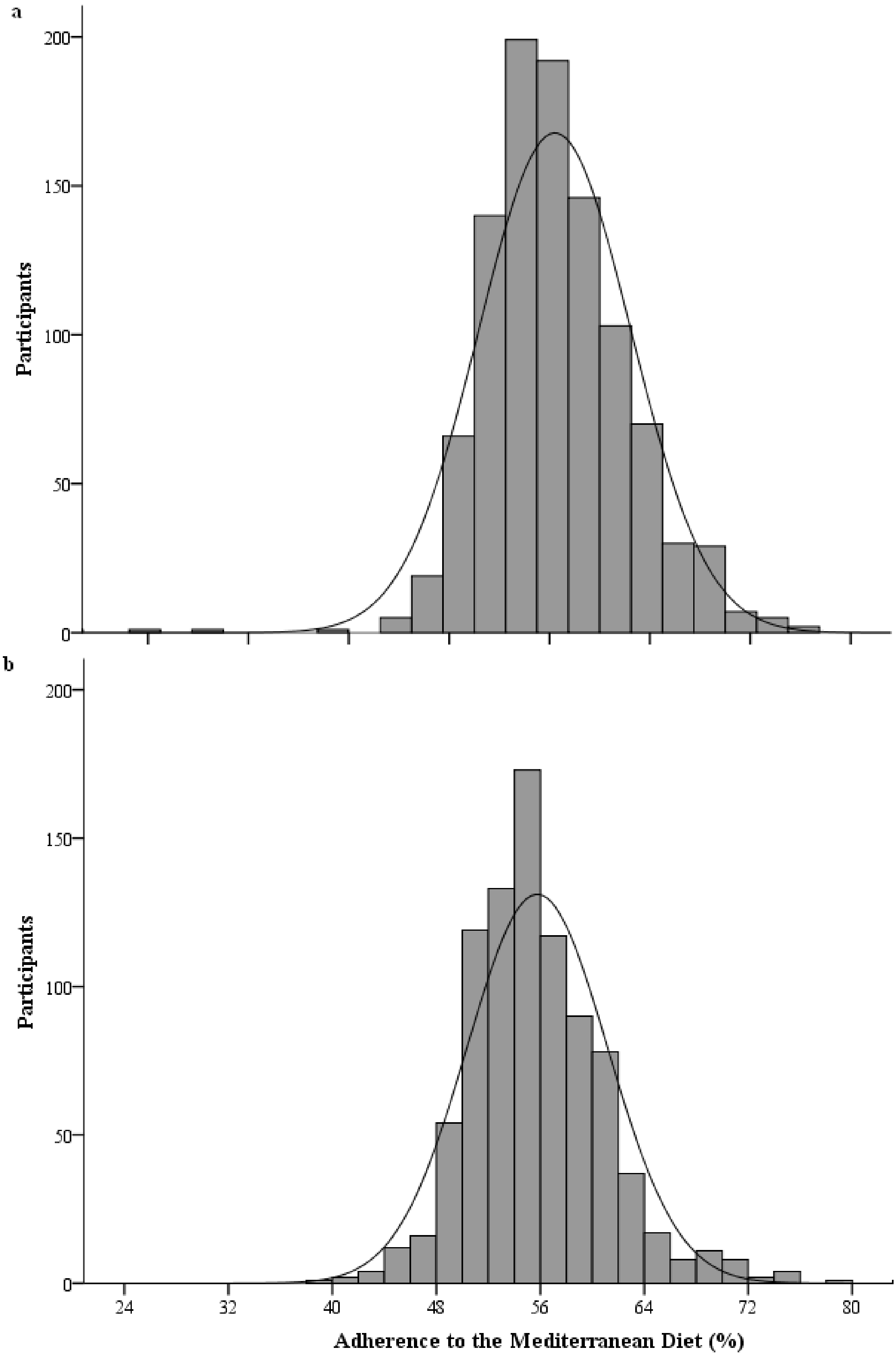

Figure 1. Percentage distribution of functional food consumers' (a) and non-consumers' (b) adherence to the Mediterranean diet (N=1018 and N=888)

Table 1. Percentage of adherence and risk of a low adherence according to socio-demographic and lifestyle variables of functional food users and non-users

Socio-demographic and lifestyle variables	Functional food user			Functional food non-user			*P* value
	Percentage of adherence		Risk of low adherence[1]	Percentage of adherence		Risk of low adherence[2]	
	Mean	SD	OR[3] (95% CI)	Mean	SD	OR[3] (95% CI)	
Gender							
Boy	55.90	6.65	1.48 (1.04, 2.11)*	55.51	4.48	1.12 (0.77, 1.63)	0.340
Girl	56.88	5.42	1.00	55.99	5.33	1.00	0.009
Age (years)							
11-13	55.99	6.31	1.77 (1.07, 2.91)*	55.47	4.76	1.08 (0.65, 1.79)	0.328
14-15	56.41	5.84	1.22 (0.81, 1.84)	55.89	5.35	0.91 (0.59, 1.42)	0.163
16-18	56.87	6.28	1.00	55.88	6.16	1.00	0.070
Education level of father[4]							
Low	55.99	5.82	1.16 (0.72, 1.87)	55.47	5.22	1.34 (0.79, 3.27)	0.262
Medium	56.82	5.42	0.82 (0.53, 1.25)	55.71	5.54	1.28 (0.77, 2.11)	0.005
High	56.19	7.01	1.00	56.23	5.41	1.00	0.953
Education level of mother[4]							
Low	55.84	5.83	1.30 (0.80, 2.10)	54.94	5.11	2.08 (1.23, 3.54)*	0.059
Medium	56.62	6.32	0.89 (0.59, 1.36)	55.84	5.40	1.35 (0.82, 2.22)	0.056
High	56.59	5.76	1.00	56.62	5.70	1.00	0.960
Work status of father							
Low	56.13	6.06	1.04 (0.63, 1.71)	55.84	5.51	1.84 (0.95, 3.56)	0.541
Medium	56.71	6.26	0.84 (0.52, 1.35)	55.50	5.38	2.21 (1.15, 4.28)*	0.003
High	56.41	5.49	1.00	56.47	5.54	1.00	0.926
Work status of mother							
Low	56.20	5.95	1.02 (0.56, 1.85	55.45	5.23	1.78 (0.84, 3.33)	0.058
Medium	56.67	6.36	0.78 (0.43, 1.41	55.90	5.40	1.60 (0.80, 3.20)	0.066
High	56.37	5.28	1.00	56.47	5.67	1.00	0.899
BMI (kg/m^2)							
Underweight (≤5th)	55.35	5.20	2.42 (0.55, 10.66)	56.93	4.60	0.24 (0.03, 2.28)	0.303
Normal weight (>5th ≤85th)	56.51	5.78	0.99 (0.53, 1.84)	55.94	5.58	1.17 (0.62, 2.23)	0.070
Overweight (>85th <95th)	56.55	6.58	0.72 (0.35, 1.50)	55.06	4.97	1.72 (0.78, 3.79)	0.037
Obese (≤95th)	56.05	7.92	1.00	55.58	4.98	1.00	0.651
Physical activity							
<60 min/day	56.50	5.23	1.04 (0.67, 1.61)	55.51	5.18	1.19 (0.79, 1.79)	0.034
≥60 min/day	56.39	6.34	1.00	55.96	5.54	1.00	0.188
Chronic diseases[5]							
No	56.35	6.03	1.17 (0.72, 1.90)	55.79	5.42	1.05 (0.63, 1.77)	0.054
Yes	56.93	6.35	1.00	55.64	5.21	1.00	0.059

[1]Low adherence was defined as a percentage of adherence below the lower quartile (52.8%); high adherence was defined as a percentage of adherence above the upper quartile (59.8%)
[2]Low adherence was defined as a percentage of adherence below the lower quartile (52.3%); high adherence was defined as a percentage of adherence above the upper quartile (58.7%)
[3]Odds ratios (ORs) adjusted for all age and sex.
*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (P<0.05)
[4]Education level of parents: low less than 6y, medium 6-12y, high: higher than 12 y.
[5]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases

Table 2. Average daily intake of functional foods and functional components by functional food users according to low and high adherence to the Mediterranean diet

Functional food	High Adherence to the MD[1]		Low Adherence to the MD[2]	
	Mean ± SD	RDI%[3]	Mean ± SD	RDI%[3]
Modified milk[4] (g/d)	64.16 ± 107.42*	-	88.09 ± 125.57	-
Probiotics (g/d)	37.60 ± 70.04**	-	65.57 ± 122.56	-
Fibre-rich bread/cookies (g/d)	6.18 ± 25.21	-	2.76 ± 13.96	-
Breakfast cereals (g/d)	8.51 ± 16.34	-	11.45 ± 20.38	-
Fruit Juice (g/d)	137.13 ± 206.56***	-	41.14 ± 112.58	-
Infusions[5] (g/d)	2.72 ± 20.71	-	5.18 ± 22.96	-
Fish (g/d)	32.75 ± 75.33	-	30.78 ± 72.94	-
Cereal bars (g/d)	0.40 ± 4.24	-	nc	-
Soy milk (g/d)	4.53 ± 32.12	-	nc	-
Functional components				
Antioxidants				
Selenium (µg/MJ)	16.29 ± 6.84	273.85 ± 131.70	15.33 ± 6.03	264.50 ± 120.79
Zinc (mg/ MJ)	1.38 ± 0.53**	88.73 ± 41.02**	1.60 ± 0.88	100.83 ± 47.75
Vitamin E (µg/ MJ)	1.13 ± 0.48***	102.70 ± 56.28***	0.70 ± 0.31	66.97 ± 41.69
Vitamin C (mg/MJ)	20.17 ± 13.33***	255.30 ± 151.11***	8.27 ± 8.54	110.98 ± 106.37
Carotene (mg/ MJ)	0.39 ± 0.47***	55.97 ± 61.82***	0.17 ± 0.23	28.06 ± 37.35
Fatty Acids				
Omega-6 (Linoleic acid)	0.36 ± 0.45	25.44 ± 35.23	0.40 ± 0.49	28.64 ± 25.71
Omega-3 (Linolenic acid)	0.08 ± 0.15***	10.138 ± 46.64*	0.17 ± 0.31	25.71 ± 95.85
Others				
Dietary fibre (g/MJ)	2.30 ± 0.91***	96.28 ± 41.88***	1.47 ± 0.74	63.26 ± 33.82
Calcium (mg/ MJ)	84.53 ± 34.15***	54.85 ± 25.63***	110.51 ± 53.92	69.70 ± 30.27
Magnesium (mg/ MJ)	36.85 ± 11.19	88.57 ± 34.22**	32.61 ± 11.59	80.29 ± 32.95
Potassium (mg/ MJ)	392.66 ± 120.31	69.87 ± 23.99***	332.99 ± 137.05	59.41 ± 24.40
Niacin (mg/ MJ)	2.60 ± 1.19	151.13 ± 71.31***	3.13 ± 1.66	184.67 ± 101.89
Folic acid (µg/ MJ)	39.52 ± 19.93	84.88 ± 38.09***	26.97 ± 13.91	61.31 ± 36.98
Pantothenic acid (mg/ MJ)	0.74 ± 0.73	130.86 ± 139.17	0.81 ± 0.64	144.51 ± 126.60

[1]Above the upper quartile (59.7%)
[2]Below the lower quartile (52.7%)
[3]RDI Recommended Dietary Intake
[4]Skimmed/semi-skimmed milk, n-3 added milk
[5]Coffee and tea
nc: no consumption
Mean values were significantly different from functional food users with low adherence to the Mediterranean diet (one-way ANOVA), $^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$

Table 3. Spearman correlation coefficients (r) between the intakes of functional foods and functional components

	Modified Milk	Probiotics	Fibre-rich bread/cookies	Breakfast cereals	Fruit Juice	Infusions	Fish	Cereal Bars	Soy milk
Dietary fibre	0.039	0.059	0.172**	-0.054	0.069*	-0.079*	0.044	-0.028	-0.013
Selenium	-0.021	0.066*	-0.032	0.092**	0.108**	-0.059	0.302**	-0.002	-0.020
Zinc	0.039	0.035	-0.019	0.271**	0.010	-0.094**	-0.013	0.005	-0.038
Vitamin E	-0.004	-0.052	-0.016	0.005	0.172**	-0.043	0.162**	0.022	-0.029
Vitamin C	-0.051	-0.069*	0.018	0.034	0.286**	-0.056	0.116**	0.006	0.000
Carotene	-0.001	0.019	0.026	0.010	0.069*	-0.050	0.069*	0.000	-0.009
Linoleic acid	-0.247**	0.323**	0.170**	-0.213**	0.277**	-0.081*	-0.010	-0.037	-0.030
Linolenic acid	-0.274**	0.409**	0.152**	-0.174**	0.187**	-0.097**	-0.041	-0.046	-0.045
Calcium	0.209**	0.196**	-0.005	0.096**	-0.137**	-0.075*	0.004	-0.016	-0.070*
Magnesium	0.041	0.037	0.063*	0.216**	0.028	-0.077*	0.148**	-0.041	0.041
Potassium	0.047	0.094**	0.006	-0.040	0.101**	-0.035	0.094**	-0.059	0.014
Niacin	-0.012	0.009	0.047	0.217**	0.051	0.013	0.081*	-0.015	0.021
Folic acid	0.021	-0.002	0.022	0.340**	0.002	-0.082**	0.149**	0.039	0.031
Pantothenic acid	0.075*	0.073*	0.035	0.144**	0.019	-0.023	-0.007	-0.037	-0.016

*Indicates a significant difference by *P*-value <0.05
**Indicates a significant difference by *P*-value <0.01

Manuscript VII

Beverage consumption and energy intake from beverages across age groups worldwide: a systematic review

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ABSTRACT

Background and aims: Fluid intake, especially water is essential for human life and necessary for physical and mental function. Water consumption, water requirements, and energy intake are linked with each other. The aim of this study is to assess differences in beverage consumption and energy intake from beverages across age groups worldwide.

Methods: Systematic review. The literature search was conducted in Medlars Online International Literature (MEDLINE), via PubMed© and Scopus. Twenty one studies were identified to examine the differences in beverage consumption across age groups and effect of beverage consumption on energy intake.

Results and Conclusions: Drinking water was the premier beverage for all age groups; and contributed up to 54, 58 and 55% of total beverage intake of children, adolescents and adults, respectively. Consumption of other beverages varied with age. Milk consumption was higher among children, consumption of soft drinks was higher among adolescents, and consumption of tea, coffee, and alcoholic beverages was higher among adults. Total relative beverage intake varied between 0.8 L and 2.6 L among age groups. Beverage consumption of males was higher than those of females. Fluid intake, mainly water, should be increased to reach the EFSA's recommended adequate intake (AI) of fluids. Beverages like milk or natural fruit juices are important sources of energy and also nutrients especially among children and adolescents. Consumption of beverages with health benefits should be encouraged, especially among adolescents.

Key words: Beverage consumption, energy intake, systematic review

INTRODUCTION

Fluid intake either from drinking water, beverages or foods is necessary for physical and mental function [1,2]. Especially water the largest constituent of the human body is essential for human life [1,2], because water loss causes some health problems. While mild dehydration, defined as a 1 to 2% loss of body weight caused by water loss [3], may cause a decrease in exercise performance, thermoregulation and appetite [4,5], loss of more than 4% of body water may cause concentration problems, headaches, and increases in body temperature and in respiratory rates [5].

In addition to drinking water, beverages, like milk, juices, soft drinks, coffee and tea, are other sources of water in our diet. While consumption of milk supplies dietary calcium which is important for bone development, consumption of 100% fruit juice supplies important micronutrients such as, vitamin C, folate and magnesium [6].

Water consumption, water requirements, and energy intake are linked in complex ways. Physical activity and energy expenditure affect the need for water. A large shift in beverage consumption over the past century has led to consumption of significant proportion of energy intake from caloric beverages [1]. Last decades, the consumption of sugar-sweetened beverages (SSBs), defined as carbonated beverages or fruit drinks with added sugar [7], has increased especially among children and adolescents [8-10].

Beverage consumption varies depending on demographics, such as age, gender, income, and ethnicity [11]. In the literature several studies, including large cross-sectional studies, have examined differences in water, milk, fruit juice, coffee, tea, regular soft drinks, diet soft drinks, and total beverage consumption across age or sex groups [11-17]. However, a systematic review which assesses the differences in beverage consumption and energy intake from beverages across age groups is missing.

This study reviews the beverage consumption and assesses systematically the differences in beverage consumption and energy intake from beverages of children, adolescents and adults worldwide.

METHODS OF THIS REVIEW

The literature search was conducted through December 2011-January 2012. Studies were identified by searching the MEDLINE database (National Library of Medicine, Bethesda, MD), via PubMed© and Scopus. The search was conducted using the medical subheading (MeSH) terms data base the following search term combinations were used: (“beverage” OR “fluid” [Major]) AND (“consumption” [Mesh] OR “drinking” [Mesh] OR “intake”[Mesh]) AND (“child” [Mesh] OR “adolescent” [Mesh] OR “adult” [Mesh]). The papers were screened by thorough reading of titles or abstracts (by AEO). In total, 1137 articles, published between 2000 and 2012 were selected by reading the title or abstract and from these studies that met inclusion criteria were reviewed in this paper. Additional published reports were obtained by cross-matching references of selected articles. Full-text articles were assessed by 2 authors (AEO and JAT). Any matter of doubt was discussed by at least two of the reviewers (AEO, AP, and JAT).

The process for the selection of studies is shown in Figure 1. Selection of articles was restricted to original research in the English language with healthy population of all age groups in a nationwide sample or a representative sample of a city or cities that examined the trends or patterns of beverage intake and the determinants of beverage intake. Studies were excluded if they did not give data on beverage consumption and not use a dietary assessment method to evaluate beverage consumption. Review articles and systematic reviews were also excluded. Author and year of publication, age range of the population, study year which the study was carried out, number and gender of participants, sampling size, country in where the study was conducted and dietary assessment methods were collected from these articles. In addition to these data, average daily consumption of beverages per capita (consumption of each individual of the study population) or per consumer (consumption of each consumers of the study population) in each study were found. Furthermore, energy intake from beverages was also evaluated from the selected studies.

Beverages in the present review were categorised as water, included tap, bottled, and unflavoured sparkling water, milk/milk drinks included any type of milk (skim, 1%, 2%, and whole milk, chocolate and flavoured milk), fruit/vegetable juice included 100% fruit/vegetable juice without sweetener, regular fruit/soft drinks included any sugar added fruit juice, fruit-flavoured drink (natural or artificial), or drinks that contain fruit juice in part and all carbonated beverages, sports drinks and cordials, low energy fruit/soft drinks included any fruit drinks or soda that was sweetened by low-calorie sweetener, coffee/tea included coffee, coffee drinks and all kinds of tea and alcoholic beverages included beer, wine, liquor and spirits. Total beverage intake included total consumption of all beverage groups. We examined the beverage consumption of the study populations by separating them into three groups, children (2-11 y), adolescents (12-18 y) and adults (>18 y), which allowed us to compare and contrast the results of the studies more effectively. However, in some studies classification of subjects into age groups were different then our classification. In this case, these age groups were placed in most appropriate group by considering the age range.

RESULTS

We identified 21 studies in this systematic review. Studies varied in their objective. Eight studies reported beverage consumption patterns based on age and sex, four studies investigated the effect of beverage consumption on energy intake, five studies reported the association between beverage consumption and weight gain, two of them examined the effect of beverage consumption on bone health and one of them reported the effect of beverage consumption on calcium intake (Table 1).

Studies also varied in their population and six of these studies involved only children [13,18-23], five involved only adolescents [17,19,24-26], two involved only adults [15,27], four involved children and adolescents [14,28-30], one involved adolescents and adults [12] and three involved children, adolescents and adults [11,16,31].

While eight studies reported water consumption [12-17,22,25], others didn't. Although most of the studies reported consumption of different beverages, four of them reported consumption of regular fruit/soft drinks [20,26,27,30]. Total beverage intake of study populations was reported only in six studies [12-16,25]. In addition to beverage consumption three of these studies investigated changes in beverage consumption patterns over years [12,23,28].

Beverage consumption among children

Average beverage intake of children by gender, age group and country is shown in Table 2. Among Canadian children water supplied from 23 up to 37% of daily beverage intake and water consumption increased with age [15]. Water contributed to more than half (53%) of total beverage intake in French children [16] and among Mexican children proportion of water to daily total beverage intake went up from 30.6 to 48.5% [13]. In Saudi Arabia water provided 37% (707 mL/d, relative intake) of daily total beverage intake of school children aged 12-13 y [25]. In contrary to high water intake of their peers in other countries, water consumption of children from UK was very low [22].

Canadian Health Study and Mexican Health and Nutrition Survey showed that consumption of milk decreased with age among children [13,14]. Contrary to this finding, it was reported that consumption of milk increased with age among Finnish children aged 1-6 year-old [21]. Dairy drinks, especially milk, provided the highest beverage intake, after water, of children in countries like Mexico [13], Canada [14], France [16], Germany [18], and Finland [21]; however, in the UK [22] and the USA [11,23,31] consumption of other beverages were higher than those of milk. Coppinger *et al.* [22] reported the lowest amount of milk intake (57 mL) among children (UK), while in other countries consumption of milk varied between 200 to 500 mL. All studies showed that milk consumption of boys was higher than those of girls [11,14,18,31]. From 1989-2008, milk consumption was decreased from 390 mL/d to 288 mL/d among American children [23].

Daily fruit/vegetable juice consumption varied among countries. While fruit/vegetable juice consumption among Canadian children decreased with age [14], opposite trend was observed in their Mexican peers [13]; however, natural fruit/vegetable juice consumption of Mexican children was much lower than their peers. Average daily fruit juice consumption was relatively stable among Finnish children [21]. Daily absolute fruit juice consumption of American children [28] was higher than those of Mexican children. Findings from two studies that compared results of NHANES reported that natural fruit juice consumption did not change significantly between 1988-2004 [28] and 1989-2008 [23].

All the studies who compared beverage consumption by age reported that consumption of regular fruit/soft drinks increased with age among children [13,14,21,22,29]. Among young children sugar added fruit drinks were more popular, while in older ages they were replaced by soft drinks. Average daily intake of regular fruit/soft drinks came from sugar sweetened fruit drinks, soda and other sugar added beverages [13,14,19-21,29-31], and when the total regular fruit/soft drinks intake was compared all Australian and American children and older Canadian children consumed a higher amount of regular fruit/soft drinks than their peers in other countries. While Bellisle *et al.* [16] reported only soda consumption on French children; Coppinger *et al.* [22] reported soda, sport drinks and cordials on UK children. Absolute regular fruit/soft drink consumption of Australian [29] and American [28] children was higher than those of their Mexican [13] peers. Consumption of regular fruit/soft drinks increased significantly among American children from 1989 to 2008 [23,28].

Consumption of low energy/diet drinks were not popular among children, but the consumption increased with age [11,13,14,22,29,31]. Absolute daily average intake of low energy beverages was higher among Australian [29] and American children [23] than those of Mexican [13].

Only in five studies coffee and tea consumption of children was reported [11,13,14,16,31]. Coffee and tea consumption was not as popular as other drinks among children.

Total beverage intake of children varied between 0.8L and 1.3L.

Energy intake from beverages among children

In Mexico beverages contributed 27.8% of total energy intake of young Mexican children (1-4 y) and whole milk which was the main beverage among this age group provided the highest proportion of energy [13]. Among older Mexican children (5-11 y) energy intake from beverages (20.7%) was lower than those of young children and sugar added beverages provided half of this energy intake [13]. American children derived 17% of total energy from beverages [11] and 10% of total energy from sugar added beverages and natural fruit juices derived [28]. Among British children beverages contributed only 9% of daily total energy intake [22]. Among German children energy intake from sugar added beverages increased with age and energy contribution of these beverages to total energy intake rose up 6% [32]. Similar to this, the percentage of total energy from sugar added soft drinks was 6.6% in Australian children [29]. Two studies compared the beverage consumption of American children at ages 6 to 11 years by using data of NHANES [23,28]. Trends for total energy intake from beverages was found stable over time [23]; however, energy contribution from sugar added beverages increased [23,28], and energy contribution from caloric nutritional beverages like whole milk or 100% fruit/vegetable juice decreased between 1989 and 2008 [23].

Beverage consumption among adolescents

Average beverage intake of teens by gender, age group and country is shown in Table 3. In total five studies reported water consumption among adolescents [13,14,16,17,25] and all them showed that drinking water was the main source of fluid in the adolescent diet. Average daily water intake of adolescents in different countries was similar and boys drank more water than girls did; however, proportion of water to total beverage intake was different by countries. Among Canadian adolescents water supplied up to 41% of total daily beverage intake [15], while in France water provided 58% of total daily beverage intake [16], and in Mexico daily water consumption contributed 54.4% of daily total beverage intake [13]. In Saudi Arabia water provided 37% of daily total beverage intake of adolescents aged 12-13 y [25].

Milk was the second main beverage in children diet, but it was replaced by regular fruit/soft drinks among adolescents [11,12,14,19,24,25,31], except among Europeans [17]. When we compared the relative consumption, Irish [24] and Canadian adolescents [14] consumed more milk than their peers and the lowest amount of milk intake was observed among Saudi Arabian adolescents [25]. HELENA study showed that daily milk intake of European adolescents [17] was higher than their Mexican peers [12].

Fruit/vegetable juice consumption of adolescents was reported in seven studies [11,12,14,16-18,31]. Natural fruit/vegetable juice (100% pure juice) was a popular drink among Canadian [14] and German [15,17] adolescents, whereas, very low consumption was reported by Mexican adolescents[12]; however, absolute fruit/vegetable juice consumption of Mexican [12], American [27] and European [17] teens were similar. Daily fruit juice consumption and the percentage of adolescents who reported consumption of fruit juice increased between 1988 and 2008 in the USA [28]. Similarly, fruit juice consumption of German adolescents increased over time [19].

Twelve studies reported consumption of caloric beverages, like sugar added fruit drinks and soda [11,12,14,16,17,19,24-26,29-31]. Among French and Spanish adolescents, consumption of regular fruit/soft drinks were similar and lower than those of other adolescents [16,26]. Furthermore, average daily fruit juice consumption was relatively stable by age. The highest relative consumption of caloric beverages, like soda or sugar added fruit drinks, was observed among Saudi Arabian [25] and American [11,31] adolescents. Similarly, the highest absolute consumption of regular fruit/soft drinks was observed among American [28] and Australian [29] teens, while absolute consumption of regular fruit/soft drinks of Mexican [12] and European [17] youth were similar. Average daily regular fruit/soft drink consumption of American teens significantly increased between 1988 and 2008 [28]. Regular fruit/soft drinks consumption of

German boys increased over time, while consumption of girls didn't change between 1988 and 2003 [19].

Consumption of low-energy/diet beverages were not popular among adolescents [11,12,14,19,29,31] and the highest consumption was observed among American teens. Diet beverage intake of Australian teens per consumer was higher than those of Mexicans.

Similar to diet beverages, consumption of tea and coffee was low among adolescents [11,12,14,16,17,25,31]. While French teens consumed a lower amount coffee and tea than others did [16], absolute consumption was similar between Mexican [12] and European [17] adolescents.

Total beverage intake of adolescents varied between 1.1 L and 2.1 L.

Energy intake from beverages among adolescents

While in Mexico beverages contributed 20% (373 kcal) of daily total energy intake of Mexican teens [12], in Germany 6% of the total energy intake was contributed by sugar added beverages [32] and in the USA energy contribution of sugar added beverages and natural fruit juice to total energy intake was 10.7% [28]. Similar to these results, the percentage of total energy from sugar added soft drinks was 7.5% in Australian adolescents [29]. Two studies reported that energy intake from sugar added beverages increased over time [28,32].

Beverage consumption among adults

Average beverage consumption of adults by gender, age group and country is shown in Table 4. Three studies reported beverage consumption of adults [12,15,16]. Two of these studies showed that consumption of water decreased with age. In Canada drinking water provided around 40 and 48% of daily total beverage intake of young men and women, respectively, this amount declined to 34 and 44% of total beverage intake at older ages [15]. In France average daily water intake slightly decreased with age, whereas proportion of water to total beverage intake increased from 43 to 46% with age [16]. Water contributed 55% of total beverage intake among Mexican adults [12].

Five studies reported milk and milk drinks consumption among adults [11,12,15,16,31]. The proportion of Canadian adults who consumed milk increased with age; however, average daily milk consumption dropped with age [15]. On the contrary, milk consumption of French and male Americans went up with age [11,16,31]. Daily milk consumption of adults from different countries was similar to each other.

Daily fruit/vegetable juice consumption of adults decreased with age among Canadian and French adults [15,16]; however, among Americans it was relatively stable [11,31]. Natural fruit juice consumption of Canadian adults was higher than those of others [15].

In contrast to regular fruit/soft drink consumption trends among children and adolescents, adults' regular fruit/soft drink consumption dropped with age [11,15,16,31]. While regular fruit/soft drink consumption of younger adults in Canada and America was as high as adolescents, their consumption decreased sharply at older ages [11,15,31] and daily regular fruit/soft drink intake of French adults was lower than those of others [16]. Comparison of sugar added beverage intake among middle aged American and British adults reported a higher amount consumption among Americans [27].

While milk was the main beverage among children, and diet and fruit juice and caloric drinks were main beverages among adolescents, coffee and tea were main beverages among adults [11,12,15,16,31]. Coffee and tea consumption increased with age among Canadian and male American adults [11,15,31], however, among French adults consumption of coffee and tea decreased with age [16]. Consumption of these drinks was lower among Mexican adults than those of others [12].

