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Natalia Giménez Legarre

Hábito de desayuno y su asociación con otros estilos de vida en niños europeos

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Tesis Doctoral

HÁBITO DE DESAYUNO Y SU ASOCIACIÓN CON OTROS ESTILOS DE VIDA EN NIÑOS EUROPEOS

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TESIS DOCTORAL

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BREAKFAST ROUTINE AND ITS ASSOCIATION WITH LIFESTYLE IN EUROPEAN CHILDREN

UNIVERSIDAD DE ZARAGOZA

Facultad de Ciencias de la Salud

Departamento de Fisiatría y Enfermería

NATALIA GIMÉNEZ LEGARRE

ZARAGOZA 2022

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Departamento de Fisiatría y Enfermería

Universidad Zaragoza

A mis padres, mi ejemplo de vida.

“Deje que su desayuno recargue su sonrisa, caliente su corazón e ilumine su día”.

Anthony T. Hincks.

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CERTIFICA:

Que la Tesis Doctoral titulada “Hábito de desayuno y su asociación con otros estilos de vida en niños europeos” que presenta Dña. **Natalia Giménez Legarre** al superior juicio del Tribunal que designe la Universidad de Zaragoza, ha sido realizada bajo mi dirección, siendo expresión de la capacidad técnica e interpretativa de su autora en condiciones tan aventajadas que le hacen merecedora del Título de Doctora, siempre y cuando así lo considere el citado Tribunal.

Fdo.: Luis A. Moreno Aznar
En Zaragoza, a 24 de junio de 2022

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CERTIFICA:

Que la Tesis Doctoral titulada “Hábito de desayuno y su asociación con otros estilos de vida en niños europeos” que presenta Dña. **Natalia Giménez Legarre** al superior juicio del Tribunal que designe la Universidad de Zaragoza, ha sido realizada bajo mi dirección, siendo expresión de la capacidad técnica e interpretativa de su autora en condiciones tan aventajadas que le hacen merecedora del Título de Doctora, siempre y cuando así lo considere el citado Tribunal.

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I. Giménez-Legarre N, Flores-Barrantes P, Miguel-Berges ML, Moreno LA, Santaliestra-Pasías AM. Breakfast Characteristics and Their Association with Energy, Macronutrients, and Food Intake in Children and Adolescents: A Systematic Review and Meta-Analysis. Nutrients. 2020;12(8).

II. Giménez-Legarre N, Miguel-Berges ML, Flores-Barrantes P, Santaliestra-Pasías AM, Moreno LA. Breakfast Characteristics and Its Association with Daily Micronutrients Intake in Children and Adolescents-A Systematic Review and Meta-Analysis. Nutrients. 2020;12(10).

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IV. Giménez-Legarre N, Santaliestra-Pasías AM, De Henauw S, Forsner M, González-Gross M, Jurado-Fasoli L, Kafatos A, Karaglani A, Lambrinou CP, Molnár D, Sjöström M, Widhalm K, Moreno LA, and on behalf of the HELENA Study Group. Breakfast consumption and its relationship with diet quality and adherence to Mediterranean diet in European adolescents: the HELENA study. *Accepted in Eur J Clin Nutr*

V. Giménez-Legarre N, Santaliestra-Pasías AM, Beghin L, Dallongeville J, de la O A, Gilbert C, González-Gross M, De Henauw S, Kafatos A, Kersting M, Leclerq C, Manios Y, Molnar D, Sjöström M, Widhalm K, Huybrech I, Moreno LA. Dietary Patterns and Their Relationship With the Perceptions of Healthy Eating in European Adolescents: The HELENA Study. J Am Coll Nutr. 2019;38(8):703-13.

CONTENIDO – INDICE

PROYECTOS DE INVESTIGACIÓN
RESEARCH PROJECTS

Los artículos incluidos en esta Tesis Doctoral están basados en los siguientes proyectos de investigación:

Estudio Feel4Diabetes (Developing and implementing a community-based intervention to create a more supportive social and physical environment for lifestyle changes to prevent diabetes in vulnerable families across Europe). Proyecto financiado por la Unión Europea: European Union's Horizon 2020 research and innovation programme (Grant agreement n° 643708).
Página web: www.feel4diabetes-study.eu
Coordinador: Yannis Manios (Harokopio University)
Investigador principal en España: Luis A. Moreno Aznar

Estudio HELENA. (Lifestyle in Europe by Nutrition in Adolescence Cross-sectional Study). Proyecto financiado por la Unión Europea: European Sixth RTD Framework Programme (Contract FOOD-CT-2005-007034)
Página web: www.helenastudy.com
Coordinador: Luis A. Moreno Aznar (Universidad de Zaragoza)

Además, Natalia Giménez Legarre, ha recibido una beca destinada a la formación predoctoral concedida por la Fundación Cuenca Villoro, de Zaragoza, desde enero de 2017 hasta marzo de 2020.

LISTADO DE ABREVIATURAS

LIST OF ABBREVIATIONS

AECOSAN Agencia Española de Seguridad Alimentaria y Nutrición

ANCOVA: Análisis de covarianza

ANOVA: Análisis de la varianza

AXIS: The Appraisal tool for Cross-sectional Studies

CEICA: Comité de Ética de la Investigación de la Comunidad Autónoma de Aragón

cm: centímetros

DM: Diferencia de medias

DM2: Diabetes mellitus tipo 2

DP: Dietary Pattern

DQI: Índice de calidad de la dieta

DQI-A: Índice de calidad de la dieta adaptado para su uso en adolescentes

DQI-A.M: Subsección del Índice de calidad de la dieta que evalúa el número de comidas

DQI-A.PA: Subsección del Índice de calidad de la dieta que evalúa la actividad física

DQI-A.MP: Subsección del Índice de calidad de la dieta que evalúa el número de comidas y la actividad física

ECV: Enfermedades cardiovasculares

FAS: Family Afluence Scale

FBDG: Flemish food-based dietary guidelines

FCP: Food Choices and Preferences

g: gramos

HbA1c: Hemoglobina glicosilada

HELENA-DIAT: Dietary Assessment Tool

HOMA.IR:	Índice de resistencia a la insulina
IBRI:	International Breakfast Research Initiative
IC del 95%	Intervalo de confianza del 95%
IMC:	Índice de masa corporal
ISCED:	International Standard Classification of Education
Kcal:	Kilocalorías
Kg:	kilogramos
m:	metros
MDS:	Mediterranean Diet Score – Score de dieta mediterránea
mg:	miligramos
MSM:	multiple source method
NHANES:	National Health and Nutrition Examination Survey
NRF 9.3:	Índice de alimentos ricos en nutrientes 9.3.
OMS:	Organización Mundial de la Salud
PCA