Total three studies in this review reported consumption of alcoholic beverages [12,15,16]. Daily consumption of alcoholic beverages decreased with age among Canadians [15]; however, among French it slightly increased at ages older than 54 [16]. Average daily alcohol intake of Mexicans was lower than those of their peers [12]. Males consumed a significantly higher amount of alcoholic beverages than females did and while younger men were the first consumers of beer, consumption of other alcoholic beverages varied with age [15].

Total beverage intake of adults varied between 1.2 L and 2.6 L.

Energy intake from beverages among adults

Two studies reported energy contribution from beverages in adults, and in both studies it was reported that young adults had the highest energy intake from beverages compared to older [11,12]. While in Mexico beverages contributed 22% of total energy [12], in the USA they contributed 17% of total energy [11]. Prospective study of Barquera *et al.* [12] showed that energy intake from beverages, especially from SSBs, has increased between 1998 and 2008 among Mexicans.

DISCUSSION

Twenty one articles were identified and included in this systematic review. Studies which included water showed that drinking water was the premier beverage for all age groups; and contributed 30-53%, 37-58% and 34-55% of total beverage intake of children [13,14,18-23,28-30], adolescents [11,12,16,17,19,24-26,31] and adults [11,12,15,16,27,31], respectively. Consumption of other beverages varied with age. Milk consumption was higher among children, consumption of soft drinks was higher among adolescents, and consumption of tea, coffee, and alcoholic beverages was higher among adults. Total relative beverage intake varied between 0.8 L/d and 2.6 L/d among age groups (males more than females), but they did not reach the European Food Safety Authority (EFSA) recommended adequate intake (AI) of fluids [5]. EFSA determined adequate intake (AI) of water for children as 1.3 L/day for boys and girls 2-3 years of age, 1.6 L/day for boys and girls 4-8 years of age, 2.1 L/day for boys 9-13 years of age, and 1.9 L/day for girls 9-13 years of age; for adolescent/adult (14 years and older) as 2.0 L/day for females and 2.5 L/day for males [5].

Energy intake from beverages has increased over time, and contributed up to 27.8, 20.0 and 22.0% in children [11,13,22,23,28,29,32], adolescents [12,28,29,32], and adults [11,12], respectively. Most of the studies in this paper were conducted in western countries and mostly focused on beverage consumption of children and adolescents. Prevalence of overweight and obesity has increased in children and adolescents over the last decades and the role of sugar sweetened beverages in obesity has become one of the target subjects of researchers, especially in developed countries [36]. Studies included in this review showed that consumption of sugar added beverages has increased over time, mainly among adolescents; however, absolute and also relative milk consumption has decreased among children and adolescents over years in many countries. While milk contributed the highest beverage intake after water among Canadian [14], European [16,18,21] and Mexican [13] children, regular fruit/soft drinks were replaced with milk among American [11,23,31], and English [22] children. The highest absolute consumption of regular fruit/soft drinks was observed among Australian [29] children and adolescents. Besides, consumption of these beverages among Saudi Arabian [25] and American [28] teens was also higher than those of others.

In most studies, data were collected in only one season of the year; however, beverage consumption varies according to seasons [33]. Bello and Hamad [25] carried out their study between March and April; conversely, one seasonal measurement can't represent the annual average beverage consumption of the population due to extremely high and dry climate of Saudi Arabia. Similarly, Australian studies [29,30] were carried out only in the hot season (February-August), a high consumption of soda or fruit drinks among Australian children and adolescents might be the result of high temperatures during summer. Only the study of Bellisle *et al.* [16] carried out the study in four different periods to eliminate seasonal differences.

Cross-sectional studies are suitable to report beverage consumption and changes in beverage patterns; however, it is not possible to examine the association between beverage intake and outcomes. A high number of the study population in the cross-sectional studies may provide sufficient power to effectively present the beverage consumption of the whole population. Four large studies in the present review reported beverage intake of Mexican [12,13], Canadian [14,15], and American [11,28,31] population by using cross-sectional design which included more than 10000 subjects.

Dietary assessment methods are important tools to evaluate food, beverage and nutrition intake. In the studies included in this review different dietary assessment methods were used. While in most of the studies beverage intake was determined from 24-h dietary recalls or dietary records, studies of Barquera *et al.* [12,13] calculated average beverage consumption of the study population by using a validated semi-quantitative FFQ. It has been considered inappropriate to use FFQ data to estimate the average dietary intake of a population, due to the error inherent in the food frequency approach [34]. On the other hand, it is not appropriate to use single 24-h dietary recalls to represent typical consumption patterns of individuals, because food and beverage consumption individually vary from day to day [34]. Furthermore, 24-h dietary recalls have limitations related to memory and bias [34]. In general, estimation of portion size and over or under reporting is the weakness of self reported dietary assessment methods [34].

Due to high economic interest of nutrition research concerns about publication biases have been raised about food industry funded studies [37]. The number of the studies that reported the adverse effect of SSBs consumption on nutrition and health was statistically higher in studies non-industry funded than those of industry funded [38]. Furthermore, publication bias may be in opposite direction and industry funded studies which found adverse health effect of SSBs consumption not published these results and vice versa [37,38]. Three studies [16,26,29] included in this systematic review received funding from the food industry and one of these studies [16] was prepared by beverage industry scientists. Besides, one study [31] was supported by the American Beverage Association.

There are many limitations to this review. It was difficult to compare the total beverage intake, due to the number of the studies which reported total beverage intake was limited. Beside this, water consumption was reported only in a small number of studies. On the other hand, in all studies consumption of regular fruit/soft drinks were reported. The inconsistencies seen among cross-sectional and prospective cohort studies may relate to study design, sample size, and duration of follow-up. Differences between studies in the assessment of beverage consumption, categorisation of beverages and representing the outcomes (per capita or per consumer; g or mL) weaken the ability to compare the results. Moreover, age classification of study populations, varied based on the studies also made it difficult to compare the results. In this systematic-review we only selected articles which were published in English; this can be a possible cause of bias. This systematic-review also has several strengths. Firstly our article selection was conducted by two independent reviewers to increase the reliability of our findings. Secondly we selected studies published in the last 10 years to represent the situation of beverage consumption in the last decade in different countries. Finally, this study provides a comprehensive summary of beverage consumption of different age groups in different countries.

Fluid intake is significant to our health and caloric beverages to our total energy intake [1]. This review has attempted to provide some data on our knowledge of beverage consumption and energy intake from beverages. There are few negative effects of water intake, whereas the positive effects are clear [1]. Otherwise, to drink water instead of sugar added beverages is linked with reduced energy intake. Total energy intakes were 7.8% higher when SSBs were consumed; studies comparing non-nutritive sweeteners with water found no impact on energy intake among adults; and replacing water with milk and juice estimated increases in energy intake of 14.9% [35]. The proportion of water in the diet has diminished over time, and has been replaced by beverages that contain sugar, natural and artificial flavourings, non-nutritive sweeteners, and carbonation [35]. Therefore, it would be desirable to promote the consumption of healthy beverages, mainly water, among those human collectives that show an increased consumption over time of sugar added beverages.

CONCLUSIONS

Drinking water was the premier water provider for all age groups. Consumption of other beverages varied with age. Milk consumption was higher among children, consumption of soft drinks was higher among adolescents and consumption of tea and coffee and alcoholic beverages was higher among adults. Beverage consumption of males in all age groups was higher than females. Fluid intake, mainly water, in all age groups should be increased to reach the EFSA's recommended AI of fluids. Beverages like milk or natural fruit juices are important sources of energy and also nutrition especially among children and adolescents. Consumption of beverages with health benefits should be encouraged especially among adolescents.

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Conflict of interest

The authors declare that they have no conflict of interest.

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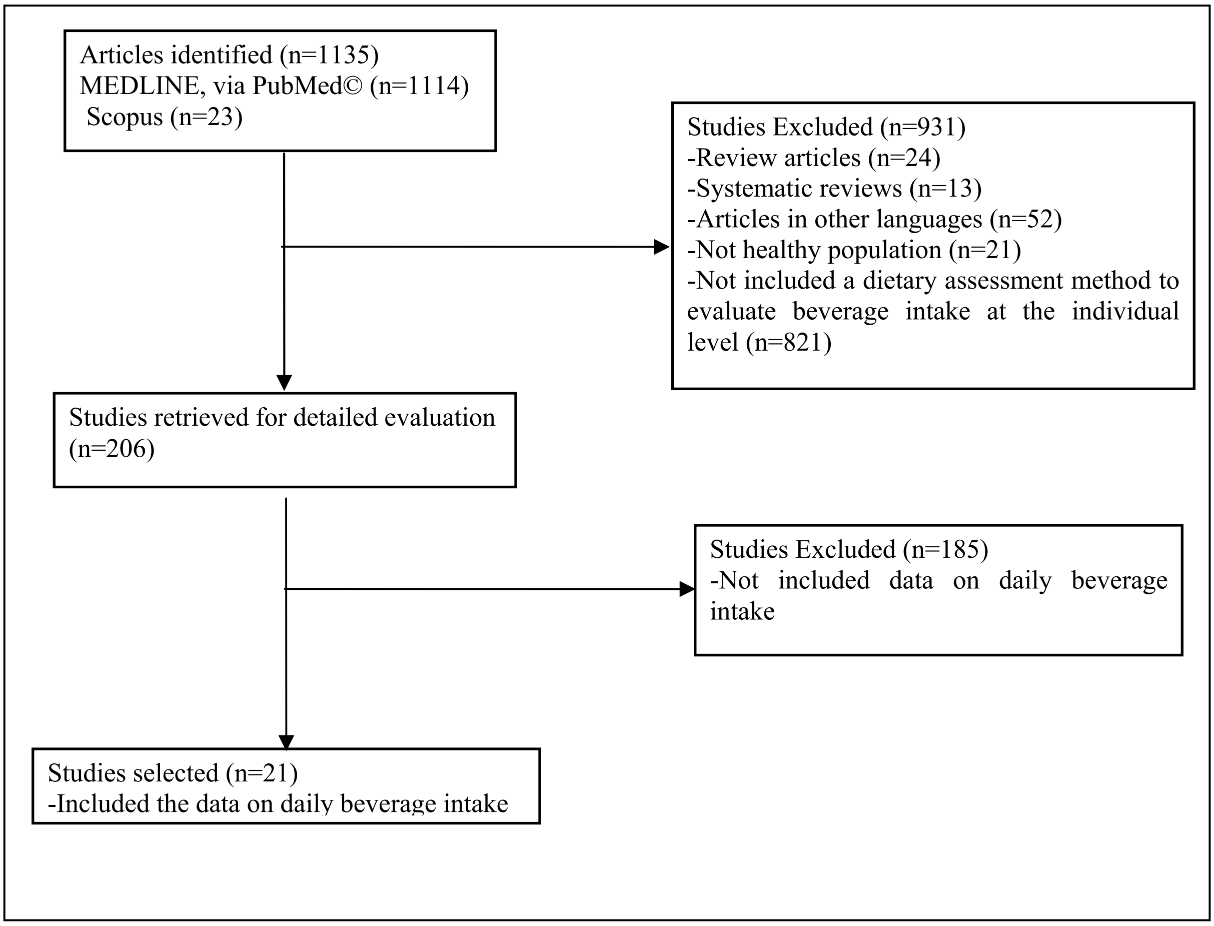

Figure 1. Flow chart for selection of articles for the present review

Table 1. Description of the beverage consumption studies

Author(s)	Country, study year* and subjects, *n*	Age range	Investigation	Method	Results
Hafekost *et al.* [30]	Australia (NCNPAS), 2007, *4834*	2-16 y	Major sources of SSB SSB consumption patterns Demographic and dietary factors associated with high and regular consumption of SSB	2-day dietary recall	The main source of SSBs in the diet of younger children was sweetened juice (2-3 year olds 39.9%, 95% CI=36.7-43.2). Carbonated drinks were the primary type of SSBs consumed in children over 9 years of age (41.7%, 95% CI=38.6-44.8, $P< 0.001$). High consumption of SSBs was associated with older age groups, male gender, lower levels of household education and a number of markers of poor dietary patterns.
Clifton *et al.* [29]	Australia (NCNPAS), 2007, *4487*	2-16 y	Consumption of SSBs and trends The relation between SSBs and overweight and obesity, SES, TV viewing time, and activity levels	24-hour dietary recall	The number of consumers of SSBs increased with age. Higher proportion of children with lower SES consumed SSBs (30.2%) compared with the highest SES (19.4%, $P<0.01$). Higher TV viewing hours were associated with increased SSBs consumption (156 g/d to 210 g/d, $P<0.01$). No relationship between overweight and SSBs consumption.
Garriguet [14]	Canada (2004 Canadian Community Health Survey), 2004, *14621*	1-18 y	Beverage consumption of Canadian children and teens aged 1 to 18	24-hour dietary recall	Children and teens get about one-fifth of their daily calories from beverages. Consumption of milk and fruit juice decreased with age. Consumption of water, soft drinks and fruit drinks increased with age ($P<0.05$).
Garriguet [15]	Canada (Canadian Community Health Survey), 2004, *20197*	> 19 y	Beverage consumption among Canadians aged 19 or older	24-hour dietary records	Total beverage consumption and total calorie intake from beverages among adults declined with age. While water was the beverage consumed most frequently and in the greatest quantity by adults, for many of them, coffee ranked second. About 20% of men aged 19 to 70 consumed more than two alcoholic drinks a day. Beverage consumption, except water and tea, of men was higher than women.
Duffey *et al.* [17]	Europe (HELENA), nd, *2741*	12.5-17.5 y	The beverage and energy consumption of beverages in a large sample of European adolescents	24-hour dietary recall	Average daily consumption of beverages was 1455 mL (include water intake). Daily energy intake from beverages was 1609 kJ/d, of which 30.4, 20.7 and 18.1% comes from SSBs, sweetened milk and fruit juice.
Kyttälä *et al.* [21]	Finland, 2003-2005, *2535*	1-6 y	Food consumption and nutrient intakes according to sex and age	3 d weighed records	Total beverage consumption among adults increased steadily with age. Especially consumption of milk and milk drinks and soft drinks increased with age.
Bellisle *et al.* [16]	France, 2002-2003, *2173*	> 5 y	Beverage intake of healthy children, adolescents, adults and seniors	7-day report of all intakes	The largest part of beverage intake, in all age groups, is from water. Beverage choices vary with age. Soda was mainly consumed by teenagers, whereas alcoholic drinks and hot drinks (mainly tea and coffee) were consumed by adults and seniors. Dairy drinks (mainly milk) contributed to the beverage intake of children and adolescents.
Barquera *et al.* [13]	Mexico, 1999 and 2006, *17215*	1-11 y	Characteristics and trends in caloric beverages	24-hour dietary recall Semi quantitative Food Frequency Questionnaire (FFQ)	Daily beverage intakes (including plain water) of pre-school children approximately 794 mL and school age children 1254 mL. Total calorie intakes per capita from beverages increased from 161 kcal in 1999 to 310 kcal in 2006 ($P<0.05$) in pre-school and from 185 kcal to 323 kcal ($P<0.05$) in school children.
Barquera *et al.* [12]	Mexico, 1999 and 2006, *26848*	>12 y	Beverage intake patterns and trends	24-hour dietary recall Semi quantitative Food Frequency Questionnaire (FFQ)	Total energy intakes from beverages increased from 151 kcal in 1999 to 349 kcal in 2006 in adolescent and in women from 143 kcal to 366 kcal. Daily beverage consumption of adolescent was 1543 mL/capita and adults was 1721 mL/capita.

Table 1. Continued

Author(s)	Country, study year* and subjects, n	Age range	Investigation	Method	Results
Bello and Hammad [25]	Saudi Arabia, 2002, 340	12-13 y	The sources of beverage intake	3 d weighed records	Boys consumed more beverage than girls. Drinking water contributes 37% of the total beverage intake. Carbonated soft drinks and fruit juice/drink constitute 51% total beverage intake.
Brown *et al.* [27]	USA and UK (INTERMAP), 1996-1999, *2195* (USA) *501* (UK)	40-59 y	Association between sugar-sweetened or diet beverages consumption and BP	24-hour dietary recalls	Average daily SSBs and diet beverage intakes were higher in USA (306 mL/d) than in UK (66 mL/d).
Storey *et al.* [11]	USA (NHANES), 1999-2002, *15635*	> 5 y	Beverage consumption based on age, sex, and race/ethnicity	24-hour dietary recalls	Average daily energy intake from beverages was higher among males than females of all ages. Boys 370 kcal–girls 300 kcal at 6-11 y Boys 561 kcal–girls 383 kcal at 12-19 y Males 630 kcal–females 381 kcal at 20-39 y Males 455 kcal–females 278 kcal at 40-59 y Males 298 kcal–females 189 kcal 60+y Milk consumption was highest among young children aged 6 to 11 years, but declined with age for males and females. The heaviest consumers of RCSDs were white adolescent and young adult males. Regular fruit drinks were favoured by African Americans and Mexican Americans.
Lasater *et al.* [23]	USA (CSFII, NHANES), 1989-2008, *3583*	6-11 y	Beverage patterns and trends	24-hour dietary recall	Total per trends from SSBs increased significantly from 1989 to 2008 (304 to 468 mL/d, P<0.05). Total per trends from CNBs decreased in similar magnitude and significance over the same time period (389 to 260 mL/d, P<0.05).
Wang *et al.* [28]	USA, NHANES III, 1988-1994, NHANES 1999-2004, *10962*	2-19 y	Beverage consumption pattern	24-hour dietary recall	Milk consumption declined significantly among children aged 2 to 5 years (P<0.05). Fruit juice consumption decrease significantly among adolescents (P<0.05). Per-Capita energy intake from SSBs increased significantly in boys (from 228 to 259 kcal/d; P<0.002)
Linardakis *et al.* [20]	Greece, 2004-2005, *856*	4-7 y	Association between intake of sugar-added beverages and obesity indices, physical activity levels and dietary habits	3 d weighed records	Positive association between high intake of SSBs and BMI (OR=2.35, P=0.023). High intake of SSBs affected diet quality adversely.
Libuda *et al.*[19]	Germany (DONALD), 1985-2007, *244*	9-18 y	The 5-year consumption patterns of soft drinks (regular and diet) and fruit juices, and association between the consumption of these beverages and body-weight status	3 d weighed records	Long-term consumption of caffeinated and un-caffeinated soft drinks appears to have bone catabolic effects in boys and girls.
Gomez-Martinez *et al.* [26]	Spain (AVENA), 2000-2002, *1523*	13-18.5 y	The relationship between the sugar-sweetened drinks consumption and obesity	24-hour dietary recall	Intake of SSBs was higher in boys than in girls in all age groups. No association between consumption of SSBs (moderate or high level) and BMI.

Table 1. Continued

Author(s)	Country, study year* and subjects, n	Age range	Investigation	Method	Results
Coppinger *et al.* [22]	UK, nd, 248	9-13 y	The relationship between beverage consumption and BMI	3 d records	Average daily energy intake from beverages was 690 kJ for boys and 586 kJ for girls. A strong positive association between daily carbohydrate intake and daily carbohydrate intake from beverages (r=0.56; $P \leq 0.01$) and also between daily energy intake from beverages and daily total sugars intake (r=0.51; P=0.001).
Libuda *et al.* [18]	Germany (DONALD) 1998-1999, 228	6-18 y	The relation between long-term consumption of soft drinks and variables of bone modelling and remodelling	3 d weighed records	The boys consumed more regular soft drinks than the girls; however, consumption of energetic beverage associated with BMI in girls. In both sexes, no relationship was observed between energetic beverage consumption and BF%.
McGartland *et al.* [24]	Ireland (YH2000), 2000, 1347	12-15 y	The relationship between CSD intake and adolescent BMD	Diet history	Liquid milk consumption decreased with increased CSDs intake. Inverse and significant association between heel BMD and CSDs consumption in girls (β=-0.122; 95% CI, -0.195 to -0.049) but not in boys; however, they consumed more CSDs than girls.
Forshee *et al.* [31]	USA (NHANES), 1999-2002, 15635	> 5 y	Calcium intake, beverage milk consumption, and non-milk beverage consumption	24-hour dietary recalls	Average daily RCSDs consumption was highest in the 20-39 y and 638 g for males and 430 g for females. Average daily coffee consumption peaked in the 40-59 y and 482 g for males and 374 g females. Consumption of fluid milk was strongly associated with calcium intake (1.3, P<0.01). Consumption of fruit juice also positively associated with calcium intake in most age-gender categories (0.2, P<0.01).

* Study year: time period the study was carried out
nd: no data was given in the study
SSBs: sugar-sweetened beverages
SES: socio-economic status
CSDs: carbonated soft drinks
RCSDs: Regular carbonated soft drinks
CNBs: caloric nutritional beverages
BMI: body mass index
BF: Body fat
BMD: bone mineral density
BP: blood pressure

Table 2. Beverage consumption among children

Country	Sex	Age (y)	Water	Milk/milk drinks	Fruit/vegetable juice	Regular fruit/soft drinks	Low-energy soft drinks	Coffee and tea	Total
Australia [30]		2-3	nd	nd	nd	243 (mL)	nd	nd	nd
		4-8	nd	nd	nd	369 (mL)	nd	nd	nd
		9-13	nd	nd	nd	561 (mL)	nd	nd	nd
Australia [29]*	Boy	2-3	nd	nd	nd	1047 (g)	197 (g)	nd	nd
	Boy	4-8	nd	nd	nd	1247 (g)	242 (g)	nd	nd
	Boy	9-13	nd	nd	nd	1625 (g)	392 (g)	nd	nd
	Girl	2-3	nd	nd	nd	1139 (g)	133 (g)	nd	nd
	Girl	4-8	nd	nd	nd	1417 (g)	223 (g)	nd	nd
	Girl	9-13	nd	nd	nd	1118 (g)	378 (g)	nd	nd
Canada [14]	Boy	1-3	248 (g)	495 (g)	200 (g)	114 (g)	nc	7 (g)	1069 (g)
	Girl	1-3	238 (g)	473 (g)	168 (g)	94 (g)	nc	nc	994 (g)
	Boy	4-8	337 (g)	377 (g)	194 (g)	229 (g)	4 (g)	31 (g)	1184 (g)
	Girl	4-8	337 (g)	312 (g)	157 (g)	181 (g)	6 (g)	15 (g)	1022 (g)
	Boy	9-13	509 (g)	380 (g)	179 (g)	363 (g)	24 (g)	48 (g)	1505 (g)
	Girl	9-13	483 (g)	301 (g)	147 (g)	301 (g)	17 (g)	42 (g)	1299 (g)
Germany [18]	Boy	6-12	nd	207 (g)	nd	137 (g)	nd	nd	nd
	Girl	6-12	nd	186 (g)	nd	120 (g)	nd	nd	nd
Greece [20]	Boy	4-7	nd	nd	nd	181 (g)	nd	nd	nd
	Girl	4-7	nd	nd	nd	162 (g)	nd	nd	nd
Finland [21]		1	nd	202 (g)	nd	84 (g)	nd	nd	nd
		2	nd	344 (g)	46 (g)	120 (g)	nd	nd	nd
		3	nd	340 (g)	56 (g)	141 (g)	nd	nd	nd
		4	nd	387 (g)	49 (g)	170 (g)	nd	nd	nd
		6	nd	427 (g)	43 (g)	169 (g)	nd	nd	nd
France [16]		6-11	549 (mL)	247 (mL)	128 (mL)	115 (mL)	nd	7 (mL)	1046 (mL)
Mexico [13]		1-4	244 (mL)	383 (mL)	14 (mL)	122 (mL)	3 (mL)	30 (mL)	794 (mL)
		5-11	608 (mL)	255 (mL)	21 (mL)	317 (mL)	7 (mL)	83 (mL)	1254 (mL)

Table 2. Continued

Country	Sex	Age (y)	Water	Milk/milk drinks	Fruit/vegetable juice	Regular fruit/soft drinks	Low-energy soft drinks	Coffee and tea	Total
UK [22]	Boy	9-10	69 (mL)	57 (mL)	nd	195 (mL)	69 (mL)	nd	nd
	Boy	11-13	66 (mL)	94 (mL)	nd	297 (mL)	235 (mL)	nd	nd
	Girl	9-10	75 (mL)	89 (mL)	nd	179 (mL)	42 (mL)	nd	nd
	Girl	11-13	75 (mL)	75 (mL)	nd	143 (mL)	69 (mL)	nd	nd
USA [11,31]	Boy	6-11	nd	282 (g)	102 (g)	385 (g)	50 (g)	43 (g)	nd
	Girl	6-11	nd	228 (g)	96 (g)	309 (g)	30 (g)	33 (g)	nd
USA [28]*	Boy	2-5	nd	nd	312 (g)	397 (g)	nd	nd	nd
	Boy	6-11	nd	nd	312 (g)	525 (g)	nd	nd	nd
	Girl	2-5	nd	nd	318 (g)	414 (g)	nd	nd	nd
	Girl	6-11	nd	nd	281 (g)	510 (g)	nd	nd	nd
USA [23]	-	6-11	nd	289 (mL)	186 (mL)	332 (mL)	78 (mL)	91 (mL)	nd

nc: no consumption was observed in the study
nd: no data was given in the study
*Values were presented as absolute consumption (per consumer)

Table 3. Beverage consumption among adolescents

Country	Sex	Age (y)	Water	Milk/milk drinks	Fruit/vegetable juice	Regular fruit/soft drinks	Low-energy soft drinks	Coffee and tea	Total
Australia [30]	-	14-16	nd	nd	nd	703 (mL)	nd	nd	nd
Australia [29]*	Boy	14-16	nd	nd	nd	2070 (g)	489 (g)	nd	nd
	Girl	14-16	nd	nd	nd	1629 (g)	417 (g)	nd	nd
Canada [14]	Boy	14-18	780 (g)	367 (g)	192 (g)	574 (g)	16 (g)	117 (g)	2121 (g)
	Girl	14-18	694 (g)	261 (g)	173 (g)	354 (g)	37 (g)	128 (g)	1666 (g)
Europe [17]*	Boy	12.5-17.5	860 (mL)	803(mL)	312 (mL)	505 (mL)	nd	612 (mL)	nd
	Girl	12.5-17.5	791 (mL)	624 (mL)	259 (mL)	343 (mL)	nd	388 (mL)	nd
France [16]	-	12-19	578 (mL)	215 (mL)	104 (mL)	169 (mL)	nd	29 (mL)	1112 (mL)
Germany [19]	Boy	13-18	nd	nd	277 (g)	455 (g)	32 (g)	nd	nd
	Girl	13-18	nd	nd	247 (g)	450 (g)	41 (g)	nd	nd
Ireland [24]	Boy	12	nd	348 (g)	nd	459 (g)	nd	nd	nd
	Boy	15	nd	379 (g)	nd	518 (g)	nd	nd	nd
	Girl	12	nd	261 (g)	nd	351 (g)	nd	nd	nd
	Girl	15	nd	239 (g)	nd	340 (g)	nd	nd	nd
Mexico [12]	-	12-18	790 (mL)	202 (mL)	25 (mL)	387 (mL)	2 (mL)	109 (mL)	1543 (mL)
Saudi Arabia [25]	Boy	12-13	795 (mL)	111 (mL)	nd	983 (mL)	nd	117 (mL)	2006 (mL)
	Girl	12-13	614 (mL)	157 (mL)	nd	962 (mL)	nd	88 (mL)	1821 (mL)
Spain [26]	Boy	13	nd	nd	nd	165 (g)	nd	nd	nd
	Boy	14	nd	nd	nd	158 (g)	nd	nd	nd
	Boy	15	nd	nd	nd	161 (g)	nd	nd	nd
	Boy	16	nd	nd	nd	180 (g)	nd	nd	nd
	Boy	17-18.5	nd	nd	nd	110 (g)	nd	nd	nd
	Girl	13	nd	nd	nd	114 (g)	nd	nd	nd
	Girl	14	nd	nd	nd	81 (g)	nd	nd	nd
	Girl	15	nd	nd	nd	72 (g)	nd	nd	nd
	Girl	16	nd	nd	nd	145 (g)	nd	nd	nd
	Girl	17-18.5	nd	nd	nd	89 (g)	nd	nd	nd
USA [11,31]	Boy	12-19	nd	279 (g)	119 (g)	734 (g)	79 (g)	131 (g)	nd
	Girl	12-19	nd	179 (g)	103 (g)	524 (g)	56 (g)	102 (g)	nd
USA [28]*	Boy	12-19	nd	nd	459 (g)	1080 (g)	nd	nd	nd
	Girl	12-19	nd	nd	366 (g)	765 (g)	nd	nd	nd

nd: no data was given in the study, *Values were presented as absolute consumption (per consumer)

Table 4. Beverage consumption among adults

Country	Sex	Age (y)	Water	Milk/milk drinks	Fruit/vegetable juice	Regular fruit/soft drinks	Low-energy soft drinks	Coffee and tea	Alcoholic beverages	Total
Canada [15]	Male	19-30	1045 (g)	243 (g)	186 (g)	439 (g)	32 (g)	332 (g)	327 (g)	2610 (g)
	Male	31-50	861 (g)	181 (g)	123 (g)	270 (g)	61 (g)	582 (g)	267 (g)	2345 (g)
	Male	51-70	705 (g)	148 (g)	118 (g)	146 (g)	53 (g)	648 (g)	234 (g)	2051 (g)
	Male	≥71	500 (g)	172 (g)	88 (g)	68 (g)	39 (g)	611 (g)	103 (g)	1584 (g)
	Female	19-31	1000 (g)	216 (g)	146 (g)	249 (g)	44 (g)	319 (g)	80 (g)	2056 (g)
	Female	31-50	1065 (g)	178 (g)	98 (g)	152 (g)	69 (g)	553 (g)	91 (g)	2206 (g)
	Female	51-70	840 (g)	146 (g)	93 (g)	96 (g)	55 (g)	591 (g)	72 (g)	1891 (g)
	Female	≥71	654 (g)	149 (g)	92 (g)	61 (g)	13 (g)	532 (g)	31 (g)	1532 (g)
France [16]	-	20-54	564 (mL)	144 (mL)	54 (mL)	93 (mL)	nd	267 (mL)	184 (mL)	1306 (mL)
	-	≥55	548 (mL)	164 (mL)	33 (mL)	17 (mL)	nd	250 (mL)	186 (mL)	1198 (mL)
Mexico [12]	-	≥19	889 (mL)	170 (mL)	34 (mL)	367 (mL)	11 (mL)	192 (mL)	39 (mL)	1721 (mL)
UK [27]	-	40-59	nd	nd	nd	66 (mL)	nd	nd	nd	nd
USA [27]	-	40-59	nd	nd	nd	306 (mL)	nd	nd	nd	nd
USA [11,31]	Male	20-39	nd	179 (g)	98 (g)	738 (g)	139 (g)	419 (g)	nd	nd
	Male	40-59	nd	181 (g)	83 (g)	392 (g)	185 (g)	686 (g)	nd	nd
	Male	≥60	nd	190 (g)	97 (g)	192 (g)	54 (g)	607 (g)	nd	nd
	Female	20-39	nd	147 (g)	85 (g)	513 (g)	129 (g)	307 (g)	nd	nd
	Female	40-59	nd	144 (g)	71 (g)	266 (g)	178 (g)	620 (g)	nd	nd
	Female	≥60	nd	147 (g)	83(g)	112 (g)	102 (g)	499 (g)	nd	nd

nd: no data was given in the study
*Values were presented as absolute consumption

Manuscript VIII

Beverage patterns of adult population in the Balearic Islands: association with socio-demographic characteristics, nutrient intakes, BMI and physical activity

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Beverage patterns of adult population in the Balearic Islands: association with socio-demographic characteristics, nutrient intakes, BMI and physical activity

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ABSTRACT

Objective: The aim of our study was to identify beverage patterns of adult population in the Balearic Islands by using cluster analysis and to examine the nutrition intake, diet quality, BMI and physical activity by beverage pattern.

Design: Beverage patterns were obtained using two 24-h diet recalls from a cross-sectional nutritional survey carried out between 2009 and 2010 in the Balearic Islands. Information about beverage groups was obtained from the food frequency questionnaire (FFQ); whereas information on nutrition quality index and energy intake was derived from the average daily food consumption reported in the 24-h recalls.

Results: Beverage patterns of the study population were identified in five clusters: water drinkers, beverages with low energy, beverages with high energy with some benefits, beverages with high energy and mix drinkers. Beverages with low energy pattern was the predominant beverage pattern among the subjects. While being female and having a low level of employment status were the characteristics of beverages with low energy cluster, being male, having a low level of education and low BMI were the characteristics of beverages with high energy cluster. Adults in the beverages with high energy cluster had the highest total energy intake; however, they had a lower mean BMI and physical activity than others did. Subjects in the mix drinker cluster had a higher NQI than others did.

Conclusions: In conclusion, the majority of the Balearic Islands adult population in the study consumed beverages with low energy; however, high mean BMI of the study population showed the risk of overweight.

Keywords: Beverage pattern, cluster analysis, nutrient intake, energy intake, adolescent, the Balearic Islands

INTRODUCTION

Nowadays, the food industry offers several kinds of beverages, while in our early ancestors' diet only water and breast milk were the main water sources [1]. Previous studies showed that while drinking water is still the main source of water in the diet of all age groups [2-7], consumption of other beverages are varied according to age groups.

Changes in lifestyle resulted in changes in food and beverage consumption which brought an increase in the prevalence of many diet related diseases such as obesity, cancer, diabetes and cardiovascular diseases [8]. While some studies examined the association between individual food and diseases [9-11], others identified the dietary patterns and examined the association between these patterns and diseases [12,13]. Due to the complex mechanism of food intake, investigation of overall food consumption with pattern analysis considers the synergistic effect of nutrients [14].

Several studies have examined dietary patterns of adults [12,15,16]; however, less is known about the beverage patterns of adults. The objective of the present paper was to identify beverage patterns of adult population in the Balearic Islands by using cluster analysis and to assess the association among beverage patterns with socio-demographic characteristics and nutrient intake.

METHODS

Study population

Subjects of this study were participants in the OBEX project which is a population based cross-sectional nutritional survey. The data collection took place between 2009 and 2010. The sample population was derived from residents aged 16-65 years, registered in the official population census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomization into subgroups, with Balearic Islands municipalities being the primary sampling units, and individuals within these municipalities comprising the final sample units. The final sample size was 1389 individuals (93% participation). Pregnant women were not considered in this study. Written informed consent was obtained from all subjects and when they were under 18 years old, also from their parents or legal tutors.

Assessment of beverage consumption, energy and nutrient intake

Dietary intake was assessed with the dietary questionnaires include two 24-h recalls and a validated quantitative food frequency questionnaire (FFQ) covering the 145-item [17]. Information about beverage consumption was obtained from the FFQ; whereas information on nutrient intake and intake of foods were derived from the daily average food consumption reported in the recalls. Nutrient intakes and total energy intake (TEI) were calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [18,19] and European Food Composition Tables [20], and complemented with food composition data available for Balearic food items [21].

The intake quality score (IQS) [22,23] for macro and micro nutrients were calculated as percentage of the age-specific Recommended Dietary Reference Intakes (RDIs). Then the nutrition quality index (NQI) [22,23] was calculated from harmonic mean of each subject's IQS for carbohydrate, protein, calcium, potassium, magnesium, phosphorous, iron, zinc, vitamin A, thiamine, riboflavin, vitamin B_6, vitamin B_{12}, vitamin C, vitamin D, vitamin E, niacin, folic acid, and pantothenic acid.

Before entering beverages into a cluster analysis, beverages were categorized in four groups according to their energy content and health benefits; beverages without energy (water), beverages with low energy (low-fat/skimmed milk, coffee, tea, vegetable juice and diet soda), beverages with high energy and some benefits (whole milk, fermented milk drinks and 100% fruit juice) and beverages with high energy (soda, commercial fruit juice, sport drinks, energy drinks and others). Energy contributed from beverages was calculated by using different food composition tables [19,24,25].

Anthropometric measurements

Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France). The subjects were weighed in bare feet and light underwear, which was accounted by subtracting 300 g from the measured weight and study participants were categorized as normal-weight (≤24.9 kg/m^2) and overweight (≥25 kg/m^2) according to BMI.

Physical Activity Assessment

Physical activity (PA) was evaluated according to guide-lines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [26] in the short form. The specific types of activity assessed were walking, moderate-intensity activities (i.e. PA at work), vigorous-intensity activities (i.e. sport practice) and sitting time (used as an indicator variable of time spent in sedentary activity). Information on hours per day of television viewing, computer use, video games, other leisure time physical activity practice and typical sleep duration to the nearest 10 min was also included. On the basis of their total weekly time of physical activity, the subjects were divided into 2 groups: inactive (<150 min/wk) and active (≥150 min/wk).

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). To identify groups of individuals with similar beverage patterns Quick Cluster procedure was used. This procedure is using k-means cluster analysis in that k, number of clusters, needs to be specified by user. To find the appropriate number of clusters in the data set, a series of steps is taken separately for each variable type. We examined solutions with two through ten clusters and chose a solution with five clusters, because it provided well separated clusters (according to the ANOVA that compared the beverage groups' variables between the clusters, for each solution) and more homogeneous cluster sizes. After determination of the number of clusters, each participant in the database is assigned to the cluster whose means on the five variables are closest to that participant's value and then participants iteratively clustered into one of these groups based on squared Euclidean distances. After each case is assigned, the cluster centre is updated before the next iteration. The assignment process is repeated until participants no longer change clusters.

Average consumption of each beverage (in millilitre-mL) of each cluster was calculated and comparisons across beverage clusters assessed by using a general linear model. Comparisons across socio-demographic characteristics of participants were evaluated by using χ^2 test. Logistic regression analyses were carried out to examine the association between beverage clusters and gender, age, marital status, education level, employment status, smoking status, BMI and physical activity. To adjust the OR all variables were entered simultaneously into the model in order to account for the effects of all other covariates. To describe nutrient intake across the 5 clusters, mean for TEI, intake of food groups, IQS for each nutrient and NQI were calculated. Differences across means were evaluated by using a general linear model and adjusting for age, sex, and BMI. The number of respondents included in the analyses may differ according to the beverage or because of missing data. For all statistical tests, $P<0.05$ was taken as the significant level.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects.

RESULTS

Beverage patterns of study population were identified in five clusters. We labelled the beverage clusters based on the predominant beverage group in the cluster; water drinkers, beverages with low energy, beverages with high energy with some benefits, beverages with high energy and mix drinkers. We named the last cluster as mix drinkers because none of the beverage group consumption was dominant. Table 1 describes each beverage pattern by showing mean beverage intake, the mean total beverage intake, and the mean percentage of total energy from beverages across beverage patterns.

Several differences were observed across the identified beverage clusters. Based on the population in each cluster, beverages with low energy was the predominant beverage pattern; however, in this cluster average total beverage intake was the lowest and significantly different from others (P<0.0001). In contrast, while the number of respondents was the lowest in the water drinkers' pattern, total beverage consumption was the highest. Adults in the beverage with high energy pattern had a significantly lower consumption of water compared to other beverage clusters. While mean intake of beverages with low energy was lower in the high energy beverage cluster, average consumption of beverages with high energy was lower in the beverages with low energy cluster. The mean percentage of total energy intake from beverages was significantly different across beverage clusters. A significantly higher percentage of energy from beverages was seen in the beverages with high energy pattern than in all other clusters (18.2±7.3%, P<0.0001).

Characteristics of respondents by beverage clusters and adjusted ORs for consumption of the beverages relative to non-consumption of the beverages in relation to the socio-demographic characteristics are illustrated in Table 2. Gender, age, marital status, education level, employment status and BMI were significantly different across beverage clusters (P<0.05), whereas no significant difference was observed smoking status and physical activity level across beverage clusters.

While to be female was the characteristic of beverages with low energy cluster, to be male was the characteristic of beverages with high energy cluster. Results of logistic regression showed a positive significant association between females and the consumption of beverages with low energy, while consumption of beverages with high energy was negatively associated with females. A strong negative relation between consumption of beverages and education level in the beverages with high energy cluster was found. Furthermore being normal weight was characteristic of beverages with high energy cluster. A high prevalence of smoking was characteristic of the water drinkers' cluster, while prevalence of physical inactivity was characteristic of beverages with high energy and some benefits cluster.

TEI, intake of food groups, macro and micro nutrients and NQI differed significantly by beverage patterns in adults (Table 3). TEI was the highest among the beverages with high energy pattern and was the lowest for beverages with low energy pattern. While adults in the water drinker clusters had the highest daily serving of many food groups like dairy, fruits and vegetables, olive oil and red meat, adults in the beverages with high energy clusters had the highest daily serving of snacks and sugar-sweet groups. Several differences were found between macro and micro nutrient intakes and beverage clusters. Mean intakes of most nutrients met or even exceeded the reference values in all clusters; besides, inadequate intake of important micronutrients like calcium, potassium, magnesium, vitamin D and folic acid was observed. Adults in the beverages with high energy cluster had the highest carbohydrate intake; whereas, the highest protein intake was found among adults in the beverages with high energy and some benefits pattern. Distribution of the lowest and highest intake of micronutrients varied across clusters and the mean NQI scores across beverage patterns ranged from 146.2 in the beverages with low energy patterns to 155.1 in the mix drinkers patterns.

Comparisons of BMI and physical activity across beverage patterns are shown in Figure 1 and 2 respectively. Mean BMI (adjusted mean, 23.2 kg/m^2) and weekly mean physical activity (adjusted mean, 62.1 min/w) of adults in the beverages with high energy cluster were significantly lower than those of others (P<0.05). Mean BMI of adults in water, beverages with low energy and beverages with high energy and with some benefits clusters had adjusted mean BMI 25.8, 25.0 and 25.1 kg/m^2, respectively.

DISCUSSION

In this study we used cluster analysis to assess the association of different beverage patterns with overall diet quality, measured by NQI, among adults and to identify if socio-demographic characteristics were associated with different beverage patterns in the Balearic Islands.

Beverage consumption patterns vary considerably among different countries and even among different regions within one country. According to an online survey of a market research company drinking water is the premier water supply of the majority and soda is consumed by a very high proportion (84%) of the Spanish population [27]. However, we observed that among the Balearic Islands population beverages with low energy pattern was the most prevalent beverage pattern (45.5% of the population).

We observed many differences in socio-demographic characteristics across beverage patterns. While females more likely to consume beverages with low energy, males were more likely to consume beverages with high energy. Similar to our finding Garriuet [2], reported that males consumed a higher amount of soft drinks, alcoholic beverages and fruit drinks than females did, whereas females consumed a higher amount of diet soft drinks than others did. We found that education level was found inversely associated with the consumption of beverages with high energy. This was supported by research that showed among young adults, consumption of sugar sweetened beverages was the highest among persons with lower education level [28]. We found that being in a normal weight was the characteristic of beverages with high energy. Belich *et al.*, [28] also reported that consumption of sugar sweetened beverages were less popular among overweight.

Alcoholic beverage consumption pattern has changed in Spain during the last decades. As a Mediterranean country in the mid-1960s two third of the alcohol was consumed as wine in Spain; however, consumption of distilled spirits has increased after 1960 [29]. Moreover, there is a transition in drinking habits. Because Spain was a wine drinking country, alcohol intake generally in form of wine with meal was common in Spain, whereas it is shifting to Central European countries in where people consume alcohol through different contexts than meal [29].

Similar to these finding we observed that proportion of beer drinkers was higher than those of wine drinkers in the Balearic Island (data not shown).

Earlier studies have suggested that a high consumption of sugar sweetened beverages was related with high levels of energy intake from other foods [30,31]. Our findings were in line with the previous studies. Sugar sweetened beverages like soda and commercial fruit juices were the largest proportion of beverages with high energy cluster and adults in this cluster had a higher total energy intake than others did. Furthermore, adults in this cluster had a higher mean daily serving for snack and sweet foods. Similar to our findings Duffey and Popkin [32] reported that adults who had unhealthy food patterns were more likely to consume high energy beverages like soda.

In general, macro and micronutrient intake varied across clusters. Carbohydrate intake of adults in the beverages with high energy cluster was higher than those of others. Our finding was in line with previous studies [33,34]. Adults in the mix drinker pattern which was the combination of all beverage groups had the highest NQI compared to others. This finding might suggest that adults in this beverage pattern consumed variety of foods in a balance like their well disturbed beverage intake.

Adults in beverage with high energy cluster had a lower BMI than others did, whereas they had the lowest weekly physical activity value. Beverages with low energy cluster, which included low fat milk, diet soda, coffee and tea, was the dominant beverage pattern among adults in the Balearic Islands; however, the study population had a mean BMI of 24.9 kg/m^2 which was on the border to overweight. This result indicates that the adult population of the Balearic Islands tried to decrease their energy intake by consuming beverages with low energy. Nevertheless, to reduce the risk of overweight they should consider the total energy intake and increase the physical activity which was inversely associated with mean BMI [35].

CONCLUSION

In conclusion, the majority of the Balearic Islands adults in this study consumed beverages with low energy; however, high mean BMI of the study population shows the risk of overweight. Consumption of food and beverages with high energy should be decreased and weakly physical activity should be increased to decrease the prevalence of overweight and obesity among adults. Further researches assessing the relations between beverage and dietary patterns are needed to examine better the influence of beverage consumption on diet quality and its influence on weight gain.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Conflict of interests

The authors state that there are no conflicts of interest.

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Table 1. Mean daily beverage intake of beverage groups, mean daily intake of total beverage consumption, and mean percentage of total energy from beverages across beverage patterns

	Cluster 1: Water (n=30)	**Cluster 2: Beverages with low energy (n=632)**	**Cluster 3: Beverages with high energy and some benefits (n=144)**	**Cluster 4: Beverages with high energy (n=164)**	**Cluster 5: Mix drinker (n=419)**	***P* value**
	Mean ± SD					
Water (mL)	3373.3 ± 630.4	218.0 ± 232.0	1976.3 ± 266.7	197.1 ± 240.5	1070.6 ± 254.2	<0.0001
Beverages with low energy						
Low Fat Milk (mL)	117.5 ± 178.7	102.6 ± 147.1	84.6 ± 108.0	50.8 ± 106.5	110.1 ± 140.9	<0.0001
Coffee/Tea (mL)	53.3 ± 96.4	93.1 ± 153.3	71.5 ± 111.5	48.6 ± 92.0	74.5 ± 129.3	0.002
Diet soda (mL)	39.7 ± 136.1	33.1 ± 148.3	10.1 ± 56.6	2.0 ± 25.8	17.2 ± 82.4	0.007
Others[1](mL)	nc	3.6 ± 36.7	nc	2.9 ± 28.2	7.6 ± 50.0	0.226
Beverages with high energy and some benefits						
Whole Milk (mL)	60.0 ± 137.3	70.9 ± 122.6	84.4 ± 124.5	107.4 ± 134.7	60.9 ± 107.8	0.001
Fruit Juice (100%) (mL)	18.1 ± 57.4	11.1 ± 33.7	13.1 ± 49.2	7.7 ± 26.7	9.0 ± 29.5	0.336
Others[2](mL)	17.4 ± 67.2	9.6 ± 36.2	9.5 ± 40.8	1.3 ± 12.1	7.0 ± 28.5	0.027
Beverages with high energy						
Soda (mL)	61.7 ± 127.4	41.5 ± 107.2	47.4 ± 135.8	432.6 ± 367.2	51.7 ± 141.1	<0.0001
Fruit Drinks (mL)	41.7 ± 130.0	34.7± 88.1	42.9 ± 107.0	152.5 ± 229.3	45.5 ± 102.5	<0.0001
Alcohol (mL)	26.7 ± 75.8	29.5 ± 86.6	37.6 ± 113.4	190.8 ± 380.5	36.9 ± 109.6	<0.0001
Others[3](mL)	44.3 ± 242.8	5.7 ± 41.5	10.6 ± 59.9	29.4 ± 121.9	8.0 ± 54.0	<0.0001
Total beverage consumption (mL)	3890.5 ± 833.7	673.8 ± 372.8	2409.1 ± 420.6	1233.5 ± 438.1	1514.7 ± 377.7	<0.0001
Total percentage of energy from beverages (%)	10.7 ± 11.0	10.2 ± 7.7	9.3 ± 7.5	18.2 ± 7.3	9.3 ± 6.3	<0.0001

nc: no consumption

[1]Others include carrot juice, beer without alcohol and diet milkshake

[2]Others include soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink and kefir[3] Others include horchate, chocolate milkshake, sugar added iced tea, energy drink, isotonic drinks

Table 2. Socio-demographic characteristics among Balearic Islands adults by beverage cluster

	Cluster 1: Water (n=30)			**Cluster 2: Beverages with low energy (n=632)**			**Cluster 3: Beverages with high energy and some benefits (n=144)**			**Cluster 4: Beverages with high energy (n=164)**			**Cluster 5: Mix drinker (n=419)**			***P* value**
	%	**OR**	**(95% CI)**	**%**	**OR**	**(95% CI)**	**%**	**OR**	**(95% CI)**	**%**	**OR**	**(95% CI)**	**%**	**OR**	**(95% CI)**	
Sex																<0.0001
Male	53.3	1.0		34.7	1.0		47.2	1.0		63.4	1.0		41.8	1.0		
Female	46.7	0.5	(0.2, 1.2)	65.3	1.7*	(1.4, 2.2)	52.8	0.9	(0.6, 1.4)	36.6	0.4*	(0.2, 0.5)	58.2	1.0	(0.7, 1.3)	
Age Group																<0.0001
16-25 y	43.3	1.0		38.8	1.0		46.5	1.0		63.3	1.0		40.7	1.0		
26-45 y	40.0	0.4	(0.1, 1.3)	41.8	1.4	(1.0, 1.9)	38.0	0.6	(0.3, 1.0)	29.0	0.9	(0.5, 1.5)	43.3	1.1	(0.8, 1.6)	
46-65 y	16.7	0.4	(0.1, 1.8)	19.5	1.5	(1.0, 2.4)	15.5	0.6	(0.3, 1.3)	7.7	0.6	(0.3, 1.5)	16.0	1.1	(0.6, 1.8)	
Marital Status																0.001
Married	34.5	1.0		32.9	1.0		30.0	1.0		16.3	1.0		27.5	1.0		
Not Married	65.5	1.1	(0.4, 3.1)	67.1	1.0	(0.8, 1.4)	70.0	1.6	(0.9, 2.8)	83.8	0.9	(0.5, 1.6)	72.5	0.8	(0.6, 1.1)	
Education Level																<0.0001
Low level (<6 years)	20.0	1.0		32.5	1.0		26.5	1.0		47.5	1.0		28.0	1.0		
Medium level (6-12 years)	46.7	2.4	(0.8, 7.0)	34.1	1.0	(0.7, 1.3)	34.6	1.4	(0.9, 2.4)	35.0	0.6*	(0.4, 0.9)	35.2	1.2	(0.8, 1.6)	
High level (>12 years)	33.3	1.9	(0.6, 6.4)	33.4	0.9	(0.6, 1.2)	39.0	1.8	(1.0, 3.2)	17.5	0.3*	(0.2, 0.6)	36.9	1.4	(1.0, 2.0)	
Employment status																<0.0001
Low level	26.7	1.0		41.8	1.0		39.4	1.0		50.9	1.0		38.2	1.0		
Medium level	6.7	0.8	(0.2, 3.9)	7.8	0.6*	(0.4, 0.9)	17.6	1.8*	(1.0, 3.2)	17.2	1.6	(0.9, 2.7)	11.3	1.1	(0.7, 1.7)	
High level	66.7	2.4	(0.8, 7.0)	50.4	0.9	(0.7, 1.2)	43.0	0.9	(0.5, 1.5)	31.9	0.9	(0.5, 1.4)	50.5	1.2	(0.8, 1.6)	
Smoking status																0.179
Non-smoker	43.3	1.0		60.8	1.0		57.6	1.0		55.6	1.0		61.9	1.0		
Ex-smoker	23.3	3.7*	(1.3, 10.2)	12.5	1.0	(0.7, 1.4)	11.5	1.0	(0.5, 1.9)	9.4	1.6	(0.8, 2.9)	10.1	0.7	(0.5, 1.1)	
Smoker	33.3	2.2	(0.9, 5.3)	26.7	0.8	(0.6, 1.0)	30.9	1.3	(0.8, 1.9)	35.0	1.5	(1.0, 2.2)	28.0	0.9	(0.7, 1.2)	
BMI																0.024
Normal weight (≤24.9 kg/m^2)	50.0	1.0		58.6	1.0		56.8	1.0		71.6	1.0		59.0	1.0		
Overweight (≥25 kg/m^2)	50.0	1.2	(0.5, 2.6)	41.4	1.0	(0.8, 1.3)	43.2	1.4	(0.9, 2.0)	28.4	0.5*	(0.4, 0.8)	41.0	1.1	(0.8, 1.4)	
Physical activity																0.075
Inactive (<150 min/week)	55.2	1.0		47.1	1.0		60.1	1.0		52.5	1.0		51.1	1.0		
Active (≥150 min/week)	44.8	1.1	(0.5, 2.3)	52.9	1.1	(0.9, 1.4)	39.9	0.6*	(0.4, 1.0)	47.5	1.2	(0.8, 1.7)	48.9	1.0	(0.8, 1.3)	

Odds ratios (ORs) adjusted for all other variables in the model

*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (P<0.05)

[1]Not married includes: single, divorced, widowed, and separated

Significance tested on basis of χ^2 comparisons

Table 3. Mean daily nutrient intakes and diet quality index by beverage patterns

	Cluster 1: Water (n=30)	Cluster 2: Beverages with low energy (n=632)	Cluster 3: Beverages with high energy and some benefits (n=144)	Cluster 4: Beverages with high energy (n=164)	Cluster 5: Mix drinker (n=419)	
	Mean ± Standard Error					***P* value**
TEI	2133.9 ± 120.1	1911.0 ± 26.8	2080.8 ± 57.5	2423.3 ± 53.8	2055.7 ± 33.2	<0.0001
Food Groups (serving/d)						
Dairy	3.5 ± 0.3	2.8 ± 0.8	2.8 ± 0.2	2.9 ± 0.2	2.7 ± 0.1	<0.0001
Fruits and vegetables	3.8 ± 0.4	2.9 ± 0.1	3.5 ± 0.2	2.4 ± 0.2	3.3 ± 0.1	<0.0001
Cereals	2.6 ± 0.8	2.8 ± 0.2	3.1 ± 0.4	2.6 ± 0.3	3.0 ± 0.1	0.105
Olive oil	2.4 ± 0.3	1.7 ± 0.1	2.1 ± 0.2	1.8 ± 0.1	2.1 ± 0.1	<0.0001
Red meat	2.4 ± 0.3	1.7 ± 0.1	1.9 ± 0.1	1.9 ± 0.1	1.7 ± 0.1	<0.0001
Snacks	0.3 ± 0.1	0.3 ± 0.0	0.3 ± 0.0	0.5 ± 0.0	0.3 ± 0.0	<0.0001
Sugar and sweet	2.6 ± 0.5	2.7 ± 0.1	2.5 ± 0.2	3.2 ± 0.2	2.6 ± 0.1	<0.0001
RDI%						
Carbohydrate	189.0 ± 12.0	159.7 ± 2.7	172.2 ± 5.7	219.8 ± 5.4	172.3 ± 3.3	<0.0001
Protein	260.8 ± 22.9	262.0 ± 5.1	290.8 ± 11.0	282.2 ± 10.3	272.1 ± 6.3	<0.0001
Calcium	69.0 ± 6.5	69.6 ± 1.5	69.5 ± 3.1	66.1 ± 2.9	72.8 ± 1.8	<0.0001
Potassium	69.2 ± 4.3	58.8 ± 1.0	67.7 ± 2.0	63.9 ± 1.9	64.1 ± 1.2	<0.0001
Magnesium	86.6 ± 5.1	70.4 ± 1.1	78.9 ± 2.4	77.1 ± 2.3	75.4 ± 1.7	<0.0001
Phosphorus	175.6 ± 11.7	156.9 ± 2.6	169.4 ± 5.6	174.2 ± 5.2	167.3± 3.2	<0.0001
Iron	133.4 ± 21.7	139.6 ± 4.8	132.2 ± 10.4	122.6 ± 9.7	141.7 ± 6.0	<0.0001
Zinc	100.1± 8.3	78.7 ± 1.9	83.8 ± 4.0	83.2 ± 3.7	83.7 ± 2.3	0.036
Vitamin A	127.6 ± 50.5	146.0 ± 11.3	131.3 ± 24.2	118.9 ± 22.6	143.5 ± 14.0	0.009
Thiamine	207.7 ± 71.1	255.2 ± 15.8	223.7 ± 34.0	216.8 ± 31.8	279.1 ± 19.6	0.033
Riboflavin	206.7 ± 75.3	275.1 ± 16.8	240.1 ± 36.1	216.2 ± 33.7	294.3 ± 20.8	0.077
Vitamin B_6	203.2 ± 68.9	177.5 ± 15.4	170.5 ± 33.0	237.1 ± 30.8	180.1 ± 19.0	0.411
Vitamin B_{12}	267.7 ± 75.7	294.7 ± 16.9	343.3 ± 36.2	325.2 ± 33.9	304.3 ± 20.9	0.391
Vitamin C	250.0 ± 30.0	193.9 ± 6.7	240.1 ± 14.4	220.1 ± 13.4	229.8 ± 8.3	<0.0001
Vitamin D	45.6 ± 12.9	49.5 ± 2.9	45.8 ± 6.28	56.8 ± 5.8	51.6 ± 3.6	0.016
Vitamin E	99.9 ± 10.1	91.6 ± 2.2	95.6 ± 4.8	99.8 ± 4.5	94.0 ± 2.8	<0.0001
Niacin	136.1 ± 13.8	124.2 ± 3.1	146.8 ± 6.6	137.5 ± 6.2	134.7 ± 3.8	0.035
Pantothenic Acid	118.1 ± 12.4	101.5 ± 2.8	115.5 ± 5.9	123.6 ± 5.5	107.3 ± 3.4	0.004
Folic Acid	85.9 ± 7.9	72.4 ± 1.8	83.4 ± 3.8	70.4 ± 3.5	79.5 ± 2.2	<0.0001
NQI	149.1 ± 13.9	146.2 ± 3.1	152.7 ± 6.6	153.2 ± 6.2	155.1 ± 3.8	0.002

TEI; Total Energy Intake,
NQI; Nutrition Quality Index
RDI; Recommended Dietary Reference Intake
Sex, age and BMI were used as covariates in the analysis of energy, nutrient and food intake

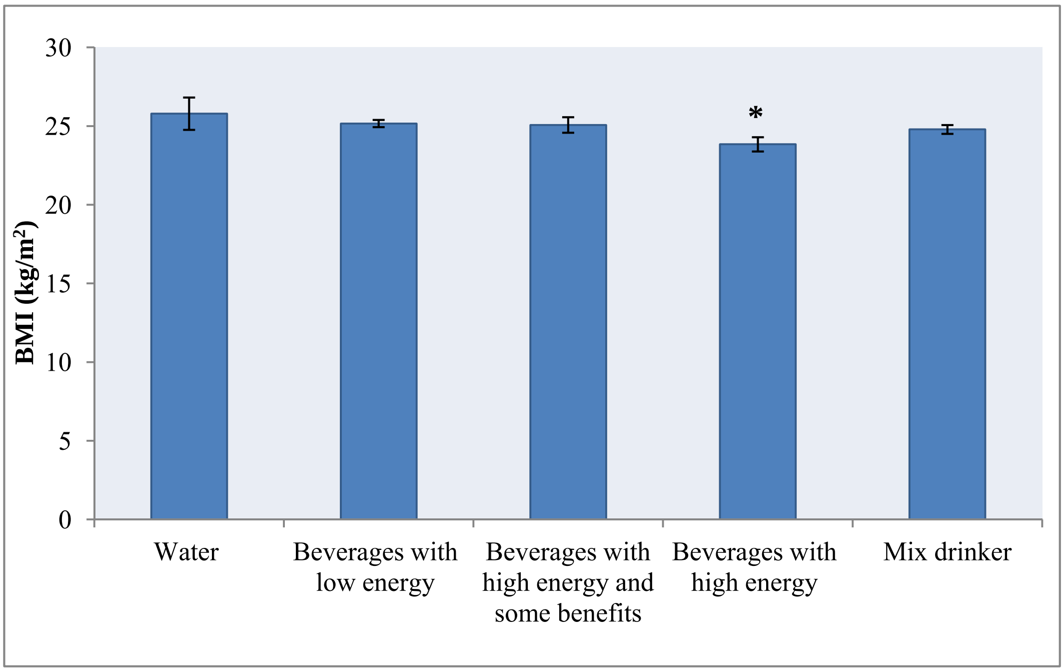

Figure 1. Mean (± SE) body mass index (BMI kg/m^2) by beverage pattern, adjusted for age, sex and TEI.

*Significantly different from the others, P<0.05

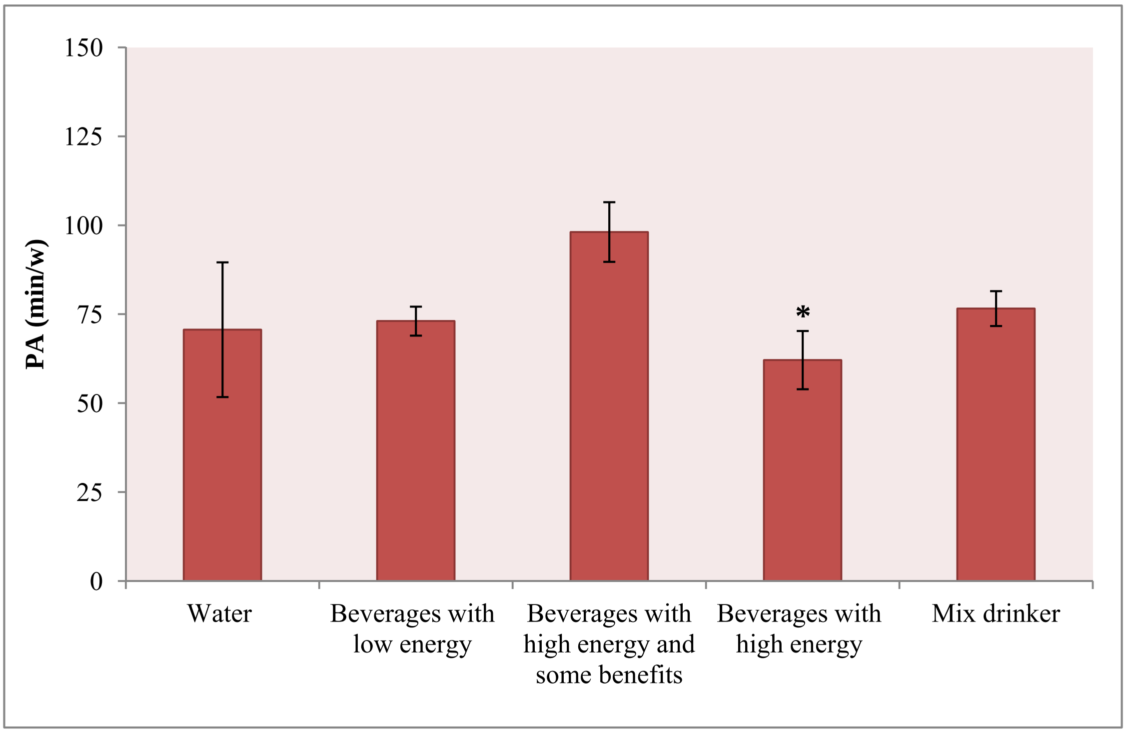

Figure 2. Mean (± SE) physical activity (PA min/w) by beverage pattern, adjusted for age, sex and TEI.

*Significantly different from the others, $P<0.05$

Manuscript IX

Beverage consumption among adolescents in the Balearic Islands: effects on nutrient and energy intake

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ABSTRACT

Objective: The aim of our study was to examine the differences in the beverage consumption of adolescent population in the Balearic Islands according to sex and age and to determine whether beverage consumption was associated with gender, age, chronic diseases, body mass index (BMI) and physical activity. We also examined the effects of beverage consumption on nutrient intake and diet quality.

Design: The study is a population-based cross-sectional nutritional survey carried out between 2007 and 2009. The target population was consisting of all residents living in the Balearic Islands aged 11-18 years. Data were obtained from two 24-h diet recalls and a semi-quantitative food frequency questionnaire (FFQ). Information about beverage consumption was obtained from the FFQ; whereas information on nutrient intake was derived from the average food daily consumption reported in the 24-h recalls.

Results: At all ages, water was the main fluid in the diet of adolescents. Total beverage consumption and total energy intake from beverages of boys were higher than those of girls. Beverages contributed 6% to 13% of the total energy intake in the adolescents' diets. A statistically significant and negative association was observed between BMI and consumption of beverages with low energy and beverages with high energy and some benefits ($p<0.001$). Mean NQI, TEI and % energy intake of adolescents who consumed beverages with high energy and some benefits were higher than those of others. Also nutrient intakes of adolescents who consumed beverages with high energy and some benefits were higher than those of their peers. While consumption of beverages with high energy and some benefits had a positive effect on nutrient intake consumption of beverages with high energy had an inverse effect on nutrient intake.

Conclusions: Overall dietary intakes of adolescents should be improved to increase the intake of inadequate nutrients and consumption of beverages with some benefits should be supported in adolescence to increase the diet quality.

Keywords: Beverage consumption, nutrient intake, energy intake, adolescent, the Balearic Islands

INTRODUCTION

While in the last decades prevalence of obesity has increased especially in children and adolescents, studies have focused on the diet related factors. Changes in dietary habits such as, increasing consumption of energy-dense, nutrient-poor foods and beverages are one of the main reasons of weight gain and obesity [1-3]. Furthermore, consumption of high energy containing beverages has been linked with overweight and poor diet [1-5]; however, adolescents have become the target population of soft drink companies [6,7].

Fluid intake is important for body function and also for the intake of many minerals [8,9]. Several studies showed that the main beverage in the diet of all children, adolescents and adults is water [10-15], while consumption of other beverages varies according to age groups. While milk is consumed in younger ages, consumption of sugar sweetened beverages (SSBs) is increasing with age among children and adolescents [16-18] and energy intake increases as a consequence of higher consumption of caloric beverages [16,18].

The objective of this study was to show the differences in the beverage consumption of adolescents according to sex and age and to determine whether beverage consumption was associated with gender, age, chronic diseases, body mass index (BMI) and physical activity. We also examined the effects of beverage consumption on nutrient intake and diet quality.

METHODS

Study population

Subjects of this study were participants in the OBIB project which is a population based cross-sectional nutritional survey. The data collection took place between 2007 and 2009. The sample population was derived from residents aged 11-18 years, registered in the scholar census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomisation into subgroups, with Balearic Islands municipalities being the primary sampling units, and individuals within the schools of these municipalities comprising the final sample units. The interviews were performed at the schools. The final sample size was 1988 individuals (98% participation). The reasons to not participate were: the subject declined to be interviewed or the parents did not authorise the interview.

Assessment of beverage consumption, energy and nutrient intake

Dietary intake was assessed with the dietary questionnaires included two 24-h recalls and a validated quantitative food frequency questionnaire (FFQ) covering the 145-item [19]. Information about beverage consumption was obtained from the FFQ; whereas information on nutrient intake was derived from the average food daily consumption reported in the two 24-h recalls. Nutrient intakes and total energy intake (TEI) were calculated using a computer program

(ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [20,21] and European Food Composition Tables [22], and complemented with food composition data available for Balearic food items [23].

Beverages were categorized in four groups according to their energy content and health benefits, beverages without energy (water), beverages with low energy (low-fat/skimmed milk, coffee, tea, vegetable juice and diet soda), beverages with high energy and some benefits (whole milk, fermented milk drinks and 100% fruit juice) and beverages with high energy (soda, commercial fruit juice, sport drinks, energy drinks and others). Energy contributed from beverages was calculated by using food composition tables [21,24,25].

The intake quality score (IQS) [26,27] for macro and micronutrients was calculated as the percentage of the age-specific Recommended Dietary Reference Intakes (RDIs). Then the nutrition quality index (NQI) [26,27] was calculated from harmonic mean of each subject's IQS for carbohydrate, protein, calcium, sodium, iron, zinc, magnesium, phosphorous, potassium, vitamin A, vitamin B_6, vitamin B_{12}, vitamin C, vitamin D, vitamin E, folic acid, pantothenic acid, niacin, riboflavin and thiamine.

Anthropometric measurements

Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France) with adolescents wearing light clothes without shoes, respectively. BMI was computed as weight/height^2 (kg/m^2) and study participants were categorized as normal-weight (<85th percentile) and overweight (>85th percentile) according to BMI.

Physical Activity Assessment

Physical activity was evaluating according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [28] in the short form, and its specific modification for adolescents (IPAQ A) [29]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice), and an additional question about sitting time was used as an indicator variable of time spent in sedentary activity. On the basis of their total daily time of physical activity, the subjects were divided into 2 groups: <60 and ≥60 min/day, according to the current physical activity recommendations [30].

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). Average consumption of each beverage and energy intake from each beverage for the age-gender grouping (in millilitre (mL)) and kilocalories (kcal) were calculated. Also mean IQS for each nutrient for consumers and non-consumers of beverages with high energy and some benefits was calculated. Differences across mean of beverage consumption, energy intake from beverages and mean IQS were evaluated with ANOVA test. Logistic regression analyses were carried out to examine association between beverage consumption and gender, age, chronic diseases, overweight and physical activity. To adjust the OR all variables were entered simultaneously into the model in order to account for the effects of all other covariates. Linear Regression analysis was used to evaluate association between nutrient intake and beverage consumption. The number of respondents included in the analyses may differ according to the beverage or because of missing data. For all statistical tests, $p < 0.05$ was taken as the significant level.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects and their parents or legal tutors.

RESULTS

Average daily beverage consumption and energy intake from beverages of the study population are represented by age groups in Table 1, 2 and 3, respectively.

Beverages without energy

At all ages, water was the main fluid in the diet of adolescents. The proportion of girls reporting that they drank water was higher than those of boys and the proportion of the population consumes water decreased with age.

Beverages with low energy

Beverages with low energy were not popular among the study population. While the proportion of coffee/tea drinkers increased with age, average daily consumption of these beverages was relatively stable with age in both genders. Only 1% of the each age group consumed diet soda. Among boys the proportion of low-fat milk drinkers dropped with age, in contrast, among girls it went up with age. Average daily low-fat milk consumption was stable with age among boys, whereas low-fat milk intake slightly rose with age among girls. Vegetable juice was also not a popular beverage among boys and young teenage girls. There was a significant difference between energy intake from beverages with low energy among younger and also older teenage boys and girls; however, at ages 14-15 there were no differences in the energy intake from these beverages anymore.

Beverages with high energy and some benefits

Mean daily intake of milk among boys was relatively stable; however, the average daily milk consumption decreased with age among girls. Fermented milk drinks were not popular among adolescents, less than 5% of the study population consumed these beverages. While the percentages of natural fruit juice consumers were stable in both ages, mean intake of 100% fruit juice varied according to age groups. Because the consumption of beverages with high energy and some benefits was relatively stable, there was no difference in the energy intake from these beverages among adolescents.

Beverages with high energy

The highest daily mean intake of soda was observed among adolescents at ages 14 to 15 years and boys consume higher amount of soda than girls did. Furthermore, consumption of fruit drinks was the highest among boys at ages 14 to 15. A very low proportion of teens reported alcohol consumption. Teens started to drink alcohol at ages 14 to 15 and daily intake increased with age. Energy/sport drinks had a similar trend like alcohol. While among young boys consumption of these drinks was not common, just one girl reported energy/sport drink consumption. At older ages energy/sport drinks became popular among boys. Less than 10% of teens consumed other high energy beverages. Energy intake from beverages with high energy increased with age among boys and it was higher than those of girls. Similarly, total beverage consumption and total energy intake from beverages of boys were higher than those of girls.

Association between beverage consumption and gender, age, chronic disease, BMI and physical activity

The crude and adjusted ORs is presented in Table 4 for consumption of the beverages relative to non-consumption of the beverages in relation to gender, age, chronic disease, BMI and physical activity. Results showed that consumption of water, beverages with low energy and beverages with high energy and some benefits were significantly associated with gender ($p \leq 0.001$). Girls were more likely to consume water than boys, while boys consumed beverages with low energy and beverages with high energy and some benefits more than girls did.

Consumption of beverages with high energy and some benefits demonstrated a significant and negative association with age after adjustment. Chronic diseases were found negatively related with consumption of beverages with low energy and high energy and some benefits ($p<0.05$) in unadjusted results; however, after adjustment significance lost.

A statistically significant and negative association was observed between BMI and consumption of beverages with low energy and beverages with high energy and some benefits ($p<0.001$).

Nutrition intake of consumers and non-consumers of beverages with high energy and some benefits

NQI, TEI and nutrition intake was compared between consumers and non-consumers of beverage with high energy and some benefits (Table 5). Mean NQI, TEI and % energy intake from beverages of consumers was significantly higher than those of non-consumers in both genders. Beverages contributed 6% to 13% of the total energy intake in the adolescents' diets. In both genders mean intake of the most nutrients met or exceed the reference value in consumers and non-consumers. Intake of calcium, magnesium, potassium, vitamin D, vitamin E and folic acid were inadequate in consumers and also non-consumers of beverages in both genders. Because milk and dairy drinks are one of the main sources of dietary calcium we calculated calcium intake from milk and fermented milk drinks and they contributed almost 50% of the total calcium intake in diets of the study population in both genders. Calcium intake of girls was lower than those of boys and the differences in mean milk consumption between boys and girls explained the differences in percent RDI of calcium across genders. In general nutrient intake of consumers was significantly higher than those of non-consumers in both genders.

Association between beverage consumption and nutrition intake

Total energy intake was found positively and statistically associated with macro and micronutrient intake and also NQI (Table 6). A weak but positive association between water consumption and nutrient intake, except carbohydrates and vitamin E intake, was observed. In contrast, consumption of beverages with low energy was negatively associated with intake of many nutrients and NQI. Except sodium, iron, zinc and vitamin B6, intakes of other nutrients were found positively associated with consumption of beverages with high energy and some benefits in model 4. Calcium, vitamin C and folic acid intakes were positively associated with consumption of beverages with high energy and some benefits. This group included whole milk, fermented milk drinks and 100% fruit juice. A positive association was found between calcium intake and whole fat consumption ($\beta=0.360$, $p<0.001$), and fermented milk drinks ($\beta=0.195$, $p<0.001$), while vitamin C intake was positively associated with 100% fruit juice consumption ($\beta=0.269$, $p<0.00$) and commercial fruit juice consumption ($\beta=0.318$, $p<0.001$). In model 5, consumption of high energy beverages was positively associated with carbohydrate and vitamin C intake, while intake of many nutrients and NQI was found negatively associated with consumption of beverages with high energy.

DISCUSSION

In the literature beverage consumption studies which included water reported that plain water consume is the greatest quantity in adolescents' diet [10,12-15,31]. As expected water was the main beverage in the diet of adolescents in the Balearic Islands. Findings for gender differences in the total beverage consumption were similar in the literature [10,13,15,32,33], total beverage consumption of boys was higher than those of girls. In the present study, we found that consumption of total milk was not decreased with age among girls while it decreased slightly among boys. In the literature several studies reported that consumption of milk decreased with age [10,13,14]; however, in these studies milk consumption of children and adolescents was compared and adolescents weren't grouped in subgroups according to their ages.

Many studies found that consumption of sugar sweetened beverages (SSBs) increased with age among teens [10,12-14,33]. Similarly, we found that total consumption of beverages with high energy increased with age. Especially soda consumption of boys peaked at ages 14-15 years. In the Balearic Islands, energy intake of adolescents from beverages was low, beverages contributed to only 11% of total energy intake. Similarly Libuda *et al.,* [34] reported that SSBs contributed around 6% of the total energy intake of German teens. In contrast to European teenagers, in Mexico and the USA energy intake from beverages was high. While one study reported that energy intake from beverages contributed 20% of total energy intake of Mexican adolescents [14], other found that SSBs consumption contributed the 10% of total energy of American adolescents [35].

We found that gender was associated with beverage consumption. While girls were more likely to consume water, boys were more likely to consume beverages with low energy and high energy and some benefits. Age was found negatively associated with consumption of beverages with high energy and some benefits. Consumption of beverages with low energy, like diet soda, tea and coffee was found negatively associated with BMI. Similarly Ludwig *et al.*, [36], reported that consumption of diet-soda was negatively associated with obesity and Dennis *et al.*, [37] reported that consumption of tea and coffee was negatively associated with weight gain. Also a negative association between BMI and consumption of beverages with high energy and some benefits was found. Contrary to our findings, consumption of whole milk and 100% fruit juice was found positively associated with weight gain [37].

In the present study, no association between BMI and consumption of beverages with high energy was observed. While some studies reported that consumption of SSBs associated with weight gain [38-41], some didn't [36,42,43]. There are discrepant results in the literature; however, it is clear that the main reason for weight gain is imbalance energy homeostasis. Since beverages have a low satiety value they don't affect the intake of solid food, they might cause excess energy intake and weight gain [37].

We found that nutrient intakes of adolescents who consumed beverages with high energy and some benefits were higher than those of non-consumers and increasing consumption of these beverages had a weak positive effect on the intake of most of the vitamins and minerals and also NQI. Bowman [44] had reported nutrient intake of teen girls who consume milk was higher than those of non-milk consumers. While mean intakes of most micronutrients were adequate, major minerals like calcium, necessary for healthy bones, were deficient in boys and girls. A strong positive association between consumption of milk and calcium intake was reported [45,46]. In line with these results, we found that milk and dairy drinks contributed half of the dietary calcium intake; however, daily calcium intake of adolescent population in the Balearic Islands was insufficient. Intake of vitamin D, another important micronutrient for bone health from diet was also deficient in the study population. A high amount of vitamin D is synthesized from exposure to sunlight [47] and the Balearic Islands have a Mediterranean climate which has long sunny summers; however, Ovesen *et al.*, [48] reported that especially in the winter the concentration of 25-hydroxyvitamin D (25(OH)) in serum was below the adequate level in Spanish adolescents and the vitamin D status of southern European countries were lower than in Scandinavian countries [48,49] in where consumption of fatty fish, vitamin D intake from supplements [48] and fortified foods [50] was high.

In the present study, we found a positive association between consumption of beverages with high energy and some benefits and calcium and vitamin C intake because this group included whole fat milk and fermented milk beverages and 100% fruit juice (mainly natural orange juice). Our findings were in line with the findings of Marshall *et al.*, [4] who reported that calcium intake of children increased with consumption of dairy foods and intake of vitamin C was associated with the consumption of 100% fruit juice. Forshee *et al.*, [51] reported a strong relation between milk consumption and calcium intake.

NQI was found positively associated with beverages with high energy and some benefits. While milk provides protein, many minerals and vitamins, 100% fruit juice provides important vitamins and minerals. Studies which evaluated the effects of beverage consumption on diet quality reported that consumption of SSBs inversely affected the diet quality and intake of many minor nutrients decreased with increasing SSBs consumption among children and teens [34,52]. Another studies reported that calcium intake decreased with soda consumption [46]. Similarly, we found a weak inverse association between increasing consumption of beverages with high energy and most of the nutrient intakes.

CONCLUSION

Beverage choices of the adolescent population in the Balearic Islands varied according to gender and age. Their energy intake from beverages was not as high as the energy intake from beverages of their American peers and no association between consumption of high energy and BMI was found; however, negative effects of consumption of these beverages on the diet quality of adolescents were found. Related with the beverage type, the consumption of beverages had different effects on the diet quality. Our findings didn't support that milk consumption decreased with age or increasing consumption of soda; whereas some of the important nutrients like calcium, magnesium and Vitamin D were found deficient among adolescents. Overall dietary intakes of adolescents should be improved to increase the intake of these inadequate nutrients and the consumption of beverages with some benefits should be supported in adolescence to increase the diet quality.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Table 1. Mean daily beverage intake of adolescents aged 11-13 years

	Male			Female		
	Consumer N, (%)	**Consumption, (mL) Mean±SD**	**Energy, (kcal) Mean±SD**	**Consumer N, (%)**	**Consumption, (mL) Mean±SD**	**Energy, (kcal) Mean±SD**
Beverages without energy						
Water	136, (63)	443.1 ± 505.0	0.0 ± 0.0	152, (64)	494.2 ± 567.3	0.0 ± 0.0
Beverages with low energy						
Coffee/Tea	8, (4)	5.1 ± 28.9	0.4 ± 2.5	12, (5)	7.5 ± 38.6	0.6 ± 3.3
Diet soda	2, (1)	2.5 ± 26.2	0.0 ± 0.0	nc	-	-
Low Fat Milk	54, (25)	74.4 ± 142.5	34.0 ± 65.4	58, (25)	57.9 ± 105.3	26.7 ± 49.1
Vegetable Juice	nc			nc	-	-
Total	**62, (29)**	**82.0 ± 146.3**	**34.4 ± 65.3**	**68, (29)**	**65.5 ± 109.6**	**27.4 ± 49.0**
Beverages with high energy and some benefits						
Whole Milk	119, (55)	160.6 ± 175.7	105.8 ± 116.0	117, (50)	128.9 ± 145.6	85.1 ± 96.1
Fermented milk drinks	5, (2)	4.6 ± 30.1*	3.3 ± 21.2*	2, (1)	1.7 ± 18.4	1.2 ± 12.7
Fruit Juice (100%)	14, (6)	14.8 ± 59.2	7.0 ± 27.9	19, (8)	17.8 ± 62.7	8.4 ± 29.6
Total	**129, (60)**	**180.0 ± 187.9***	**116.1 ± 120.8***	**131, (56)**	**148.4 ± 153.0**	**94.6 ± 98.1**
Beverages with high energy						
Soda	52, (24)	96.0 ± 194.0	20.8 ± 42.3	48, (20)	68.9 ± 147.9	14.9 ± 31.9
Fruit Drinks	70, (32)	98.1 ± 169.6*	45.2 ± 78.0*	56, (24)	60.7 ± 122.9	28.5 ± 58.1
Alcohol	nc	-	-	nc	-	-
Energy/Sport Drinks	nc	-	-	1, (0.4)	1.4 ± 21.5	0.4 ± 6.8
Others[1]	10, (5)	11.3 ± 57.7	7.7 ± 35.2	16, (7)	18.3 ± 84.8	11.5 ± 45.8
Total	**111, (51)**	**205.4 ± 261.6***	**73.7 ± 93.7***	**106, (45)**	**149.2 ± 213.6**	**55.3 ± 81.7**
TOTAL	**209, (97)**	**910.5 ± 563.6**	**224.2 ± 141.3***	**228, (97)**	**857.3 ± 578.1**	**177.2 ± 102.4**

*Significantly different from the mean for girls of same age (P<0.05)

nc: no consumption

[1]Others include coffee with milk, hot chocolate, Nestea, chocolate milk shake, strawberry milkshake and vanilla milkshake

1 kcal = 4.184 kJ

Table 2. Mean daily beverage intake of adolescents aged 14-15 years

	Male			Female		
	Consumer N, (%)	**Consumption, (mL) Mean±SD**	**Energy, (kcal) Mean±SD**	**Consumer N, (%)**	**Consumption, (mL) Mean±SD**	**Energy, (kcal) Mean±SD**
Beverages without energy						
Water	257, (61)*	515.3 ± 613.2	0.0 ± 0.0	332, (68)	554.9 ± 608.9	0.0 ± 0.0
Beverages with low energy						
Coffee/Tea	25, (6)†	5.0 ± 23.4	0.3 ± 1.6	31, (6)†	7.2 ± 33.1	0.6 ± 2.8
Diet soda	2, (1)	1.6 ± 22.7	0.0 ± 0.0	4, (1)	3.1 ± 35.3	0.0 ± 0.0
Low Fat Milk	94, (22)	65.5 ± 134.9	29.7 ± 61.9	135, (28)	77.3 ± 137.5	34.5 ± 62.4
Vegetable Juice	nc	-	-	2, (0.4)	0.9 ± 13.6	0.6 ± 10.0
Total	**114, (27)**	**72.1 ± 137.5**	**30.0 ± 61.8**	**160, (33)**	**88.5 ± 145.9**	**35.7 ± 62.7**
Beverages with high energy and some benefits						
Whole Milk	231, (55)*	165.9 ± 203.5*	109.3 ± 134.1*	171, (35)†	98.7 ± 154.6†	65.2 ± 102.0†
Fermented milk drinks	7, (2)	4.3 ± 36.7	3.0 ± 25.4	6, (1)	2.2 ± 20.2	1.5 ± 13.7
Fruit Juice (100%)	21, (5)	10.8 ± 49.2	5.1 ± 23.2	39, (8)	16.5 ± 57.8	8.8 ± 34.4
Total	**243, (57)**	**181.0 ± 212.9***	**117.4 ± 138.4***	**201, (41)**	**117.5 ± 163.5†**	**75.4 ± 106.4†**
Beverages with high energy						
Soda	129, (30)*	151.0 ± 281.1*†	32.6 ± 60.7*†	120, (25)	98.5 ± 204.4	21.7 ± 45.4
Fruit Drinks	102, (24)	81.1 ± 192.9	37.3 ± 88.8	142, (29)	92.6 ± 210.7	42.5 ± 96.5
Alcohol	2, (1)	0.8 ± 12.2	0.9 ± 14.8	2, (0.4)	0.1 ± 1.2	0.0 ± 0.8
Energy/Sport Drinks	8, (2)*†	7.0 ± 52.8*	2.4 ± 19.6*	2, (0.4)	0.8 ± 15.0	0.2 ± 4.8
Others[1]	17, (4)	9.7 ± 51.3	6.3 ± 33.3	28, (6)	14.0 ± 63.2	10.2 ± 49.3
Total	**214, (51)**	**248.8 ± 345.5***	**79.6 ± 116.1**	**247, (51)**	**205.8 ± 295.6**	**74.6 ± 129.3**
TOTAL	**392, (93)**	**1017.2 ± 707.2**	**227.0 ± 168.7***	**452, (93)**	**966.7 ± 652.1**	**185.7 ± 173.1**

*Significantly different from the mean for girls of same age (P<0.05)
†Significantly different from the mean for same sex at 11-13y age group (P<0.05)
nc: no consumption
[1]Others include coffee with milk, hot chocolate, Nestea, chocolate milk shake, strawberry milkshake and vanilla milkshake.
1 kcal = 4.184 kJ

Table 3. Mean daily beverage intake of adolescents aged 16-18 years

	Male			**Female**		
	Consumer N, (%)	**Consumption, (mL) Mean±SD**	**Energy, (kcal) Mean±SD**	**Consumer N, (%)**	**Consumption, (mL) Mean±SD**	**Energy, (kcal) Mean±SD**
Beverages without energy						
Water	154, (59)	564.4 ± 664.1†	0.0 ± 0.0	185, (67)	539.9 ± 603.1	0.0 ± 0.0
Beverages with low energy						
Coffee/Tea	24, (9)†	7.4 ± 30.5	0.5 ± 2.4	30, (11)†	10.8 ± 47.6	0.8 ± 4.0
Diet soda	3, (1)	5.0 ± 49.8*	0.0 ± 0.0	2, (1)	1.9 ± 23.1	0.0 ± 0.0
Low Fat Milk	48, (18)*	54.6 ± 126.6	24.0 ± 55.7	88, (32)	93.6 ± 152.2†	40.2 ± 65.3†
Vegetable Juice	nc	-	-	2, (1)	1.1 ± 13.4	0.3 ± 3.2
Total	**66, (25)**	**67.0 ± 138.4***	**24.5 ± 55.8***	**114, (41)**	**107.4 ± 159.5†**	**41.2 ± 65.4†**
Beverages with high energy and some benefits						
Whole Milk	113, (43)*†‡	130.0 ± 173.7*‡	85.7 ± 114.7*‡	95, (34)†	91.3 ± 144.9†	60.0 ± 95.4†
Fermented milk drinks	3, (1)	8.8 ± 94.9	6.1 ± 65.7	1, (0.4)	1.4 ± 24.0	1.0 ± 16.6
Fruit Juice (100%)	13, (5)	14.1 ± 78.2	6.7 ± 36.9	24, (9)	18.8 ± 63.2	8.9 ± 29.8
Total	**125, (48)**	**152.9 ± 202.8***	**98.4 ± 131.1***	**115, (42)**	**111.5 ± 154.2†**	**69.9 ± 98.4†**
Beverages with high energy						
Soda	71, (27)*	129.3 ± 256.7*	27.9 ± 55.5*	53, (19)	73.8 ± 187.4	15.9 ± 40.3
Fruit Drinks	68, (26)	101.6 ± 232.6	47.2 ± 108.7	87, (32)	89.2 ± 148.3	41.3 ± 68.4
Alcohol	1, (0.4)	1.3 ± 20.4	0.5 ± 8.6	1, (0.4)	3.6 ± 59.5	0.9 ± 15.2
Energy/Sport Drinks	9, (3)†	11.7 ± 67.0†	4.0 ± 23.1†	6, (2)†‡	7.1 ± 48.1	2.6 ± 17.6
Others[1]	15, (6)	14.7 ± 78.4	9.4 ± 41.5	26, (9)	22.6 ± 76.6	16.2 ± 52.8
Total	**124, (47)**	**257.3 ± 371.2***	**89.0 ± 134.0**	**142, (51)**	**192.8 ± 248.0**	**76.6 ± 95.5**
TOTAL	**223, (85)**	**1041.6 ± 817.8**	**211.9 ± 193.6**	**250, (91)**	**951.5 ± 651.8**	**188.0 ± 134.7**

*Significantly different from the mean for girls of same age ($P<0.05$)
†Significantly different from the mean for same sex at 11-13y age group ($P<0.05$)
‡Significantly different from the mean for same sex at 14-15y age group (P<0.05)
nc: no consumption
[1]Others include coffee with milk, hot chocolate, Nestea, chocolate milk shake, strawberry milkshake and vanilla milkshake

Table 4. Unadjusted and adjusted logistic regression analysis of the relationship between beverage consumption and gender, age, chronic disease, BMI and physical activity

	Beverages without energy		**Beverages with low energy**		**Beverages with high energy and some benefits**		**Beverages with high energy**	
	Unadjusted OR (95% CI)	**Adjusted[1] OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted[1] OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted[1] OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted[1] OR, (95% CI)**
Gender								
Boy	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Girl	1.37 (1.14, 1.64)*	1.33 (1.09, 0.62)*	0.62 (0.52, 0.74)*	0.56 (0.46, 0.68)*	0.68 (0.57, 0.81)*	0.61 (0.50, 0.74)*	1.03 (0.86, 1.23)	1.12 (0.88, 1.41)
Age (years)								
11-13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14-15	1.24 (0.99, 1.56)	1.09 (0.85, 1.39)	0.89 (0.71, 1.10)	0.84 (0.66, 1.06)	0.82 (0.66, 1.03)	0.76 (0.60, 0.96)*	1.25 (1.00, 1.56)*	1.12 (0.88, 1.41)
16-18	1.07 (0.91, 1.50)	0.99 (0.76, 1.30)	0.77 (0.60, 0.98)*	0.72 (0.55, 0.94)*	0.70 (0.55, 0.90)*	0.63 (0.49, 0.82)*	1.20 (0.94, 1.53)	1.07 (0.83, 1.39)
Chronic diseases[2]								
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.04 (0.80, 1.34)	1.03 (0.79, 1.34)	0.76 (0.59, 0.97)*	0.83 (0.64, 1.07)	0.78 (0.61, 1.00)*	0.86 (0.67, 1.12)	1.01 (0.79, 1.29)	1.04 (0.81, 1.34)
BMI (kg/m^2)								
Normal (<85th)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Overweight (>85th)	1.00 (0.82, 1.23)	1.11 (0.89, 1.37)	0.67 (0.54, 0.82)*	0.61 (0.48, 0.75)*	0.61 (0.50, 0.74)*	0.55 (0.44, 0.68)*	0.89 (0.73, 1.09)	0.92 (0.74, 1.13)
Physical activity								
≤60 min/day	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
>60 min/day	1.01 (0.82, 1.24)	1.05 (0.84, 1.31)	1.11 (0.91, 1.36)	1.02 (0.82, 1.27)	1.15 (0.94, 1.14)	1.09 (0.89, 1.35)	0.98 (0.80, 1.12)	0.97 (0.78, 1.20)

OR: Odds ratio
CI: Confidence intervals
BMI: Body mass index
*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (P<0.05)
[1]Adjusted for gender, age, chronic disease, BMI and physical activity
[2]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases

Table 5. Mean daily nutrient intakes and diet quality in subjects by consumption of beverages with high energy

	Male		**Female**	
	Non_consumer of beverages with high energy and some benefits (N, 447)	**Consumer of beverages with high energy and some benefits (N, 505)**	**Non_consumer of beverages with high energy and some benefits (N, 587)**	**Consumer of beverages with high energy and some benefits (N, 451)**
	Mean±SD	**Mean±SD**	**Mean±SD**	**Mean±SD**
NQI	58.66 ± 31.52***	70.38 ± 32.69	53.20 ± 29.00***	61.63 ± 29.91
TEI (kcal/d)	2206.60 ± 762.41***	2457.08 ± 866.78	1877.13 ± 605.00***	2013.44 ± 685.21
Energy from beverages (%)	5.99± 5.96***	12.09 ± 6.02	6.86 ± 6.07***	13.42 ± 7.63
RDI%				
Carbohydrates	195.49 ± 76.51**	211.07 ± 86.19	164.60 ± 62.04	172.56 ± 69.05
Proteins	175.29 ± 103.56***	213.98 ± 89.61	174.83 ± 87.17***	198.43 ± 78.75
Calcium	51.91 ± 26.32***	63.97 ± 28.60	45.44 ± 23.52***	55.73 ± 23.88
Sodium	176.20 ± 87.81*	189.89 ± 94.81	148.99 ± 75.78	144.07 ± 77.16
Iron	130.28 ± 127.20***	166.71 ± 190.53	104.83 ± 156.21*	132.38 ± 249.57
Zinc	104.49 ± 66.04***	127.39 ± 67.45	110.81 ± 66.04	116.74 ± 59.01
Magnesium	63.22 ± 36.64***	79.12 ± 32.78	66.37 ± 32.72***	77.70 ± 30.30
Phosphorus	106.93 ± 39.75***	119.47 ± 43.22	92.56 ± 31.91***	101.08 ± 33.96
Potassium	51.50 ± 30.26***	61.25 ± 25.01	48.53 ± 23.04***	56.20 ± 22.02
Vitamin A	74.45 ± 115.17*	100.31 ± 194.76	88.69 ± 128.39**	117.38 ± 208.41
Vitamin B_6	147.36 ± 195.77*	185.79 ± 267.46	168.55 ± 301.49	174.51 ± 209.69
Vitamin B_{12}	345.49 ± 488.23*	413.12 ± 477.83	363.82 ± 474.49	395.51 ± 478.15
Vitamin C	114.12 ± 120.36***	142.57 ± 128.49	140.63 ± 126.07***	180.27 ± 142.09
Vitamin D	21.62 ± 177.07	42.79 ± 300.43	16.51 ± 100.44	28.16 ± 196.20
Vitamin E	47.76 ± 34.55***	56.61 ± 32.41	46.20 ± 32.62*	50.96 ± 27.77
Folic Acid	53.46 ± 37.73***	66.71 ± 33.99	53.95 ± 32.93***	65.17 ± 34.17
Pantothenic Acid	99.96 ± 73.44***	136.87 ± 130.10	103.51 ± 108.52	113.00 ± 68.16
Niacin	128.99 ± 94.35***	154.37 ± 80.60	137.71 ± 85.87*	149.22 ± 78.93
Riboflavin	216.73 ± 535.72	255.45 ± 526.19	201.99 ± 435.12*	270.23 ± 619.99
Thimain	189.26 ± 429.99	210.09 ± 419.72	166.34 ± 337.70	207.28 ± 473.29

Significantly different from the mean for consumer of beverages with energy and some benefits within same gender (*P<0.05, **P<0.01, ***P<0.001)
NQI: Nutrition Quality Index
TEI: Total Energy Intake
RDI: Recommended Dietary Reference Intake

Table 6. Results of linear regression models of the association between beverages consumption and intake of nutrition

	Model 1[1]		Model 2[2]		Model 3[3]		Model 4[4]		Model 5[5]	
RDI%	**β**	***P***	**β**	***P***	**β**	***P***	**β**	***P***	**β**	***P***
Carbohydrate	0.80	<0.0001	-0.02	0.124	-0.04	0.115	0.02	0.481	0.15	<0.0001
Protein	0.67	<0.0001	0.05	0.010	-0.02	0.532	0.03	0.466	-0.07	<0.0001
Calcium	0.55	<0.0001	0.09	<0.0001	-0.01	0.711	0.24	<0.0001	-0.10	<0.0001
Sodium	0.75	<0.0001	0.06	<0.0001	-0.01	0.784	-0.06	0.060	-0.10	<0.0001
Iron	0.28	<0.0001	0.04	0.121	0.12	0.011	-0.10	0.028	-0.03	0.196
Zinc	0.57	<0.0001	0.01	0.579	-0.05	0.247	-0.01	0.778	-0.08	<0.0001
Magnesium	0.55	<0.0001	0.06	0.004	-0.07	0.077	0.12	0.003	-0.06	0.007
Phosphorus	0.82	<0.0001	0.05	<0.0001	-0.04	0.107	0.12	<0.0001	-0.07	<0.0001
Potassium	0.63	<0.0001	0.07	<0.0001	-0.12	0.001	0.16	0.000	-0.03	0.164
Vitamin A	0.08	0.002	0.02	0.304	-0.01	0.861	0.05	0.347	0.01	0.704
Vitamin B_6	0.19	<0.0001	0.06	0.013	0.10	0.037	-0.11	0.021	-0.03	0.201
Vitamin B_{12}	0.21	<0.0001	0.03	0.260	-0.18	0.000	0.16	0.001	0.03	0.240
Vitamin C	0.07	0.005	0.06	0.006	-0.46	0.000	0.48	<0.0001	0.13	0.000
Vitamin D	0.01	0.611	0.01	0.570	-0.01	0.799	0.04	0.386	-0.01	0.597
Vitamin E	0.55	<0.0001	-0.03	0.091	-0.08	0.043	0.02	0.723	0.03	0.198
Folic Acid	0.40	<0.0001	0.08	<0.0001	-0.28	0.000	0.31	<0.0001	-0.06	0.010
Pantothenic Acid	0.31	<0.0001	0.08	<0.0001	0.02	0.634	0.03	0.579	-0.01	0.878
Niacin	0.44	<0.0001	0.06	0.004	-0.09	0.029	0.06	0.166	-0.01	0.884
Riboflavin	0.21	<0.0001	0.03	0.140	-0.09	0.057	0.09	0.070	-0.05	0.030
Thimain	0.23	<0.0001	0.03	0.134	-0.09	0.048	0.07	0.160	-0.05	0.042
NQI	0.60	<0.0001	0.04	0.019	-0.09	0.024	0.20	<0.0001	-0.08	<0.0001

[1]Model 1 include total energy intake (kcal/d) as independent variables
[2]Model 2 include intake of water (mL/d) as independent variables
[3]Model 3 include intake of beverages with low energy (mL/d) as independent variables
[4]Model 4 include intake of beverages with high energy and benefits (mL/d) as independent variables
[5]Model 5 include intake of beverages with high energy (mL/d) as independent variables
NQI: Nutrition Quality Index
RDI: Recommended Dietary Reference Intake

Manuscript X

Beverage patterns of the adolescent population in the Balearic Islands

Aslı Emine Özen, Maria del Mar Bibiloni, Antoni Pons, Josep A. Tur

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ABSTRACT

Objective: The aim of our study was to examine the beverage pattern of the adolescent population in the Balearic Islands and to determine whether beverage pattern was associated with socio demographic and lifestyle characteristics.

Design: The study is a population-based cross-sectional nutritional survey carried out between 2007 and 2009. The target population was consisting of all residents living in the Balearic Islands aged 11-18 years. Data were obtained from two 24-h diet recalls and a semi-quantitative food frequency questionnaire (FFQ). Information about beverage consumption was obtained from the FFQ; whereas information on nutrient intake was derived from the average food daily consumption reported in the 24-h recalls.

Results: Beverage patterns of the study population were identified in five clusters as; low-fat milk drinkers, whole fat milk drinkers, commercial fruit juice drinkers, soda drinkers, and mix drinkers and whole fat milk drinkers' cluster was the predominant beverage pattern among the subjects. Total beverage intake and total percentage of energy from beverages were the highest among the subjects in commercial fruit drinkers patter, whereas these values were the lowest among the adolescents in mix drinkers pattern. Socio-demographic and lifestyle characteristics of subject varied according to beverage clusters. Teens in the commercial fruit juice drinkers cluster had the highest total energy, carbohydrate, protein intake and nutrition quality index. Adolescents in this cluster had the highest mean BMI; on the contrary, they were physically more active than others.

Conclusions: Overall dietary intakes of adolescents should be improved to increase the intake of inadequate nutrients and consumption of beverages with some benefits should be supported in adolescence to increase their diet quality.

Keywords: Beverage consumption, nutrient intake, cluster analysis, adolescent, the Balearic Islands

INTRODUCTION

In the last decades changes in dietary habits such as, increasing consumption of energy-dense, nutrient-poor foods and beverages are one of the main reasons of weight gain and obesity [1-3].

Furthermore, consumption of sugar sweetened beverages (SSBs) has been linked with overweight and poor diet [1-5]; whereas, young population have become the target population of soft drink companies [6,7].

Water consumption is necessary for body function and also for the intake of many minerals [8,9]. Several studies showed that the main beverage in the diet of all children, adolescents and adults is water [10-15], while consumption of other beverages varies according to age groups.

In the literature many studies reported beverage consumption and its effect on diet quality and health status [16-18]. However studies that investigate the beverage pattern of adolescents and its effects on nutrient intake is missing. The objective of this study was to examine the beverage pattern of the adolescent population in the Balearic Islands and to determine whether beverage pattern was associated with socio demographic and lifestyle characteristics. We also examined the association between beverage patterns and nutrient intake and diet quality.

METHODS

Study population

Subjects of this study were participants in the OBIB project which is a population based cross-sectional nutritional survey. The data collection took place between 2007 and 2009. The sample population was derived from residents aged 11-18 years, registered in the scholar census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomisation into subgroups, with Balearic Islands municipalities being the primary sampling units, and individuals within the schools of these municipalities comprising the final sample units. The interviews were performed at the schools. The final sample size was 1988 individuals (98% participation). The reasons to not participate were: the subject declined to be interviewed or the parents did not authorise the interview.

Assessment of beverage consumption, energy and nutrient intake

Dietary intake was assessed with the dietary questionnaires included two 24-h recalls and a validated quantitative food frequency questionnaire (FFQ) covering the 145-item [19]. Information about beverage consumption was obtained from the FFQ; whereas information on nutrient intake was derived from the average food daily consumption reported in the two 24-h recalls. Nutrient intakes and total energy intake (TEI) were calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [20,21] and European Food Composition Tables [22], and complemented with food composition data available for Balearic food items [23].

Beverages were categorized in four groups according to their energy content and health benefits, beverages without energy (water), beverages with low energy (low-fat/skimmed milk, coffee, tea, vegetable juice and diet soda), beverages with high energy and some benefits (whole milk, fermented milk drinks and 100% fruit juice) and beverages with high energy (soda, commercial fruit juice, sport drinks, energy drinks and others). Energy contributed from beverages was calculated by using food composition tables [21,24,25].

The intake quality score (IQS) [26,27] for macro and micronutrients was calculated as the percentage of the age-specific Recommended Dietary Reference Intakes (RDIs). Then the nutrition quality index (NQI) [26,27] was calculated from harmonic mean of each subject's IQS for carbohydrate, protein, calcium, sodium, iron, zinc, magnesium, phosphorous, potassium, vitamin A, vitamin B_6, vitamin B_{12}, vitamin C, vitamin D, vitamin E, folic acid, pantothenic acid, niacin, riboflavin and thiamine.

Anthropometric measurements

Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France) with adolescents wearing light clothes without shoes, respectively. BMI was computed as weight/height^2 (kg/m^2) and study participants were categorized as normal-weight (<85th percentile) and overweight (>85th percentile) according to BMI.

Physical Activity Assessment

Physical activity was evaluating according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [28] in the short form, and its specific modification for adolescents (IPAQ A) [29]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice), and an additional question about sitting time was used as an indicator variable of time spent in sedentary activity. On the basis of their total weekly time of physical activity, the subjects were divided into 2 groups: inactive (<300 min/w) and active (≥300 min/w), according to the current physical activity recommendations [30].

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). To identify groups of individuals with similar beverage patterns Quick Cluster procedure was used. This procedure is using k-means cluster analysis in that k, number of clusters, needs to be specified by user. To find the appropriate number of clusters in the data set, a series of steps is taken separately for each variable type. We examined solutions with two through ten clusters and chose a solution with five clusters, because it provided well separated clusters (according to the ANOVA that compared the beverage groups' variables between the clusters, for each solution) and more homogeneous cluster sizes. After determination of the number of clusters, each participant in the database is assigned to the cluster whose means on the five variables are closest to that participant's value and then participants iteratively clustered into one of these groups based on squared Euclidean distances. After each case is assigned, the cluster centre is updated before the next iteration. The assignment process is repeated until participants no longer change clusters.

Average consumption of each beverage (in millilitre-mL) of each cluster was calculated and comparisons across beverage clusters assessed by using a general linear model. Comparisons across socio-demographic characteristics of participants were evaluated by using χ^2 test. Logistic regression analyses were carried out to examine the association between beverage clusters and gender, age, education level father and mother, employment status father and mother, chronic disease, BMI and physical activity. To adjust the OR all variables were entered simultaneously into the model in order to account for the effects of all other covariates. To describe nutrient intake across the 5 clusters, mean for TEI, intake of food groups, IQS for each nutrient and NQI were calculated. Differences across means were evaluated by using a general linear model and adjusting for age, sex, and BMI. The number of respondents included in the analyses may differ according to the beverage or because of missing data. For all statistical tests, $P<0.05$ was taken as the significant level.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects and their parents or legal tutors.

RESULTS

Beverage patterns of study population were identified in five clusters (Table 1). The beverage clusters were labelled based on the predominant beverage group in the cluster; low-fat milk drinkers, whole fat milk drinkers, commercial fruit juice drinkers, soda drinkers and mix drinkers. While adolescents in the commercial fruit drinkers cluster had the highest average daily total beverage intake, the lowest total beverage intake was observed among subjects in mix drinkers pattern. Furthermore, total percentage of energy from beverages was highest (16.1%) in commercial fruit juice drinkers. Whereas it was the lowest (2.7%) in mix drinkers pattern.

Characteristics of respondents by beverage clusters and adjusted ORs for consumption of the beverages relative to non-consumption of the beverages in relation to the socio-demographic characteristics are illustrated in Table 2. Percentage of gender, age, education level of mother, employment status of mother and father and BMI were significantly different across beverage clusters (P<0.005), whereas no significant difference was observed in percentages of chronic disease and physical activity level across beverage clusters.

While to be female was the characteristic of low fat milk drinkers cluster, to be male was the characteristic of soda drinkers cluster. Results of logistic regression showed a positive significant association between being overweight and a high consumption of low fat milk (OR=1.55, *P*=0.001) but also commercial fruit juice (OR=1,94, *P*=0.027). On the other hand, a positive association was observed between high consumption of whole fat milk and being normal weight (OR=0.60, *P*<0.0001).

TEI, macro and micro nutrients and NQI differed significantly by beverage patterns in adults (Table 3). TEI was the highest among commercial fruit juice drinkers pattern and was the lowest for mix drinkers pattern. Several differences were found between macro and micro nutrient intakes and beverage clusters. Mean intakes of most nutrients met or even exceeded the reference values in all clusters; besides, inadequate intake of important micronutrients like calcium, potassium, magnesium, vitamin D, vitamin E and folic acid was observed. Adolescents in the commercial fruit juice drinkers cluster had the highest carbohydrate and protein intake; whereas, the lowest intakes of them was found in the mix drinkers pattern. The mean NQI scores across beverage patterns ranged from 70.4 in the commercial fruit juice drinkers pattern to 53.9 in the mix drinkers patterns.

Comparisons of BMI and physical activity across beverage patterns are shown in Figure 1 and 2 respectively. Mean BMI (adjusted mean, 23.2 kg/m^2) of adolescents in the commercial fruit juice drinkers cluster were significantly higher than those of others (*P*<0.05).

DISCUSSION

In the present study the association between different beverage patterns and overall diet quality, measured by NQI, among adolescents were analyzed by cluster analysis. Beverage consumption patterns vary considerably among different countries and even among different regions within one country. According to an online survey of a market research company drinking water is the premier water supply of the majority and soda is consumed by a very high proportion (84%) of the Spanish population [31]. However, we observed that among the young population of the Balearic Islands whole fat milk drinkers cluster was the most prevalent beverage pattern (33.8% of the population), whereas 18% of the adolescent population were in soda drinkers cluster and only 3% of them were in the commercial fruit juice drinkers pattern.

Beverages contributed between 2.7 and 16.1% of the total energy intake of adolescents and average percentage of energy intake from the beverages was 11% (data not shown). Similarly Libuda *et al.,* [32] reported that SSBs contributed around 6% of the total energy intake of German teens. In contrast to European teenagers, in Mexico and the USA energy intake from beverages was high. While one study reported that energy intake from beverages contributed 20% of the total energy intake of Mexican adolescents [14], other found that SSBs consumption contributed the 10% of the total energy intake of American adolescents [33].

Many differences in socio-demographic characteristics across beverage patterns was observed. While girls more likely to consume low-fat milk, boys were more likely to consume beverages with high energy like soda, commercial fruit juice or whole fat milk. Similar to our findings it was reported that boys consumed a higher amount of soft drinks and fruit drinks than girls did [10,32].

We found that being in a normal weight was the characteristic of whole fat drinkers' cluster; whereas, being overweight was the characteristic of low-fat milk drinkers and commercial fruit juice drinkers patterns. These findings might suggest that while a group of overweight adolescents were considering their weight and preferred to consume low-fat milk because of its low energy content, other group of overweight adolescents consumed high amount of soda contrary to its sugar content. Clifton *et al.*, [34] also reported that consumption of SSBs were more popular among overweight adolescents. Moreover, adolescents in the commercial fruit juice drinkers cluster had a higher TEI and BMI than others did. Several studies which examine the beverage consumption of adolescents reported that consumption of SSB has increased among adolescents and might be the reason for weight gain [35-38]. High BMI of subjects in the commercial fruit juice might be related with high sugar intake from these SSBs.

Earlier studies have suggested that a high consumption of SSBs was related with high levels of energy intake from other foods [39-41]. Our findings were in line with the previous studies. The highest total energy intakes were observed among the adolescents in commercial fruit juice and soda drinkers clusters. Additionally, carbohydrate and protein intake of subjects in the commercial fruit juice drinkers cluster was higher than those of others. Previous studies also reported high carbohydrate intake of SSB consumers [5,42]. The highest NQI was found among commercial fruit juice drinkers cluster.

We found that micronutrient intakes of adolescents in commercial fruit juice cluster were higher than those of others. While mean intakes of the most micronutrients were adequate, major minerals like calcium, necessary for healthy bones, were deficient in boys and girls. A strong positive association between consumption of milk and calcium intake was reported [43-45]. In line with these results, we found that milk and dairy drinks contributed half of the dietary calcium intake and calcium intake of subjects in low and whole milk drinkers cluster were higher than others; however, daily calcium intake of adolescent population in the Balearic Islands was under RDI value. Intake of vitamin D, another important micronutrient for bone health from diet was also deficient in the study population. A high amount of vitamin D is synthesized from exposure to sunlight [46] and the Balearic Islands have a Mediterranean climate which has long sunny summers; however, Ovesen *et al.*, [47] reported that especially in the winter the concentration of 25-hydroxyvitamin D (25(OH)) in serum was below the adequate level in Spanish adolescents and the vitamin D status of southern European countries were lower than in Scandinavian countries [46-49] in where vitamin D intake from supplements [47] and fortified foods [48] was high.

Subjects in the mix drinker cluster had the lowest total beverage intake, TEI and NQI. Moreover most of the macro and micronutrient intakes of adolescents in this cluster were lower than others. This results indicated that around 25% of the adolescent population in the Balearic Islands had bad eating and drinking habits. Besides, a high proportion of the adolescent population consumed high amount of SSBs like commercial fruit juice and soda and TEI of these teens were higher than others. In contrary they were physically more active than their peers.

Conclusion

Although milk consumption replaced by consumption of SSB in children and adolescents, more than half of the adolescents still consumed high amount of low or whole fat milk in the Balearic Islands, whereas some of the important nutrients like calcium, magnesium and Vitamin D were found deficient among young population. Overall dietary intakes of adolescents should be improved to increase the intake of these inadequate nutrients and the consumption of beverages with some benefits should be supported in adolescence to increase their diet quality.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Table 1. Mean daily beverage intake of beverage groups, mean daily intake of total beverage consumption, and mean percentage of total energy from beverages across beverage patterns

	Cluster 1: Low-fat milk drinkers (n=393)	**Cluster 2: Whole fat milk drinkers (n=673)**	**Cluster 3: Commercial fruit juice drinkers (n=63)**	**Cluster 4: Soda drinkers (n=355)**	**Cluster 5: Mix drinker (n=505)**	***P* value**
	Mean ± SD					
Water (mL)	456.1 ± 657.7	714.9 ± 590.9	365.5 ± 496.0	497.5 ± 586.1	505.9 ± 103.1	<0.0001
Beverages with low energy						
Low Fat Milk (mL)	295.8 ± 113.3	nc	48.8 ± 101.4	46.1 ± 100.8	1.4 ± 12.5	<0.0001
Coffee/Tea (mL)	4.2 ± 22.7	6.5 ± 31.6	3.6 ± 18.0	10.0 ± 39.3	7.9 ± 38.6	<0.0001
Diet soda (mL)	nc	nc	72.1 ± 153.0	nc	nc	0.007
Vegetable juice (mL)	nc	nc	8.3 ± 39.4	0.6 ± 10.6	nc	<0.0001
Beverages with high energy and some benefits						
Whole Milk (mL)	5.2 ± 33.7	278.5 ± 164.9	62.2 ± 116.8	143.2 ± 157.5	3.3 ± 19.1	<0.0001
Fruit Juice (100%) (mL)	21.9 ± 69.4	14.3 ± 55.9	6.4 ± 35.4	8.7 ± 43.3	15.1 ± 68.5	0.033
Fermented milk drinks(mL)	2.6 ± 27.1	1.8 ± 18.7	11.1 ± 67.5	2.9 ± 29.0	6.5 ± 70.2	0.210
Beverages with high energy						
Soda (mL)	25.5 ± 83.9	12.7 ± 50.0	79.5 ± 149.8	496.0 ± 253.8	10.8 ± 44.9	<0.0001
Fruit Drinks (mL)	76.3 ± 132.9	83.0 ± 138.5	644.4 ± 411.7	69.6 ± 128.0	27.8 ± 69.0	<0.0001
Alcohol (mL)	nc	0.0 ± 0.4	nc	3.1 ± 52.9	1.1 ± 17.7	0.327
Energy/sport drinks (mL)	4.2 ± 37.0	3.0 ± 31.1	5.2 ± 41.6	7.4 ± 55.0	5.4 ± 46.3	0.581
Others[1] (mL)	12.5 ± 58.9	10.2 ± 60.9	8.4 ± 48.3	19.4 ± 87.2	18.3 ± 65.0	0.125
Total beverage consumption (mL)	1163.0 ± 606.7	907.5 ± 620.5	1438.3 ± 730.8	1172.5 ± 539.7	550.9 ± 708.6	<0.0001
Total percentage of energy from beverages (%)	10.2 ± 5.7	12.1 ± 5.7	16.1 ± 8.3	12.1 ± 5.7	2.7 ± 4.4	<0.0001

nc: no consumption

[1]Others include soy milk, horchate, milkshake, sugar added iced tea

Table 2. Socio-demographic characteristics of the beverage clusters

	Cluster 1: Low-fat milk drinkers (n=393)		Cluster 2: Whole fat milk drinkers (n=673)		Cluster 3: Commercial fruit juice drinkers (n=63)		Cluster 4: Soda drinkers (n=355)		Cluster 5: Mix drinker (n=505)		χ^2 value
	%	**OR (95% CI)**	**%**	**OR (95% CI)**	**%**	**OR (95% CI)**	**%**	**OR (95% CI)**	**%**	**OR (95% CI)**	
Gender											<0.0001
Boy	39.2	1.00	50.7	1.00	52.4	1.00	55.8	1.00	44.5	1.00	
Girl	60.8	1.70 (1.13, 2.20)*	49.3	0.88 (0.70, 1.10)	47.6	0.84 (0.46, 1.52)	44.2	0.60 (0.46, 0.79)*	55.5	1.13 (0.88, 1.44)	
Age Group											<0.0001
11-13 y	23.4	1.00	29.5	1.00	14.5	1.00	21.1	1.00	24.4	1.00	
14-15 y	47.6	1.15 (0.84, 1.57)	47.4	0.72 (0.56, 0.94)*	50.0	1.82 (0.78, 4.25)	52.4	1.04 (0.75, 1.43)	42.3	1.20 (0.88, 1.64)	
16-18 y	29.0	1.13 (0.80, 1.60)	23.0	0.65 (0.42, 0.76)	35.5	2.23 (0.90, 5.49)	26.5	0.89 (0.62, 1.28)	16.0	1.78 (1.27, 2.48)*	
Education level of father											0.267
Low level (<6 years)	27.8	1.00	29.6	1.00	32.8	1.00	34.9	1.00	33.5	1.00	
Medium level (6-12 years)	42.0	1.39 (0.98, 1.98)	43.3	1.10 (0.81, 1.49)	41.0	0.63 (0.29, 1.36)	43.0	0.90 (0.63, 1.29)	39.4	0.79 (0.57, 1.10)	
High level (>12 years)	30.2	1.56 (1.00, 2.43)*	27.1	0.89 (0.60, 1.30)	26.2	0.61 (0.22, 1.69)	22.1	0.96 (0.60, 1.53)	27.1	0.87 (0.57, 1.33)	
Education level of mother											0.002
Low level (<6 years)	25.6	1.00	27.2	1.00	17.5	1.00	33.3	1.00	30.2	1.00	
Medium level (6-12 years)	41.6	0.88 (0.61, 1.26)	45.2	0.95 (0.69, 1.29)	57.1	2.44 (1.07, 5.61)*	47.7	0.95 (0.68, 1.36)	43.1	1.07 (0.77, 1.51)	
High level (>12 years)	32.8	1.01 (0.65, 1.58)	27.6	0.92 (0.62, 1.37)	25.4	2.15 (0.71, 6.56)	19.0	0.73 (0.45, 1.18)	26.7	1.22 (0.79, 1.87)	
Employment status of father											0.001
Low level	36.4	1.00	30.4	1.00	44.1	1.00	43.7	1.00	37.3	1.00	
Medium level	43.0	0.84 (0.63, 1.13)	51.1	1.61 (1.25, 2.09)*	33.9	0.75 (0.38, 1.49)	43.7	0.80 (0.60, 1.09)	43.6	0.83 (0.63, 1.10)	
High level	20.6	0.83 (0.53, 1.28)	18.5	1.50 (1.02, 2.21)*	22.0	1.83 (0.70, 4.75)	12.7	0.76 (0.47, 1.25)	19.1	0.84 (0.55, 1.29)	
Employment status of mother											
Low level	41.5	1.00	40.9	1.00	50.0	1.00	52.6	1.00	41.5	1.00	0.005
Medium level	44.1	1.22 (0.91, 1.64)	47.3	1.05 (0.81, 1.35)	40.0	0.62 (0.31, 1.22)	40.6	0.84 (0.62, 1.13)	45.5	1.01 (0.76, 1.34)	
High level	14.4	1.47 (0.92, 2.35)	11.8	1.04 (0.68, 1.58)	10.0	0.45 (0.14, 1.44)	6.8	0.58 (0.33, 1.04)	13.1	1.11 (0.70, 1.76)	
Chronic disease											0.320
Have disease	16.7	1.00	13.6	1.00	17.7	1.00	15.3	1.00	18.1	1.00	
No disease	83.3	1.06 (0.76, 1.47)	86.4	1.37 (1.01, 1.85)*	82.3	0.73 (0.37, 1.25)	84.7	0.90 (0.62, 1.13)	81.9	0.77 (0.57, 1.04)	
BMI											0.001
Normal weight	65.6	1.00	76.1	1.00	62.7	1.00	72.6	1.00	68.2	1.00	
Overweight	34.4	1.55 (0.19, 2.02)*	23.9	0.60 (0.47, 0.77)*	37.3	1.94 (1.08, 3.49)*	27.4	0.82 (0.62, 1.10)	31.8	1.25 (0.96, 1.61)	
Physical activity											0.128
Inactive (<300 min/week)	36.7	1.00	35.5	1.00	44.3	1.00	35.9	1.00	42.2	1.00	
Active (≥300 min/week)	63.3	1.19 (0.91, 1.54)	64.5	1.08 (0.86, 1.36)	55.7	0.69 (0.39, 1.25)	64.1	1.06 (0.80, 1.41)	57.8	0.80 (0.62, 1.02)	

Odds ratios (ORs) adjusted for all other variables in the model

*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (P<0.05)

Significance tested on basis of χ^2 comparisons

Table 3. Mean daily nutrient intakes and diet quality index by beverage patterns

	Cluster 1: Low-fat milk drinkers (n=393)	**Cluster 2: Whole fat milk drinkers (n=673)**	**Cluster 3: Commercial fruit juice drinkers (n=63)**	**Cluster 4: Soda drinkers (n=355)**	**Cluster 5: Mix drinker (n=505)**	***P* value**
			Mean ± SE			
TEI	2155.8 ± 36.9	2141.5 ± 28.3	2547.1 ± 91.8	2360.8 ± 38.3	1927.9 ± 35.6	0.006
RDI%						
Carbohydrate	189.4 ± 3.6	180.7 ± 2.7	236.7 ± 8.9	218.9 ± 3.7	162.1 ± 3.5	0.005
Protein	213.6 ± 4.4	197.3 ± 3.3	232.6 ± 10.8	203.0 ± 4.5	159.5 ± 3.9	<0.0001
Calcium	65.0 ± 1.3	58.2 ± 1.0	53.7 ± 3.2	53.6 ± 1.3	40.8 ± 1.2	<0.0001
Potassium	62.1 ± 1.2	57.6 ± 1.0	68.1 ± 3.1	55.9 ± 1.3	44.3 ± 1.1	<0.0001
Magnesium	81.9 ± 1.6	75.2 ± 1.2	86.0 ± 3.9	73.8 ± 1.6	58.6 ± 1.4	<0.0001
Phosphorus	113.9 ± 1.9	105.8 ± 1.5	116.9 ± 4.7	108.8 ± 2.0	92.9 ± 1.8	0.004
Iron	139.8 ± 9.6	144.0 ± 7.3	154.9 ± 23.9	136.6 ± 10.0	112.9 ± 8.6	<0.0001
Zinc	130.7 ± 3.3	119.2 ± 2.5	130.7 ± 8.1	117.5 ± 3.4	98.0 ± 2.9	<0.0001
Vitamin A	99.4 ± 8.9	103.2 ± 6.8	131.2 ± 22.0	104.5 ± 9.2	75.8 ± 7.9	<0.0001
Thiamine	240.1 ± 21.7	189.2 ± 16.6	296.0 ± 54.0	172.3 ± 22.5	174.1 ± 19.5	<0.0001
Riboflavin	300.3 ± 27.6	237.0 ± 21.2	347.8 ± 68.8	204.9 ± 28.7	203.0 ± 24.8	<0.0001
Vitamin B_6	187.5 ± 13.5	182.8 ± 10.3	221.9 ± 33.6	175.1 ± 14.0	137.5 ± 12.1	0.004
Vitamin B_{12}	436.5 ± 25.2	362.1 ± 19.3	590.9 ± 62.7	428.1 ± 26.2	317.6 ± 22.6	0.002
Vitamin C	168.2 ± 6.7	146.9 ± 5.0	290.7 ± 16.4	124.1 ± 6.8	120.2 ± 5.9	<0.0001
Vitamin D	14.5 ± 10.2	39.5 ± 7.8	12.3 ± 25.4	14.3 ± 10.6	28.8 ± 9.9	0.401
Vitamin E	52.3 ± 1.6	51.7 ± 1.3	80.7 ± 4.1	54.5 ± 1.7	43.6 ± 1.5	<0.0001
Niacin	160.0 ± 4.3	144.9 ± 3.3	181.7 ± 10.8	150.9 ± 4.5	131.7 ± 3.9	<0.0001
Pantothenic Acid	127.4 ± 5.2	123.9 ± 4.0	152.4 ± 13.1	118.4 ± 5.5	87.9 ± 4.7	<0.0001
Folic Acid	69.1 ± 1.8	62.7 ± 1.3	74.6 ± 4.4	58.1 ± 1.8	50.1 ± 1.6	<0.0001
NQI	66.6 ± 1.6	63.6 ± 1.2	70.4 ± 4.0	57.9 ± 1.7	53.9 ± 1.6	<0.0001

TEI: Total Energy Intake,
NQI: Nutrition Quality Index,
RDI: Recommended Dietary Reference Intake
Sex, age and BMI were used as covariates in the analysis of energy, nutrient and food intake

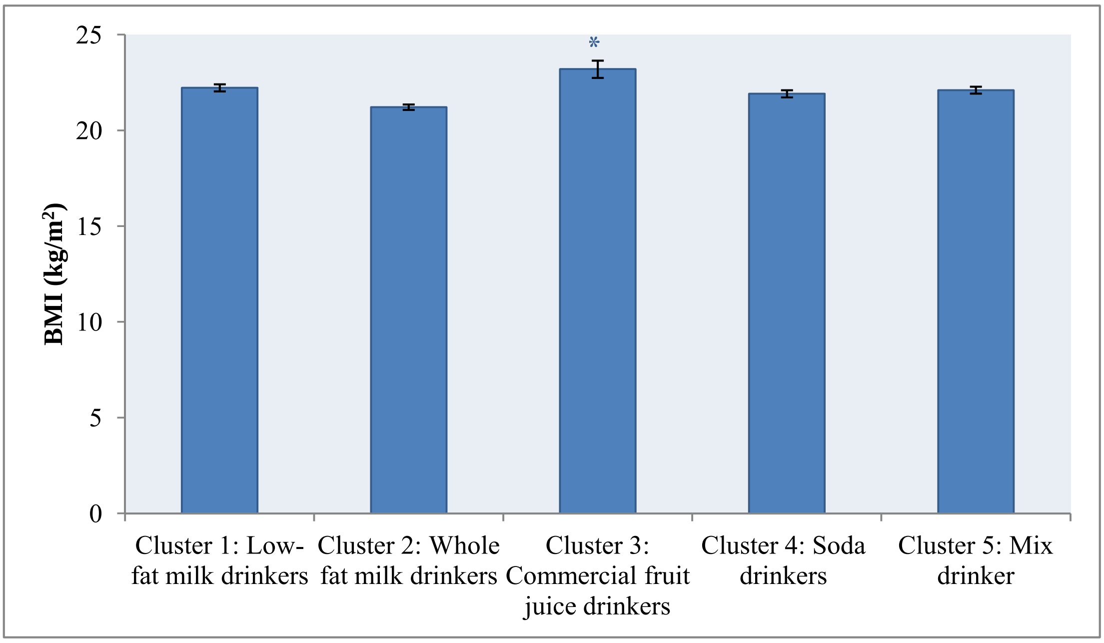

Figure 1. Mean (±SE) body mass index (BMI kg/m^2) by beverage pattern, adjusted for age, sex and TEI. (*Significantly higher than those of others (P<0.05))

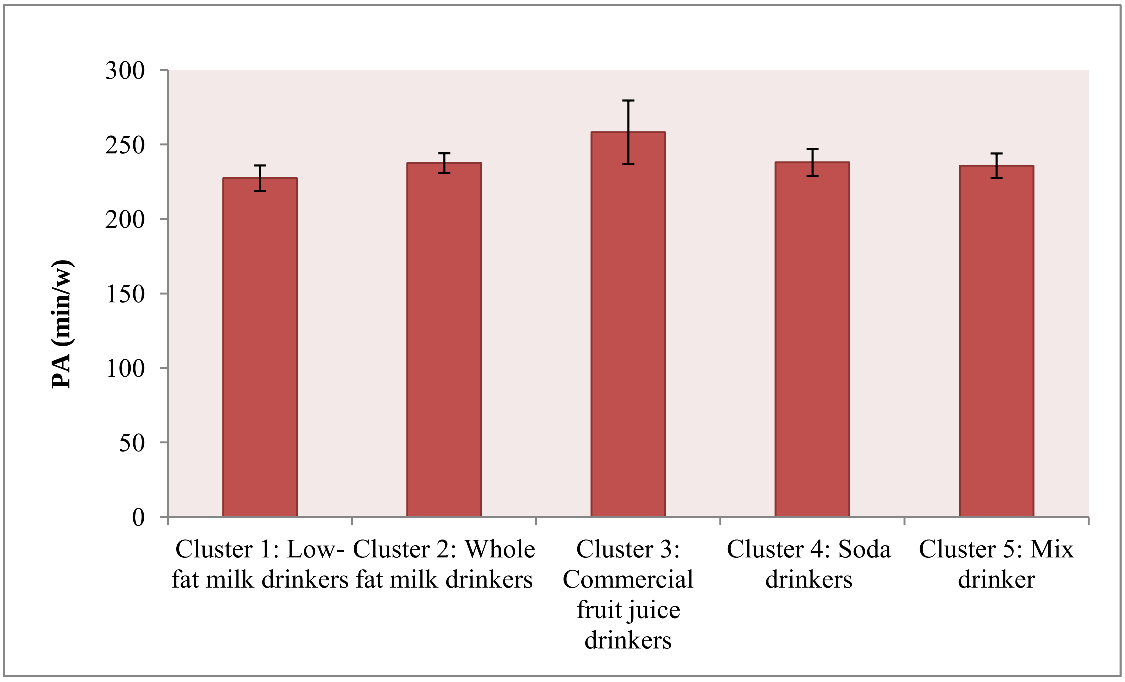

Figure 2. Mean (±SE) physical activity (PA min/w) by beverage pattern, adjusted for age, sex and TEI

Manuscript XI

Beverage consumption and physical activity among the adult population in the Balearic Islands

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ABSTRACT

Objective: The aim of the study was to assess the relation between beverage consumption and physical activity (PA) level among the adult population in the Balearic Islands and compare the beverage intake of adults with different PA levels.

Design: The study was a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2009 and 2010. Data were obtained from a semi-quantitative food frequency questionnaire (FFQ), two non-consecutive 24-h recalls and a global questionnaire. The target population was consisting of all inhabitants living in the Balearic Islands aged 16-65 years.

Results: The majority of the Balearic Islands population (73.3%) had a low level of PA. Gender, age, marital status, alcohol consumption and chronic disease were significant determinants for the level of PA in the Balearic Islands. Consumption of water and fruit drinks was found significantly higher among highly active males, while consumption of low-fat milk was significantly higher among highly active females. Moreover, total energy intake (TEI) was also significantly higher among males with a high PA level. A statistically significant and positive association was observed between consumption of water, low-fat milk, fruit drinks and energy/sport drinks and PA level, whereas, there was an inverse and significant association between soda consumption and PA level.

Conclusions: The results of this study showed the prevalence of low PA among the adult population in the Balearic Islands. Moreover, we observed that daily total beverage intake was lower than recommended adequate intake (AI) of water. To improve their health, individuals should increase their PA level by considering the importance of water intake before, during and after PA to prevent dehydration.

Keywords: Beverage consumption, physical activity, adult, the Balearic Islands

INTRODUCTION

Bad eating habits and physical inactivity are major risk factors for non-communicable diseases such as obesity, diabetes and cardiovascular diseases [1-3]. An adequate level of regular physical activity (PA) reduces the morbidity and mortality risk of several chronic diseases [4].

Moreover, type, frequency and duration of PA plays an important role in its health effects [4,5] and public health recommendation for PA is a daily minimum of 30 min moderate-intensity PA [4,6,7].

During PA, almost 75% of the chemical energy in foods is converted into heat energy and the rest of it turns into mechanical energy [8]. Due to heat production, body temperature increases and evaporative heat loss is the main and most effective cooling mechanism to prevent hyperthermia during PA [9,10]. However, sweating causes the loss of water and electrolytes, so fluid intake before, during and after exercise is important to avoid dehydration [11,12].

Generally daily water requirements depend on several factors such as, gender, age, body size [10], the thirst mechanism [13], food habits, level of respiration [14], climate [15] and PA [16]. Particularly, during PA sweat production varies according to air temperature, exercise intensity and duration [11] and water loss via skin can reach up to 8% of body mass in vigorous-intensity activities [17]. In this study we aimed to assess the relation between beverage consumption and PA level among the adult population in the Balearic Islands and compare the beverage intake of adults with different PA levels.

METHODS

Study population

Subjects of this study were participants in the OBEX project which is a population based cross-sectional nutritional survey. The data collection took place between 2009 and 2010. The sample population was derived from residents aged 16-65 years, registered in the official population census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomization into subgroups, with the Balearic Islands municipalities being the primary sampling units, and individuals within these municipalities comprising the final sample units. The final sample size was 1386 individuals (92.4% participation). Pregnant women were not considered in this study. Written informed consent was obtained from all subjects and when they were under 18 years old, also from their parents or legal tutors.

General questionnaire

A questionnaire incorporating the following questions was used: age group; marital status; educational level (grouped according to years and type of education: low, <6 years at school; medium, 6-12 years of education; high, >12 years of education) and socio-economic level (classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology) [18].

Information about smoking habits and alcohol consumption was collected and grouped as: non-smoker, ex-smoker, smoker, and non-drinker, occasional drinker, daily drinker and alcoholic.

Height was determined to the nearest millimetre using a mobile anthropometer (Kawe 44444, France), with the subject's head in the Frankfurt plane. Body weight was determined to the nearest 100 g using a digital scale (Tefal, sc9210, France). The subjects were weighed in bare feet and light underwear, which was accounted by subtracting 300 g from the measured weight. BMI was computed as weight/height^2 (kg/m^2) and study participants were categorized as <24.9, 25-29.9 and ≥30 kg/m^2.

Assessment of beverage consumption and energy intake

Dietary questionnaires included non-consecutive 24-h diet recalls and a validated quantitative food frequency questionnaire (FFQ) covering the 145-item [19]. To prevent seasonal variations 24-h dietary recalls administered in the warm season (May-September) and in the cold season (November-March). Furthermore, to account for day-to-day intake variability, the two 24-hour recalls were administered from Monday to Sunday.

Beverages were categorized in ten groups; water (tap water and bottled water), low-fat milk (low-fat and skimmed milk), whole milk, fruit juice 100% (all kinds of natural fruit juice), fruit drinks (all kinds of fruit juice sweetened with sugar), soda (all kinds of carbonated soft drinks), diet soda (low calorie carbonated soft drinks), coffee/tea (coffee, black tea and herbal tea), alcoholic beverages (wine, beer, vodka, whisky, liquor), energy/sport beverages (energy drinks, isotonic drinks) and others (carrot juice, beer without alcohol, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink, kefir, horchata, chocolate milkshake, sugar added ice tea). Total energy intake (TEI) was calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [20,21] and European Food Composition Tables [22], and complemented with food composition data available for the Balearic food items [23].

Physical Activity Assessment

Physical activity (PA) was evaluated according to guide-lines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [7] in the short form. The specific types of activity assessed were walking, moderate-intensity activities (i.e. PA at work), vigorous-intensity activities (i.e. sport practice) and sitting time (used as an indicator variable of time spent in sedentary activity). Weekly minutes of walking, moderate-intensity and vigorous-intensity activity were calculated separately by multiplying the number of days/week by the duration on an average day. Reported minutes per week in each category were weighted by a metabolic equivalent (MET) and PA computed by multiplying METs by min/w and expressed in MET-min/w. MET-values for different level activities were established based on the

Compendium of Physical Activities [24] and were set as 3.3 MET for walking, 4 MET for moderate-intensity PA and 8 MET for vigorous-intensity PA. On the basis of their total weekly time of PA, the subjects were divided into 3 groups: "low", "moderate" and "high" levels of PA.

• Low: Meets neither 'moderate' nor 'high' criteria.

• Moderate: Meets any of the following three criteria:

(a) 3 or more days of vigorous-intensity activity of at least 20 min/day;

(b) 5 or more days of moderate-intensity activity/walking of > 30 min/day;

(c) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 600 MET-min/w.

• High: Meets either of two criteria:

(a) vigorous-intensity activity on 3 or more days/week and accumulating at least 1500 MET-min/week;

(b) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving at least 3000 MET-min/w [7].

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). For descriptive purposes absolute numbers and percentages of participants according to PA were calculated for demographic and lifestyle characteristics and differences tested by χ^2. Multinomial logistic regression was used to examine the relationship between socio-demographic and lifestyle characteristic and PA. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. The referent group consisted of low level of PA. Average daily beverage consumption (in mL) of each PA group was calculated and differences across means were evaluated by using ANOVA. Linear Regression analysis was used to evaluate association between PA and beverage consumption. Model 1 was adjusted for sex and age and Model 2 was adjusted for sex, age, TEI and BMI. Proportions of PA level for consumers of each beverage were calculated. For all statistical tests, $P<0.05$ was taken as the significant level. The number of respondents included in the analyses may differ according to the beverage or because of missing data.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects.

RESULTS

Table 1 describes the socio-demographic and lifestyle characteristics of the study population according to their PA level. The majority of the Balearic Islands population (73.3%) had a low level of PA and gender, age, marital status, alcohol consumption and chronic disease were found to be significant determinants for the level of PA in the Balearic Islands. Females (82.4%) were more inactive than males (60.4%) and younger adults (23.1%) were more active than older adults (12.6%).

Females were significantly more likely to have a low level of PA than moderate (OR=2.39 95%CI 1.53, 3.76, *P*<0.0001) or high (OR=3.06 95%CI 2.21, 4.24, *P*<0.0001) level of PA, while respondents with a medium level of socio-economic status were statistically less likely to have a low level of PA (OR=0.30 95%CI 0.16, 0.55, *P*<0.0001).

Average daily beverage and energy intake of respondents related with PA level are presented in Table 2. Mean daily consumption of water, low-fat milk, energy/sport drinks and TEI were higher among male respondents with high PA level, whereas, consumption of soda, diet soda, coffee/tea and other beverages were higher among males with low PA level. Female respondents with high PA level consumed also higher amounts of low-fat milk than other females did; however, water and total energy intake (TEI) of females with moderate PA level were higher than those of other females. Differences were observed in beverage consumption between genders within the same level of PA. Soda (*P*<0.0001) and alcoholic beverage (*P*<0.0001) consumption and TEI (*P*<0.0001) of males with low PA were significantly higher than those of females with low PA, while coffee/tea consumption (*P*<0.0001) of females with low PA was higher than those of males. Highly active males consumed a higher amount of whole milk (*P*=0.012), fruit drinks (*P*=0.005) and soda (*P*=0.032) than highly active females did. Moreover TEI of high active males was significantly higher than those of females (*P*<0.0001). Daily total beverage intake of the respondents was around 1.2 L and there was no difference between the total beverage intake of the respondents according to their PA level or gender.

Results of the linear regression analysis on the association between beverage consumption and PA level are shown in Table 3. A statically significant and positive association was observed between consumption of water (*P*=0.009), low-fat milk (*P*<0.0001), fruit drinks (*P*<0.03) and energy/sport drinks (*P*<0.003) and PA level in model 1 and 2, whereas, there was an inverse and significant association between soda consumption and PA level in model 2 (*P*=0.017).

The proportions of PA level according to consumers of each beverage are presented in Figure 1. More than half of the consumers for each beverage, except energy/sport drinkers had low PA.

The highest proportion of high PA was observed among energy/sport beverage drinkers, whereas the highest proportion of low PA was observed among diet soda drinkers.

DISCUSSION

In the present analysis we observed that the majority of the adult population in the Balearic Islands had low PA and gender, age, marital status, alcohol status and having chronic disease affected the PA level. More than half of the population in both gender had low PA and Román-Viñas *et al.*, [25] reported also high physical inactivity among the Catalan population; however, we can't compare the results, because they used a different PA questionnaire and reported physical activity at work, during leisure time, way of transport and regular stair climbing. In this study we used IPAQ in short form and grouped participants according to their weekly MET-min as low PA, moderate PA and high PA. In another study conducted in Spain, it was reported that only around 24% of Spanish people had low PA [26]. Bauman *et al.*, [26] used IPAQ short form also; however, the criteria in which they grouped participants according to their PA, was different than our criteria. According to our analysis, 40% of the population was physically inactive and around 20 % of the population had PA but less than the recommended level which is minimum of 30 min of moderate-to-vigorous physical activity each day [4,6,7].

Our findings were in line with various other studies that observed men were more active than women [26-31]. Furthermore, we found that physical inactivity increased with age which was reported in many other studies [26,28]. Reis *et al.*, [32] found that individuals with high socio-economic status were more inactive than individuals with low socio-economic level. We also observed that respondents with lower socio-economic status were more active. However, in the World Health Organization's (WHO) [33] PA report it was written that adults with lower socio-economic status had lower PA. There are many explanations for the relation between PA and socio-economic level. In general, individuals with low socio-economic status mostly use public transport or walk or cycle for transportation and they had more work related with PA in their work environment, whereas in their leisure time they are more sedentary than individuals with high socio-economic status [33]. However, in our study population, we didn't observe any difference between leisure-time activities of subjects with low socio-economic status and high work status.

The European Food Safety Authority (EFSA) determined the recommended adequate intake (AI) of water as 2.0 L/day for females and 2.5 L/day for males [34]. Furthermore, especially during vigorous intensity PA water loss can be up to 6 L/day by sweating [10] and it should be replaced to prevent dehydration. However, in our study total average beverage intake was found 1.2 L/d which was under recommended values and no differences were observed between total beverage intake of physically active and inactive subjects.

In addition to water loss, loss of electrolytes such as sodium occurred via sweating [12,35,36]. It is recommended to drink isotonic beverages during and after PA to replace missing water and electrolytes [12,35]. In our study we observed that the daily consumption of energy/sport drinks was higher among physically active males and consumption of these beverages was positively associated with PA. Moreover, Shirreffs *et al.*, [37] reported low-fat milk as an effective rehydration drink after exercise due to high content of electrolyte. In this study the average daily intake of low-fat milk was found higher among respondents with high PA level and also a positive association between low-fat milk consumption and PA was observed. An inverse association between PA level and the consumption of beverages like whole fat milk, soda and alcohol which provided high energy was observed. Beside them the consumption of coffee/tea was also inversely associated with PA level. On the other hand, consumption of other high energy beverages like fruit juice (100%), fruit drinks and energy/sport drinks were positively related with PA level.

Regular moderate to vigorous-intensity PA causes energy expenditure which leads into an increase in energy intake [38]. In this study we found that average TEI was the highest in highly active male respondents, while among females the highest TEI was observed in moderately active ones.

Except energy/sport beverage drinkers, a high percentage of all other beverage consumers had low PA. Artificially sweetened beverages like diet soda might be preferred by individuals who want to lose weight. Beside this, it is recommended to increase the daily level of PA for weight loss [4]; however, we observed the highest proportion of physical inactivity among diet soda drinkers. On the other hand, around 20% of the individuals who consumed high energy beverages like natural fruit juice, fruit drinks and soda had high PA.

CONCLUSION

The results of this study showed the prevalence of low PA among the adult population in the Balearic Islands. Moreover, we observed that the daily total beverage intake was lower than the recommended AI of water. Individuals should be informed about benefits of regular PA by public health providers. Furthermore, to improve their health, individuals should increase their PA level by considering the importance of water intake before, during and after PA to prevent dehydration.

Acknowledgements

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Table 1. Socio-demographic and lifestyle characteristics, according to physical activity and Multivariable Analysis of Risk Factors for Low PA versus Moderate and High PA

	Low PA	Moderate PA	High PA	χ^2	Moderate PA	High PA
	N (%)	N (%)	N (%)		OR (95% CI)	OR (95% CI)
Gender				<0.0001		
Male	339 (60.4)	61 (10.9)	161 (27.8)		1.00	1.00
Female	660 (82.4)	52 (6.5)	89 (11.1)		2.39 (1.53, 3.76)*	3.06 (2.21, 4.24)*
Age (years)				<0.0001		
16-25	377 (66.0)	62 (10.9)	132 (23.1)		1.00	1.00
26-45	431 (78.8)	33 (6.0)	83 (15.2)		2.11 (0.88, 5.04)	1.66 (0.86, 3.22)
46-65	179 (80.3)	16 (7.2)	28 (12.6)		0.92 (0.45, 1.87)	1.12 (0.65, 1.93)
Marital Status				<0.0001		
Not married[1]	665 (70.4)	85(9.0)	194 (20.6)		1.00	1.00
Married	317 (80.9)	25 (6.4)	50 (12.8)		1.49 (0.80, 2.78)	1.23 (0.78, 1.94)
Education level				0.100		
Low (<6 y)	304 (71.7)	42 (9.9)	78 (18.4)		1.00	1.00
Medium (6-12 y)	328 (70.7)	38 (8.2)	98 (21.1)		1.65 (0.90, 3.05)	0.98 (0.62, 1.54)
High (>12 y)	344 (77.5)	30 (6.8)	70 (15.8)		1.37 (0.76, 2.46)	1.39 (0.93, 2.08)
Socio-economic status				0.145		
Low	400 (72.7)	40 (7.3)	110 (20.0)		1.00	1.00
Medium	108 (72.5)	9 (6.0)	32 (21.5)		0.30 (0.16, 0.55)*	0.71 (0.46, 1.11)
High	480 (74.0)	64 (9.9)	105 (16.2)		0.48 (0.21, 1.07)	1.03 (0.61, 1.769
BMI (kg/m^2)				0.493		
>25	610 (73.1)	71 (8.5)	153 (18.3)		1.00	1.00
25-29.9	266 (71.7)	30 (8.1)	75 (20.2)		0.92 (0.46, 1.86)	1.32 (0.75, 2.34)
≥30	121 (78.6)	12 (7.8)	21 (13.6)		0.89 (0.42, 1.88)	1.53 (0.85, 2.78)
Smoking status				0.744		
Non-smoker	576 (72.6)	71 (9.0)	146 (18.4)		1.00	1.00
Ex-smoker	112 (74.7)	11 (7.3)	27 (18.0)		1.40 (0.83, 2.35)	1.07 (0.75, 1.52)
Smoker	280 (74.9)	25 (6.7)	69 (18.4)		1.29 (0.58, 2.89)	1.11 (0.65, 1.919
Alcohol status				0.001		
Non-drinker	306 (74.6)	45 (11.0)	59 (14.4)		1.00	1.00
Occasional drinker	393 (74.6)	45 (8.5)	89 (16.9)		3.10 (0.88, 10.87)	0.93 (0.45, 1.93)
Daily drinker	225 (68.2)	19 (5.8)	86 (26.1)		2.28 (0.65, 7.95)	0.97 (0.48, 1.95)
Alcoholic	56 (75.7)	4 (5.4)	14 (18.9)		1.21 (0.32, 4.62)	1.40 (0.68, 2.88)
Chronic Disease				0.009		
Have disease	296 (72.4)	23 (5.6)	90 (22.0)		1.00	1.00
No disease	635 (73.2)	85 (9.8)	148 (17.1)		0.60 (0.36, 1.01)	0.93 (0.45, 1.93)

[1]Not married includes: single, divorced, widowed, and separated

Percentage of population was tested by χ^2

Multinomial logistic regression was performed. Low PA is the reference group in all analyses. (*P>0.0001)

Table 2. Mean daily beverage (mL) and energy intake (kcal)of adults according to physical activity level

Beverage	Male: Low PA (N= 339) Mean ± SD	Male: Moderate PA (N= 61) Mean ± SD	Male: High PA (N= 160) Mean ± SD	Male: *P* value[1]	Female: Low PA (N= 658) Mean ± SD	Female: Moderate PA (N= 52) Mean ± SD	Female: High PA (N= 89) Mean ± SD	Female: *P* value[1]
Water	764.48 ± 813.45	506.07 ± 696.76*	889.69 ± 782.54	0.006	680.27 ± 716.98	798.08 ± 799.02	776.74 ± 764.55	0.300
Low Fat Milk	89.82 ± 149.17	95.57 ± 136.85	116.94 ± 181.80	0.564	96.33 ± 121.11	79.81 ± 111.59	128.03 ± 150.41	0.041
Whole Milk	77.55 ± 126.74	91.31 ± 150.96	89.00 ± 133.27*	0.201	64.22 ± 109.47	87.12 ± 128.22	46.63 ± 112.71	0.110
Fruit Juice (100%)	21.42 ± 65.98	32.79 ± 110.64	27.81 ± 100.17	0.511	19.27 ± 61.39	26.92 ± 68.93	31.63 ± 89.41	0.201
Fruit Drinks	45.31 ± 120.30	91.80 ± 157.37	89.19 ± 188.46**	0.002	46.12 ± 104.85	61.92 ± 123.43	29.21 ± 82.85	0.174
Soda	122.52 ± 261.33***	123.44 ± 195.41	118.69 ± 239.98*	0.985	65.29 ± 168.34	89.62 ± 204.25	58.76 ± 139.82	0.548
Diet soda	26.37 ± 117.89	15.25 ± 67.67	13.00 ± 73.29	0.350	23.47 ± 99.21	43.27 ± 312.02	11.91 ± 81.39	0.344
Coffee/Tea	57.99 ± 96.99***	46.72 ± 87.97	53.69 ± 95.68*	0.670	100.49 ± 164.43	68.27 ± 91.30	82.19 ± 126.47	0.241
Alcoholic Beverages	80.86 ± 208.13***	44.75 ± 183.78	71.19 ± 234.35	0.468	36.98 ± 130.02	9.62 ± 35.75	35.39 ± 108.34	0.309
Energy/Sport Beverages	5.28 ± 50.88	nc	21.63 ± 125.98	0.057	27.08 ± 91.76	18.26 ± 57.55	26.40 ± 70.65	0.243
Others[2]	20.99 ± 77.63	5.33 ± 29.97	14.28 ± 63.98	0.223	26.82 ± 90.49	22.18 ± 63.46	25.56 ± 75.85	0.785
Total beverage	1193.68 ± 758.14	1377.38 ± 732.92**	1208.14 ± 720.35	0.205	1260.78 ± 823.52	1022.69 ± 599.95	1288.93 ± 894.07	0.116
TEI	2177.40 ± 753.50***	2126.40 ± 668.03	2478.15 ± 1123.70**	0.002	1904.75 ± 736.70	1949.91 ± 588.05	1901.51 ± 571.12	0.878

[1]Significantly different from the mean value of inactive vs. active in the same gender by ANOVA
Significantly different from the mean for females of same PA group ($^{*}P$<0.05 $^{**}P$<0.01 $^{***}P$<0.001)
nc: no consumption
[2] Others include carrot juice, beer without alcohol, chocolate milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink, fermented milk drink with sugar, kefir, horchate, sugar added iced tea

Table 3. Association between beverage consumption and physical activity

Beverages	**Physical Activity (MET-min/w)**					
	Model 1[1]			**Model 2[2]**		
	β	**SE**	***P***	**β**	**SE**	***P***
Water	0.029	0.010	0.006	0.027	0.010	0.009
Low Fat Milk	0.009	0.002	>0.0001	0.009	0.002	>0.0001
Whole Milk	-0.001	0.002	0.509	-0.002	0.002	0.268
Fruit Juice (100%)	0.002	0.001	0.062	0.002	0.001	0.072
Fruit Drinks	0.004	0.002	0.010	0.004	0.002	0.030
Soda	-0.004	0.003	0.114	-0.006	0.003	0.017
Diet soda	0.000	0.003	0.950	-0.001	0.002	0.343
Coffee/Tea	-0.003	0.003	0.298	-0.001	0.002	0.533
Alcoholic Beverages	-0.002	0.002	0.288	-0.003	0.002	0.180
Energy/Sport Beverages	0.002	0.001	0.002	0.002	0.001	0.003
Others[1]	-0.002	0.002	0.215	-0.002	0.001	0.169
Total Beverage	-0.003	0.011	0.810	-0.002	0.011	0.841

[1]Adjusted for age and sex
[2]Adjusted for age, sex, total energy intake and BMI
[3]Others include carrot juice, beer without alcohol, chocolate milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink, fermented milk drink with sugar, kefir, horchate, sugar added iced tea

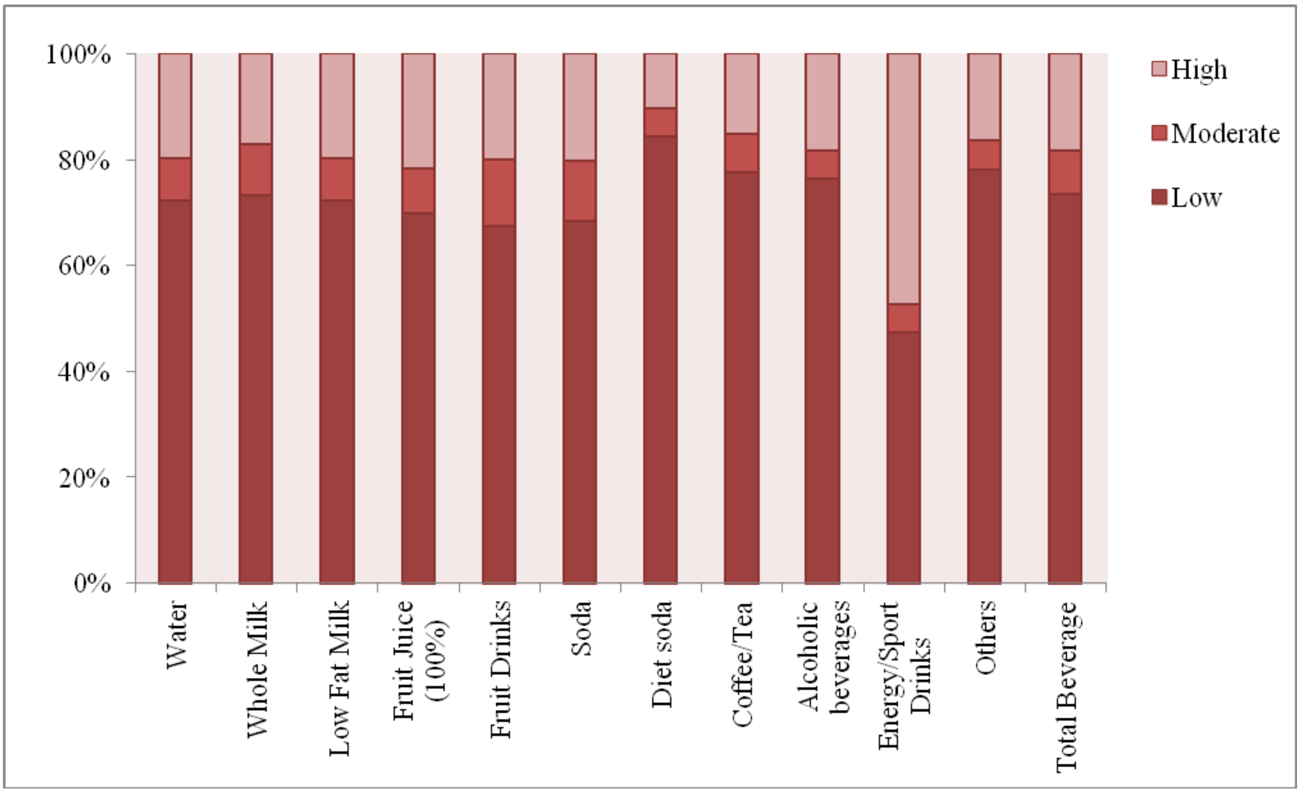

Figure 1. Proportions of total physical activity level for consumers of each beverage
(Others include carrot juice, beer without alcohol, chocolate milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink, fermented milk drink with sugar, kefir, horchate, sugar added iced tea)

Manuscript XII

Association between beverage consumption and physical activity in the adolescent population

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Association between beverage consumption and physical activity in the adolescent population

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ABSTRACT

Objective: The aim of our study was to examine the determinants of physical activity level and assess the relation between beverage consumption and physical activity level among the adolescent population in the Balearic Islands. Furthermore, the beverage intakes of adolescents with different physical activity levels were compared.

Design: The study is a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2009. The target population was consisting of all inhabitants living in the Balearic Islands aged 11-18 years. Data were obtained from a semi-quantitative food frequency questionnaire (FFQ), two non-consecutive 24-h recalls and a global questionnaire.

Results: The majority of adolescents (62.2%) in the Balearic Islands population was found active. Gender, age, education level and employment status of parents, alcohol intake and time spent watching TV, were significant determinants for the level of physical activity. Boys (OR=0.31, 95%CI 0.25, 0.39) and younger (OR=0.59, 95%CI 0.42, 0.82) adolescents had a lower risk of being inactive. Moreover, adolescents whose father had lower employment status were more likely to be inactive (OR=1.66, 95%CI 1.12, 2.45). The risk of being inactive was lower for adolescents that watched TV less than 1 hour a day (OR=0.68, 95%CI 0.48, 0.97). Mean daily consumption of water (P=0.003) and total beverages (P=0.012) were significantly higher in physically active girls than those of physically inactive girls. Whole fat milk (P<0.0001), fruit drinks (P=0.015) and soda (P<0.0001) consumption and TEI (P<0.0001) of physically active boys were higher than those of physically active girls. A statistically significant and positive association was observed between total beverage consumption and physical activity level (P=0.032). The highest proportion of physical activity was observed among energy/sport beverage drinkers, whereas the highest proportion of physical inactivity was observed among diet soda drinkers.

Conclusions: Overall, the results of this study showed that the majority of the adolescent population in the Balearic Islands met the recommendation for physical activity and gender and age were significant determinants of physical activity levels. However, daily total beverage intake of adolescents was lower than recommended AI of water. Physical activity should be promoted in adolescents by considering the health benefits of the physically active lifestyle and

also the importance of water intake before, during and after physical activity to prevent dehydration.

Key words: Beverage consumption, physical activity, adolescent, the Balearic Islands

INTRODUCTION

In our modern way of living the number of physically inactive individuals with bad eating habits has increased and the combination of unhealthy diet with physical inactivity has given rise to an increase in prevalence of obesity, type 2 diabetes, metabolic syndrome or cardiovascular diseases not only in adults but also adolescents and children [1-4] and physical inactivity has become one of the causes for mortality in the last decades [5,6].

Moreover, engage in physical activity during childhood and adolescence is important for development of skeletal muscle functions and healthy growth [7] and children and adolescents should meet the daily physical activity recommendations which is at least 60 min of moderate intensity physical activity [8-10] for healthy development. Furthermore, the greater amount of physical activity might provide more health benefits [9].

Physical activity specifically, moderate or vigorous-intensity causes an increase in body temperature and sweat is the main way of maintaining the heat balance during physical activity, especially in hot climate [11-13]. Since acclimation time of children and pre-pubertal individuals is longer than those of adults, a physically active youth has a greater risk of exercise-induced hyperthermia [14,15]. On the other hand, young people might have a lower risk of dehydration because of their lower sweat rate, but insufficient voluntary fluid intake is common among active young people [14] and if they failure to replace fluid loss during and after exercise, hypohydration results in more heat storage in the body [16].

Daily water requirement of physically active people is influenced by intensity and duration of physical activity and climate [17]. The purpose of this study was to examine the determinants of physical activity level and assess the relation between beverage consumption and physical activity level among the adolescent population in the Balearic Islands. Furthermore, the beverage intakes of adolescents with different physical activity levels were compared.

METHODS

Study design

The study is a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2007 and 2009.

Study population

The data collection took place in the Balearic Islands and the sample population was derived from residents aged 11–18 years, registered in the scholar census of the Balearic Islands. The sampling technique included stratification according to municipality size, age and sex of inhabitants, and randomization into subgroups, with Balearic Islands municipalities being the primary sampling units, and individuals within the schools of these municipalities comprising the final sample units. The interviews were performed at schools. The final sample size was 1988 individuals (98% participation). The reasons to not participate were: the subject declined to be interviewed or the parents did not authorize the interview.

General questionnaire

A questionnaire incorporating the following questions was used: age group, father's and mother's education level (grouped according to years of education: low, <6 years at school; medium, 6–12 years of education; high, >12 years of education), father's and mother's socio-economic level, based on the occupation of parents and classified as low, medium and high, according to the methodology described by the Spanish Society of Epidemiology [18].

Information about smoking habits, alcohol consumption and time spent watching TV was collected and grouped as: non-smoker, occasionally smoker and smoker; and non-drinker and drinker; and less than 1 h/d, 1-2 h/d and more than 2 h/d.

Anthropometric measurements were also obtained. Height and body weight were measured by anthropometer (Kawe 44444, Asperg, Germany) and electronic balance (Tefal, sc9210, Rumilly, France) with adolescents wearing light clothes without shoes, respectively. BMI was computed as weight/height^2. Study participants were categorized as, underweight ($\leq 5^{th}$ percentile), normal-weight ($>5^{th}$ $\leq 85^{th}$ percentile), overweight ($>85^{th}$ percentile) and obese ($\geq 95^{th}$ percentile) according to BMI.

Physical activity was evaluating according to the guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAQ) [19] in the short form, and its specific modification for adolescents (IPAQ A) [20]. The specific types of activity assessed were walking, moderate-intensity activities (i.e. physical activity at school) and vigorous-intensity activities (i.e. sport practice), and an additional question about sitting time was used as an indicator variable of time spent in sedentary activity. On the basis of their total weekly physical activity (at least 60 minutes of physical activity per day on at least 5 d/w), the subjects were divided into 2 groups: inactive (<300 min/w) and active (≥300 min/w), according to the current physical activity recommendations [8].

Assessment of beverage consumption and energy intake

Dietary questionnaires included non-consecutive 24-h diet recalls and a validated quantitative food frequency questionnaire (FFQ) covering the 145-item [21]. To prevent seasonal variations 24-h dietary recalls administered in the warm season (May-September) and in the cold season (November-March). Furthermore, to account for day-to-day intake variability, the two 24-hour recalls were administered from Monday to Sunday.

Beverages were categorized in ten groups; water (tap water, bottled water, and spring water), low fat milk (low-fat and skimmed milk), whole milk, diet soda (low calorie carbonated soft drinks), coffee/tea (coffee, black tea and herbal tea), fruit juice 100% (all kinds of natural fruit juice), soda (all kinds of carbonated soft drinks), fruit juice (all kinds of fruit juice sweetened with sugar), alcohol (wine, beer, vodka, whisky) and others (carrot juice, beer without alcohol, chocolate milkshake, vanilla milkshake, strawberry milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink, kefir, horchata, sugar added iced tea). Total energy intake (TEI) was calculated using a computer program (ALIMENTA®, NUCOX, Palma, Spain) based on Spanish [22,23] and European Food Composition Tables [24], and complemented with food composition data available for Balearic food items [25].

Statistics

Statistical analyses were performed using SPSS for Windows, version 19.0 (SPSS Inc., Chicago, IL, USA). For descriptive purposes absolute numbers and percentages of participants according to physical activity were calculated for demographic and lifestyle characteristics and differences tested by $\chi 2$. Logistic regression was used to examine the relationship among socio-demographic and lifestyle characteristic and physical activity. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. Average daily beverage consumption (in mL) of each physical activity group was calculated and differences across means were evaluated by using a general linear model and adjusting for age, sex, and BMI. Linear Regression analysis was used to evaluate association between physical activity and beverage consumption. The number of respondents included in the analyses may differ according to the beverage or because of missing data. For all statistical tests, $P<0.05$ was taken as the significant level.

Ethics

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Balearic Islands Ethics Committee. Written informed consent was obtained from all subjects and their parents or legal tutors.

RESULTS

Table 1 describes the socio-demographic and lifestyle characteristics of the study population according to their physical activity level. The majority of the youth (62.2%) in the Balearic Islands were physically active. Gender, age, education level and employment status of parents, alcohol intake and time spent watching TV, were significant determinants for the level of physical activity. Boys (76.8%) were significantly more active than girls (48.9%) and younger adolescents (69.5%) were physically more active than older ones (58.3%). Adolescents whose parents had a high education level were physically more active than their peers and physical activity of adolescents increased with employment status of the father. Adolescents who consumed alcohol (63.9%) were more active than their counterparts (59.0%). Physical inactivity was significantly higher for adolescents who watched TV longer than 2 hours a day (43.9%).

Boys (OR=0.31, 95%CI 0.25, 0.39) and younger (OR=0.59, 95%CI 0.42, 0.82) adolescents had a lower risk of being inactive. Moreover, adolescents whose father had lower employment status were more likely to be inactive (OR=1.66, 95%CI 1.12, 2.45). We found that the length of time spent watching TV was positively associated with physical inactivity, and the risk of being inactive was lower for adolescents that watched TV less than 1 hour a day (OR=0.68, 95%CI 0.48, 0.97).

Average daily beverage and energy intake of respondents related with physical activity level is presented in Table 2. Mean daily consumption of water (P=0.003) and total beverages (P=0.012) were significantly higher in physically active girls than those of physically inactive girls. Differences were also observed between genders. Whole milk (P=0.009) and soda (P=0.030) consumption and TEI (P<0.0001) of inactive boys was found significantly higher than those of physically inactive girls; whereas, whole fat milk (P<0.0001), fruit drinks (P=0.015) and soda (P<0.0001) consumption and TEI (P<0.0001) of physically active boys were higher than those of physically active girls.

Results of the linear regression analysis on the association between beverage consumption and physical activity level are shown in Table 3. A statistically significant and positive association was observed between total beverage consumption and physical activity level in model 2 (P=0.032).

Proportions of physical activity level according to consumers of each beverage are presented in Figure 1. More than half of the consumers for each beverage were physically active. The highest proportion of physical activity was observed among energy/sport beverage drinkers, whereas the highest proportion of physical inactivity was observed among diet soda drinkers.

DISCUSSION

In the present analysis we observed that the majority of the adolescents in the Balearic Islands were physically active and gender, age, education and work status of the parents determined the physical activity level. Despite the overall health benefits of regular physical activity, many studies reported physical inactivity of adolescents [4,7,26]. Boys met the recommendations for physical activity which is a minimum of 60 min at least 5 days of the week [8,9], more often than girls did. Our findings were in line with various other studies that observed boys were more active than girls [4,26-30]. Younger adolescents were physically more active than their older counterparts, which is consistent with the results from many other studies [4,27,28,30,31].

Low level of employment status of the father was significantly associated with increased likelihood of being physically inactive. Similar to our findings several other studies also reported that adolescents from a higher socio-economic level engaged in high level of physical activity [10,32,33].

We observed that the time spent watching TV was inversely associated with physical activity level. Koezuka *et al.*, [28] reported also a negative association between TV watching and physical activity. Many adolescents engage to watch TV during their leisure time instead of social or physical activities [34] and displacement of physical activity by TV viewing decreases the energy expenditure [28]. Moreover, during TV viewing the consumption of snack foods and beverages may increase the total energy intake [35]. These may contribute to the increase in body weight [28]; however, we didn't find any association between BMI and physical activity level.

Consumption of beverages varied according to gender and physical activity level. It is interesting that while physically active boys preferred to consume high energy beverages like whole fat milk, fruit drinks or soda, physically active girls preferred to consume low energy beverage like low fat milk. Furthermore, the highest amount of TEI was observed in physically active males and no difference was observed between TEI and the physical activity level of girls. Physical activity causes energy expenditure which leads into an increase in energy intake [36]. Among physically active boys the consumption of beverages with high energy and high TEI might be the reason to gain back the energy which was spent during physical activity. On the other hand, girls take usually more care about their appearance than boys do, so to prevent weight gain by excess energy intake physically active girls might prefer to consume low energy drinks.

Water loss via skin can reach up to 8% of body mass in vigorous-intensity activities [37] and it should be replaced to prevent dehydration. The recommended adequate intake (AI) of water was determined as 2.1 L/day for boys 9-13 years of age, and 1.9 L/day for girls 9-13 years of age;

for adolescent/adult (14 years and older) as 2.0 L/day for females and 2.5 L/day for males by European Food Safety Authority (EFSA) [38]. However, in our study total average beverage intake was found 0.9 L/d which was under recommended values and no differences were observed between total beverage intake of physically active and inactive subjects. Naughton and Carlson, [14] reported also an inadequate beverage intake of children and adolescents during exercise.

As expected, total beverage intake was positively associated with physical activity level; however, we didn't observe any association between consumption of each beverage and physical activity. Ma and Jones [39] also didn't find any association between consumption of soda and dairy drinks and physical activity level.

Except diet soda and alcoholic beverage drinkers, more than 50% of all other beverage consumers' met the physical activity recommendations. Artificially sweetened beverages like diet soda might be preferred by individuals who want to lose weight. Beside this, it is recommended to increase the daily level of physical activity for weight loss [40]. Controversially, we observed the highest proportion of physical inactivity among diet soda drinkers. Excess exercise may increase the requirement of many electrolytes due to their loss via sweat [41,42] and isotonic beverages were recommended for recovery of missing water and electrolytes during or after physical activity [41,42]. We didn't find any association between energy/sport drinks and physical activity level; however, we observed the highest proportion of physical activity among energy/sport beverage drinkers.

This study has some limitations that need to be mentioned. Dietary assessment methods are important tools to evaluate food, beverage and nutrition intake. Using single 24-h dietary recalls is not appropriate to represent typical consumption patterns of individuals, because food and beverage consumption individually vary from day to day and 24-h dietary recalls have limitations related to memory and bias [43]. We used two 24-h dietary recalls to calculate usual beverage and energy intake of the study population and we excluded over and under-reporting records. Moreover, in addition to 24-h recalls we used FFQ and the combination of these two methods is recommended to assess the dietary intake of children and adolescents [44]. Furthermore, physical activity was assessed according to self-reported questionnaire, so the physical activity level might be affected by recall bias because adolescents might not able to accurately remember and capture their activities [45]. This study was limited to examine the relationship between physical activity and beverage consumption during or after physical activity. Further research is necessary to measure fluid intake during or after physical activity among children and adolescents.

CONCLUSION

Overall, the results of this study showed that the majority of the adolescent population in the Balearic Islands met the recommendation for physical activity and gender and age were significant determinants of physical activity levels. However, daily total beverage intake of adolescents was lower than recommended AI of water. Physical activity should be promoted in adolescents by considering the health benefits of the physically active lifestyle and also the importance of water intake before, during and after physical activity to prevent dehydration and also hyperthermia.

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Authors' contributions

AEO, MMB and JAT conceived, designed, devised and supervised the study, AEO, MMB and JAT collected and supervised the samples. AEO and JAT analysed the data and wrote the manuscript. AP and JAT obtained funding. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Table 1. Socio-demographic and lifestyle characteristics, according to physical activity and multivariable analysis of risk factors for low physical activity versus moderate and high physical activity

	Inactive[1]	Active[2]	χ^2	Risk of being inactive
	N (%)	N (%)		OR[3] (95% CI)
Gender			<0.0001	
Boys	213 (23.2)	707 (76.8)		0.31 (0.25, 0.39)*
Girls	516 (51.1)	494 (48.9)		1.00
Age (years)			0.001	
11-13	141 (30.5)	322 (69.5)		0.59 (0.42, 0.82)*
14-15	344 (38.5)	550 (61.5)		0.82 (0.63, 1.06)
16-18	277 (41.7)	317 (58.3)		1.00
Education level of father[4]			<0.0001	
Low	241 (41.1)	341 (58.6)		0.94 (0.63, 1.39)
Medium	310 (39.2)	480 (60.8)		1.08 (0.78, 1.49)
High	149 (29.9)	350 (70.1)		1.00
Education level of mother[4]			<0.0001	
Low	229 (42.6)	309 (57.4)		1.48 (0.99, 2.20)
Medium	329 (38.8)	519 (61.2)		1.27 (0.92, 1.75)
High	154 (30.6)	350 (69.4)		1.00
Employment status of father			<0.0001	
Low	281 (42.6)	378 (57.4)		1.66 (1.12, 2.45)*
Medium	296 (35.79	533 (64.3)		1.28 (0.90, 1.83)
High	102(30.3)	235 (69.7)		1.00
Employment status of mother			0.013	
Low	334 (41.5)	471 (58.5)		0.72 (0.47, 1.10)
Medium	281 (34.4)	535 (65.6)		0.68 (0.46, 1.01)
High	82 (36.8)	141 (63.2)		1.00
BMI (kg/m^2)			0.870	
Underweight	17 (41.5)	24 (58.5)		1.08 (0.50, 2.30)
Normal weight	507 (37.6)	835 (62.3)		0.83 (0.56, 1.23)
Overweight	116 (39.7)	176 (60.3)		0.94 (0.60, 1.47)
Obese	65 (39.2)	101 (60.8)		1.00
Smoking			0.473	
Yes	49 (43.4)	64 (56.6)		1.09 (0.67, 1.77)
Occasionally	183 (37.8)	301 (62.2)		1.01 (0.78, 1.30)
No	492 (37.6)	818 (62.4)		1.00
Alcohol intake			0.032	
Yes	409 (36.1)	724 (63.9)		1.02 (0.80, 1.31)
No	309 (41.0)	445 (59.0)		1.00
Time spent watching TV			0.001	
<1 h/d	92 (31.0)	205 (69.0)		0.68 (0.48, 0.97)*
1-2 h/d	408 (36.7)	703 (63.3)		0.82 (0.64, 1.04)
>2 h/d	229 (43.9)	293 (56.1)		1.00
Chronic Disease[5]			0.164	
No disease	594 (37.2)	1002 (62.8)		0.96 (0.72, 1.28)
Have disease	126 (41.4)	178 (58.6)		1.00

[1]<300 min/w
[2]≥300 min/w
[3]Odds ratios (ORs) adjusted for all age and sex
Percentage of population was tested by χ^2
*Odds ratios within a column, for a characteristic, were statistically significant from 1·00 (*P*<0.05)
[4]Education level of parents: low less than 6y, medium 6-12y, high: higher than 12y
[5]Chronic disease includes: diabetes, overweight, cholesterol, celiac disease, lactose intolerance and other chronic diseases

Table 2. Mean daily beverage (mL) and energy intake (kcal) of adolescents according to physical activity level

Beverages	**Boys**			**Girls**		
	Inactive (N= 209) Mean ± SD	**Active (N=700) Mean ± SD**	***P* value**[1]	**Inactive (N= 512) Mean ± SD**	**Active (N=488) Mean ± SD**	***P* value**[1]
Water	458.73 ± 546.70	516.53 ± 621.71	0.226	476.35 ± 541.10	589.44 ± 645.85	0.003
Low Fat Milk	63.28 ± 129.93	61.60 ± 133.56**	0.873	70.73 ± 130.78	83.31 ± 139.67	0.142
Whole Milk	135.77 ± 199.83**	153.97 ± 185.13***	0.221	99.29 ± 154.92	100.78 ± 145.02	0.875
Fruit Juice (100%)	7.66 ± 38.47	14.07 ± 66.21	0.182	15.20 ± 68.46	21.00 ± 66.40	0.174
Fruit Drinks	70.96 ± 221.83	94.66 ± 191.58**	0.131	92.03 ± 203.70	70.05 ± 138.02	0.047
Soda	122.54 ± 234.58*	129.32 ± 257.26***	0.733	86.02 ± 190.19	73.22 ± 175.79	0.270
Diet Soda	6.32 ± 45.32	1.70 ± 28.87	0.080	1.56 ± 21.59	2.52 ± 32.51	0.582
Coffee/Tea	5.72 ± 27.62	5.47 ± 25.84	0.906	8.89 ± 37.23	7.52 ± 40.25	0.574
Alcoholic Beverages	1.05 ± 15.22	0.64 ± 13.27	0.705	0.07 ± 1.19	2.02 ± 44.77	0.323
Energy/Sport Beverages	4.74 ± 50.94	6.74 ± 49.61	0.610	1.36 ± 20.66	4.72 ± 39.24	0.088
Others[2]	19.53 ± 69.99	15.65 ± 87.12	0.552	24.30 ± 110.73	20.39 ± 84.56	0.529
Total Beverage	879.81 ± 673.55	988.37 ± 745.48	0.057	857.82 ± 602.63	960.02 ± 679.92	0.012
TEI	2254.41 ± 732.13***	2378.72 ± 846.69***	0.059	1952.63 ± 637.07	1923.75 ± 660.22	0.486

[1]Significantly different from the mean value of inactive vs. active in the same gender by ANOVA

Significantly different from the mean value of girls in the same physical activity group by ANOVA ($^{*}P<0.05$ $^{**}P<0.01$ $^{***}P<0.001$)

nc: no consumption

[2] Others include carrot juice, beer without alcohol, chocolate milkshake, vanilla milkshake, strawberry milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink, kefir, horchata, sugar added iced tea

Table 3. Association between beverage consumption and physical activity

	Physical Activity					
	Model 1[1]			**Model 2[2]**		
Beverages	**β**	**SE**	***P***	**β**	**SE**	***P***
Water	0.164	0.130	0.205	0190	0.137	0.166
Low Fat Milk	-0.021	0.029	0.478	-0.018	0.031	0.566
Whole Milk	0.018	0.037	0.620	0.046	0.038	0.213
Fruit Juice (100%)	0.016	0.014	0.246	0.021	0.015	0.157
Fruit Drinks	-0.023	0.040	0.564	-0.029	0.043	0.493
Soda	0.081	0.047	0.087	0.089	0.050	0.073
Diet Soda	0.011	0.007	0.092	0.010	0.007	0.152
Coffee/Tea	0.006	0.007	0.435	0.008	0.007	0.300
Alcoholic Beverages	0.002	0.005	0.674	0.002	0.006	0.725
Energy/Sport Beverages	0.003	0.009	0.772	0.003	0.010	0.743
Others[3]	-0.010	0.020	0.609	-0.011	0.021	0.611
Total Beverage	0.265	0.147	0.072	0.313	0.146	0.032

[1]Adjusted for age and sex
[2]Adjusted for age, sex, total energy intake and BMI
[3] Others include carrot juice, beer without alcohol, chocolate milkshake, vanilla milkshake, strawberry milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink, kefir, horchata, sugar added iced tea

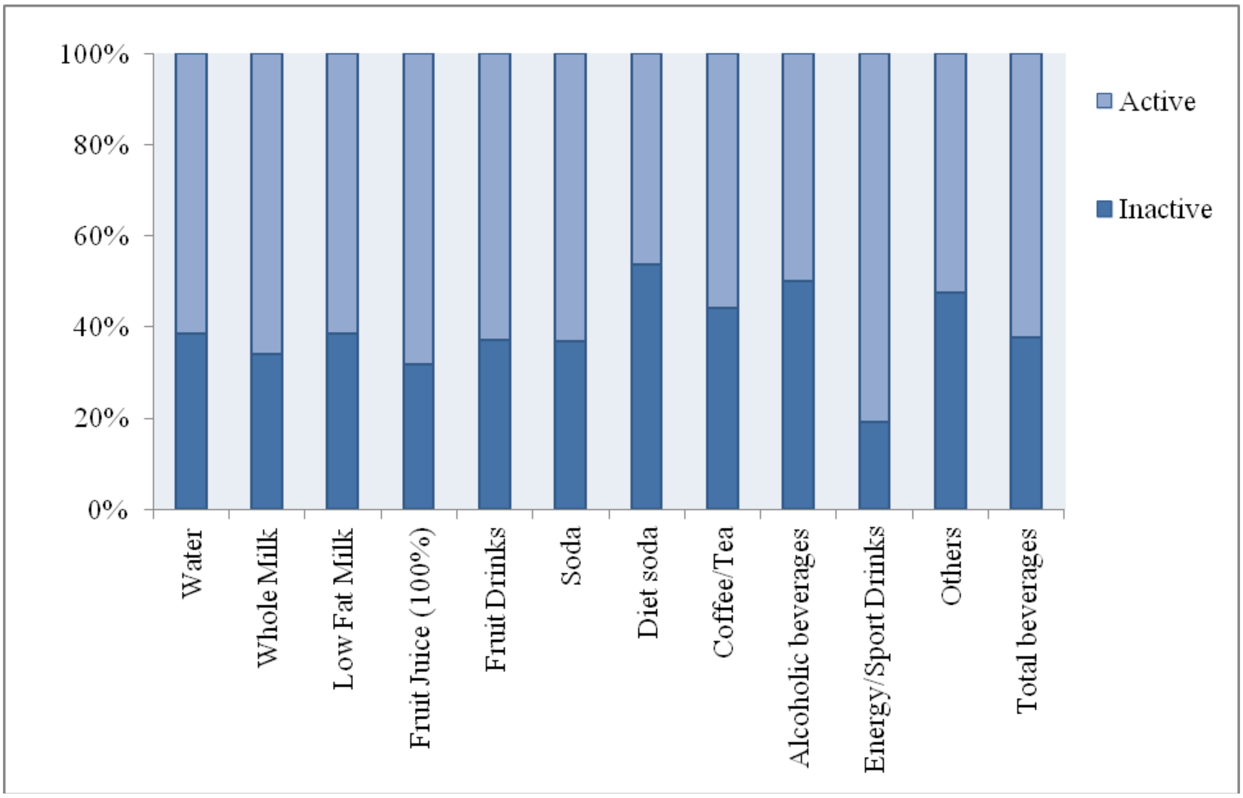

Figure 1. Proportions of total physical activity level for consumers of each beverage

(Others include carrot juice, beer without alcohol, chocolate milkshake, vanilla milkshake, strawberry milkshake, diet milkshake, soy milk, rice milk, oat milk, fermented milk drink with sugar, fermented milk drink, kefir, horchata, sugar added iced tea)

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Beverage consumption and physical activity among the Balearic Islands' adult population

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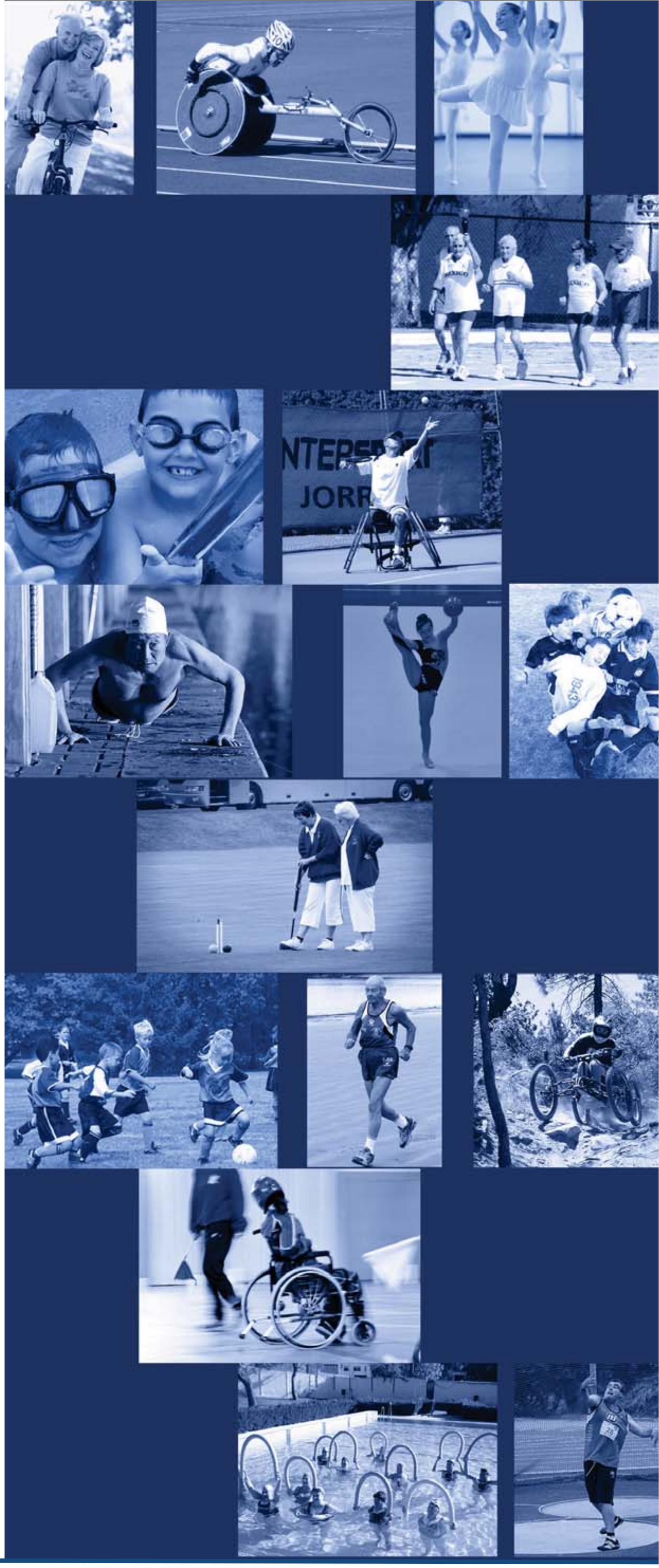

Beverage consumption and physical activity among the Balearic Islands' adult population

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Objective: To assess relation between beverage consumption and physical activity (PA) level among the Balearic Islands' adult population.

Design: The study was a population based cross-sectional nutritional survey carried out in the Balearic Islands between 2009 and 2010. Data were obtained from a semi-quantitative food frequency questionnaire (FFQ), two non-consecutive 24 h recalls and a global questionnaire. The target population was consisting of all inhabitants living in the Balearic Islands aged 16-65 years.

Results: Most of Balearic Islands population (73.3 %) had low level of PA. Gender, age marital status, alcohol consumption and chronic disease were found to be significant determinants for the level of PA in the Balearic Islands. Consumption of water and fruit drinks was found higher among highly active males, while consumption of low fat milk was higher among highly active females. Moreover, total energy intake (TEI) was also higher among males with high PA level. A positive association was observed between consumption of water, low fat milk, fruit drinks and energy/sport drinks and PA level, whereas, there was an inverse association between soda consumption and PA level.

Conclusion: The Balearic Islands' adult population showed low PA. Daily total beverage intake was lower than recommended AI of water. To improve their health, individuals should increase their PA level by considering the importance of water intake before, during and after PA to prevent dehydration.

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Differences in consumption of functional foods between European countries: a systematic review

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Objective: To assess differences in functional food consumption between European countries.

Design: Systematic review. The literature search was conducted in Medlars Online International Literature (MEDLINE), via PubMed© and Scopus. Twenty two studies were identified to examine the differences in functional food consumption between European countries.

Results: There are disparities between functional food consumers' percentage across European countries. While functional foods are popular in most of the European countries like Finland, Sweden, The Netherlands, Poland, Spain and Cyprus, in some countries like Denmark, Italy and Belgium they are not popular. High percentage of adolescents in the European Mediterranean countries (Spain and Cyprus) consumed functional foods. Evaluation of functional food consumption according to gender is difficult, because results varied from study to study.

Conclusion: Functional foods have become very popular in Europe in recent years Additional studies are necessary for better understanding the differences between European countries and to find out reasons behind the differences.

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Recapitulation

My work is founded on two sets of cross-sectional studies. The first study is a nutritional survey carried out between 2009 and 2010 and the target population of this study is residents of the Balearic Islands at ages 15-65 years. The second study is also a nutritional survey carried out between 2007 and 2009 and the target population of the second study is young residents of the Islands at ages 13-18 years. I analyzed the data from these cross-sectional studies and determined the factors which affect the functional food consumption and beverage consumption.

1. Functional Food Consumption

Growing scientific evidence regarding the effectiveness of functional components in enhancing health, reducing the risk of diseases and preventing some chronic diseases, it is important to understand factors which affect the functional food choices of consumers. Therefore, in the study of the functional food consumption, I was interested which socio-demographic (gender, age, education level, economic status) and lifestyle (body mass index (BMI), chronic disease, physical activity) determinants were associated with the consumption of functional food. I got the frequencies and daily intake of the functional foods and analyzed the effects of socio-demographic and lifestyle determinants on functional food consumption.

When I analysed the relationship between consumption of functional food and gender or age no significant differences were observed; however, the association between consumption of a specific functional food and gender or age was found for many functional food products.

It seems that acceptance of functional foods like low-fat/skimmed milk, probiotics, fruit juices or breakfast cereals was high in the Balearic Islands because the percentage of adolescents and adults, who consume these functional foods are high. Whereas functional foods like cholesterol lowering products were not consumed by a high percentage of the population. This behaviour can be related with health concerns of the consumers. Health concerns may be connected with manufacturing of the functional foods. While some functional foods are produced by using a simple process, some need high technology and the more processed foods are perceived as unnatural products by the consumers [17]. For example, in the production of low-fat or skimmed milk only fat is separated by centrifugation or in the production of probiotic yogurts beneficial microorganisms are added for the fermentation whereas the production of cholesterol lowering products is more complicated. Some chemical processes like distillation, ethanolysis/transesterification, and crystallization are necessary to obtain sterols from crude oil then these sterols are added to the margarine or other foods [149].

Moreover, health concerns may be related with the health effects of the functional foods. To discover the health effects of some products may be possible by consumers. If someone consumes whole fat milk it can cause a weight gain; however, the consumption of skimmed milk provides nutrients without excess fat intake. Or consumption of probiotics may improve the gut health and it is also possible to realize by consumers. On the other hand, consumers of cholesterol lowering products need a blood test to find out if these products are beneficial to lower their serum cholesterol level.

The acceptance of functional foods is related with one's health. If one person has a disease the acceptance of functional foods which may have a beneficial effect for treatment of this disease is easier. For instance, cholesterol lowering products may be used by a person who has a high cholesterol level in his/her serum. But I didn't find any association between chronic diseases and consumption of cholesterol lowering products in the study population. On the other hand, a significant association between the consumption of cholesterol lowering products and age was observed and older adults were more likely to consume these products. Generally older people more often have health problems like high cholesterol level, hypertension, and osteoporosis and are more likely to consume functional foods [20,21].

Some functional foods like low-fat products can be used for weight control and the consumption of low-fat or skimmed milk may play a role in weight regulation in two aspects. First, intake of fat from low-fat or skimmed milk is lower than those of whole fat milk and second, calcium intake is inversely associated with BMI [150]. In this study population no relation was found between low-fat milk intake and BMI in adult population, while overweight adolescents were more likely to consume low-fat/skimmed milk. This might be related that overweight subjects want to lose weight thus they prefer to consume low-fat/skimmed milk instead of whole-fat milk.

Functional food users are generally described as health oriented consumers [15]. So I analyzed the interest of functional food consumers to the Mediterranean diet of whom functionality and disease preventing effects have been proven by several studies in the literature [38,41,145,151-153]. As expected the functional food users had a higher adherence to the Mediterranean diet, 56.4% for adolescents and 51.2% for adults.

It has been demonstrated that adults take health consideration into account more when making food choices than adolescents and in general they have a healthier diet than adolescents; however, we observed that the young population in the Balearic Islands had a higher adherence to the Mediterranean diet than adults. The explanation might be that parents take more care about their children's healthy diet.

Like other Mediterranean countries Spain has a lower mortality for diet related diseases than northern or eastern European countries [154]; however, prevalence of obesity, physical inactivity and nutrition transition in Spain has been reported in many studies [155,156]. This study also showed that there is a nutrition transition in a Spanish islands group as well, the

Balearic Islands. In this study we found that the adherence of the adult population to the Mediterranean diet was moderate and during the last decade it increased from 43 to 50% [43] but still it is low when we consider that the traditional Balearic diet belongs to healthy Mediterranean diets.

It is obvious that inadequate intake of many nutrients is the result of the diet composition. The intake of nutrients that have functional properties and may be protective for chronic diseases, such as zinc, dietary fibre, magnesium, potassium and folic acid were inadequate in adult and also adolescents. Another study conducted in the Balearic Islands in 2000 reported also an inadequate intake of β-carotene, zinc and vitamin E [157] and after one decade we observed a low intake of other micronutrients in addition to β-carotene, zinc and vitamin E.

Food and nutrient intakes have a complex interaction and instead of examining the role of single nutrients or food in disease risk, the investigation of the whole diet accounts the synergistic and antagonistic effects of foods and nutrients on health [158]. Although the consumption of functional foods provides some health benefits, consumers should consider the quality of their whole diet. Herein, the Mediterranean diet which offers several functional foods without recurring to the food industry is a good example of a healthy diet with large variety of food choice.

2. Beverage Consumption

2.1. Adult population

In this study I observed that beverages with low energy pattern, which included low-fat milk, diet soda, coffee and tea, was the dominant beverage pattern among adults in the Balearic Islands and many differences in socio-demographic characteristics across beverage patterns in the adult population. While females were more likely to consume beverages with low energy, males were more likely to consume beverages with high energy. High consumption of soft drinks, alcoholic beverages and fruit drinks among males and high consumption of diet soft drinks among females were reported in previous studies [65,66]. Education level was found another determinant which affects the beverage choice and low educated people tended to consume beverages with high energy. Bleich *et al*., [116] also reported a higher consumption of sugar sweetened beverages in low educated people.

In line with the study of Bleich *et al*., [116] normal weight adults were found more likely to consume high energy beverages. This association might be explained by overweight subjects want to lose weight thus they don't prefer to consume high energy beverages.

Earlier studies have suggested that a high consumption of sugar sweetened beverages is related with high levels of energy intake from other foods [71,159]. Our findings were in line with the previous studies. Adults who consumed beverages with high energy like soda and fruit drinks had a higher carbohydrate and total energy intake than others did. Furthermore, they had a higher mean daily serving for snacks and sweet foods. Individuals with unhealthy eating patterns were more likely to consume high energy beverages like soda [75]. Adults in the mix drinker pattern had the highest nutrition quality index (NQI) compared to others. This finding might suggest that adults in this beverage pattern consumed variety of foods in a balance like their well disturbed beverage intake.

Adults who consumed beverages with high energy had lower BMI than others did; in contrast they had the lowest weekly physical activity value. Beverages with low energy pattern was the dominant beverage pattern among the adults in the Balearic Islands; however, the study population had a mean BMI of 24.9 kg/m^2 which was on the border to overweight. This result indicates that the adult population of the Balearic Islands tried to decrease their energy intake by consuming beverages with low energy. Nevertheless, to reduce the risk of overweight they should consider the total energy intake and increase their physical activity level which was inversely associated with mean BMI [160].

In the present analysis the majority of adult population in the Balearic Islands had a low physical activity. More than half of the population in both gender had a low physical activity. While 40% of the population was physically inactive, around 20 % of the population had physical activity but less than the recommended level which is a minimum of 30 min of moderate-to-vigorous physical activity each day [161-163].

Findings of this study were in line with various other studies that observed men were more active than women [164-169]. Furthermore, physical inactivity increased with age which was reported in many other studies [164,166]. Reis *et al.*, [170] found that individuals with a high socio-economic status were more inactive than individuals with low socio-economic level. In line with this, respondents with lower socio-economic status were found physically more active.

The total average beverage intake of the adult population was found 1.2 L/d which was under recommended values [72] and no differences were observed between the total beverage intake of physically active and inactive subjects. The average daily intake of low-fat milk was found higher among respondents with high physical activity level and also there was a positive association between low-fat milk consumption and physical activity. An inverse association between physical activity level and consumption of beverages like whole fat milk, soda and alcohol which provided high energy was observed.

Regular moderate to vigorous-intensity physical activity causes energy expenditure which leads into an increase in energy intake [171]. In this study, average total energy intake (TEI) was the highest in highly active male respondents, while among females the highest TEI was observed in moderately active ones.

2.2. Adolescent population

Adolescence is a transition period which covers the development of secondary sexual characteristics, somatic growth and psychology [172]. In this period dependency on parents decreased and the adolescents behave more independent in their choices [173]. For instance, their food choices may change related with self image, peers influence [173,174] and they may start to consume unhealthy food and beverages. Several studies in the literature reported that the consumption of high energy beverages like soda, fruit drinks and alcohol increased with age [65,67-69,71].

High consumption of high energy beverages causes an increase in energy intake and the excess energy intake may result in weight gain. However findings of this study didn't show any association between the consumption of high energy beverages and overweight. On the other hand, an inverse association between the consumption of beverages with low energy or high energy with some benefits and BMI was observed. Moreover, their energy intake from beverages was lower than those of their peers in other parts of the world and beverages contributed 11% of the total energy intake. Energy intake from beverages of Mexican adolescents was reported as 20% of the total energy intake [69]. Another study reported that energy intake from sugar sweetened beverages of American adolescents was 10% of the total energy intake [87].

Beverage pattern analysis also proved that more than half of the adolescent population consumed beverages with some benefits like low or whole fat milk, because high proportion of the subjects were clustered in low-fat milk drinkers or whole-fat milk drinkers, whereas the around 25% of them were clustered in soda or commercial fruit juice drinkers. Rest of them didn't have a specific beverage choice and consumed most of the beverages in a small amount.

Beverage consumption affected the nutrient intake of adolescents. Consumers of beverages with high energy and some benefits like whole fat milk, natural fruit juice, had a higher NQI than non-consumers in both genders. Also the nutrient intake of adolescents who consume beverages with high energy and some benefits was higher than those of non-consumers. On the other hand, the intake of many micronutrients such as calcium, magnesium, potassium, vitamin D, E and folic acid were under RDI values in adolescents. Several differences were observed between adolescents nutrient intake across beverage patterns. While commercial fruit juice drinkers had a higher NQI than others, mix drinkers had the lowest NQI.

The total energy intake was found positively associated with the intake of macro and micronutrients; whereas, the consumption of beverages with high energy was negatively related with the intake of many macro and micronutrients. Moreover, an increase in the consumption of high energy beverages caused an increase in carbohydrate intake and a decrease in protein intake. Similar to the results of this study, several other studies also reported that consumption of sugar sweetened beverages inversely affected the diet quality and the intake of many nutrients decreased with a high consumption of sugar sweetened beverages among children and teens [77,78].

Despite the overall health benefits of regular physical activity, many studies reported physical inactivity of adolescents [175,176]; however, in the present analysis we observed that the majority of adolescents in the Balearic Islands were physically active. Boys met the recommendations for physical activity which is a minimum of 60 min at least 5 days of the week [130,178], more often than girls. Our findings were in line with various other studies that observed boys were more active than girls [175,177,179,180]. Younger adolescents were physically more active than their older counterparts, which is consistent with the results from many other studies [175,177,179,180].

A low level of employment status of the father was significantly associated with increased likelihood of being physically inactive. Similar to our findings several other studies also reported that adolescents from a higher socio-economic level engaged in high levels of physical activity [172,181].

The time spent for watching TV is another determinant for the physical activity level of adolescents. An inverse association between physical activity level and time spent for watching TV was observed. Koezuka *et al.*, [180] reported also a negative association between TV watching and physical activity. Many adolescents engage to watch TV during their leisure time instead of social or physical activities [183] and displacement of physical activity by TV viewing decreases the energy expenditure [180]. Moreover, during TV viewing the consumption of snack foods and beverages may increase the total energy intake [184]. These may contribute to the increase in body weight [180]; however, we didn’t find any association between BMI and physical activity level.

Consumption of beverages varied according to gender and physical activity level. It is interesting that while physically active boys preferred to consume high energy beverages like whole fat milk, fruit drinks or soda, physically active girls preferred to consume low energy beverage like low-fat milk. Furthermore, the highest amount of TEI was observed in physically active males and no difference was observed between TEI and the physical activity level of girls. Physical activity causes energy expenditure which leads into an increase in energy intake

[171]. Among physically active boys the consumption of beverages with high energy and high TEI might be the reason to gain back the energy which expenditure during physical activity. On the other hand, girls take usually more care about their appearance more than boys do, so to prevent weight gain by excess energy intake physically active girls might prefer to consume low energy drinks.

As expected, total beverage intake was positively associated with physical activity level; however, we didn't observe any association between consumption of each beverage and physical activity. Total beverage intake of adolescents was found 0.9 L/d which was under recommended values [72] and no differences were observed between total beverage intake of physically active and inactive subjects.

Some results of this study show the positive attitudes of the Balearic Islands population toward a healthy eating and also healthy life. On the other hand, some other outcomes proved the nutrition transition and also changes in lifestyle characteristics. Consumption of functional foods like low fat milk, fibre rich products and fruit juice was common in both study population and intake of antioxidants like selenium, vitamin C exceeded the RDI value. Moreover, in the Balearic Islands the consumption of high energy beverages was not as high as in the USA, Mexico and Australia, so the energy intake from beverages was not high as well. Besides, a high proportion of adolescents met the recommended physical activity level.

The results of the study showed that adherence to the Mediterranean diet was moderate among adults and adolescents and adults had a lower adherence than adolescents. Moreover, the intake of many functional components like zinc, carotene, vitamin E and dietary fibres were inadequate. More importantly, physical inactivity was observed among the majority of adults.

Adolescents were physically more active than adults and they had a high adherence to the Mediterranean diet. These indicated that parents take care about their children's eating habits more than about their own ones. To improve the diet and encourage the regular physical activity of all the population the regional government and health authorities in the Balearic Islands should inform the individuals about the positive impact of healthy eating and physical activity.

CONCLUSION

1. Functional Food Consumption

1.1. Adult Population

I. Consumption of functional foods is common among the adult population in the Balearic Islands. Coffee, low fat/skimmed milk, fibre-rich bread/cookies, probiotics, and breakfast cereals are the most preferred functional foods, respectively.

II. Females have a higher interest for consumption of some of the functional foods, like soy milk, fibre-rich bread/cookies and tea, and males have a higher interest to cholesterol lowering products. Elder adults (45-64 y.o.) are more likely to consume cholesterol lowering products, fibre rich bread/cookies, tea, coffee, low fat/skimmed milk and red wine.

III. Adherence to the Mediterranean diet of functional food users (51.2%) is slightly higher than those of non-users (49.6%). Being female and young are the major determinants of low adherence to the Mediterranean diet.

IV. Consumption of functional foods such as modified milk, probiotics, fibre-rich bread/cookies, breakfast cereals, infusions and soy milk is positively associated with the intake of many functional components Moreover, daily mean intake of functional components which are from plant origin foods, like dietary fibre, vitamin C, vitamin E, carotene, folic acid is significantly higher in adults with high adherence to the Mediterranean diet. Inadequate intakes of zinc, omega-6 fatty acid, dietary fibre, magnesium, potassium and folic acid are observed in adults with high and low adherence to the Mediterranean diet.

2.1. Adolescent Population

V. The proportion of the adolescents who consume functional food is lower than those of adults. The most common functional foods among the adolescent population are probiotics, low-fat/skimmed milk, fruit juice or breakfast cereals.

VI. Girls are more likely to consume fibre-rich bread/cookies, cereal bars and low-fat/skimmed milk; whereas, boys are more likely to consume breakfast cereals. Older adolescents (16-18 y.o.) are more likely to consume functional foods except breakfast cereals and cereal bars.

VII. Adherence to the Mediterranean diet of functional food users (56.5%) is slightly higher than those of non-users (55.8 %). Being males and young are the major determinants of a low adherence to the Mediterranean diet. Consumption of fruit juice, fibre rich bread/cookies, cereal bars, fish and soy milk is higher in adolescents with high adherence to the Mediterranean diet. Inadequate intakes of zinc, carotene, omega-6 fatty acid, dietary fibre, calcium, magnesium, potassium and folic acid are observed in adolescents with high and low adherence to the Mediterranean diet.

2. Beverage Consumption

2.1. Adult Population

VIII. Based on the population in each cluster, beverages with low energy is the predominant beverage pattern among the adult population in the Balearic Islands. While being female is the determinant of beverages with low energy cluster's, being male, normal weight and having low education level are the determinants of beverages with high energy clusters.

IX. Total energy intake (TEI) is the highest among beverages with high energy pattern and the lowest for beverages with low energy pattern. Macro and micronutrient intake varies across clusters. Adults in the beverages with high energy cluster have the highest carbohydrate intake; whereas the highest protein intake is observed among adults in the beverages with high energy and some benefits pattern. Inadequate intake of calcium, potassium, magnesium, vitamin D and E and folic acids are found in all the beverage clusters. Respondents in the mix drinkers' pattern have the highest mean nutrition quality index (NQI) scores.

X. The majority of the Balearic Islands population (73.3 %) have a low level of physical activity. Being female and older are the main determinants of being physically inactive.

XI. Daily total beverage intake of respondents is around 1.2 L and there is no difference between total beverage intake of respondents according to their physical activity level or gender. Mean daily consumption of water, low-fat milk, energy/sport drinks and TEI are higher among male respondents with a high physical activity level, whereas consumption of soda, diet soda, coffee/tea and other beverages are higher among males with a low physical activity level. Physical activity level is positively associated with the consumption of water, low-fat milk, fruit drinks and energy/sport drinks, whereas it is inversely associated with soda consumption.

2.2. Adolescent Population

XII. Drinking water is the main water source in the diet of adolescents at all ages. Approximately half of the adolescents consume beverages with high energy and some benefits. Teens started to drink alcohol at ages 14 to 15 and the daily intake increases with age.

XIII. Total beverage consumption and TEI from beverages of boys are higher than those of girls. Beverages contributed 6% to 13% of the total energy intake in the adolescents' diets. Mean NQI, TEI and proportion of energy intake from beverages are significantly higher in adolescents who consume beverages with high energy and some benefits than those of non-consumers. Intake of calcium, magnesium, potassium, vitamin D, vitamin E and folic acid are inadequate in both genders.

XIV. The predominant beverage pattern among adolescents is to be a whole fat milk drinker, whereas 3% of the young population consume high amount of commercial fruit juice. While total beverage consumption varies between 551 and 1438 mL/d, percentage of energy intake from beverages varies 3 to 16% across the beverage clusters.

XV. The majority of the adolescents (62.2%) in the Balearic Islands are physically active. Boys are significantly more active than girls and younger adolescents are physically more active than older ones. Education level of parents is positively associated with the physical activity level of adolescents. Physical inactivity is significantly higher for adolescents who watch TV longer than 2 hours per day.

XVI. Total beverage intake is positively associated with physical activity level. Mean daily fruit drinks and soda consumption and TEI of physically active boys are higher than those of physically active girls. The highest proportion of physical activity is observed among energy/sport beverage drinkers, whereas the highest proportion of physical inactivity is observed among diet soda drinkers.

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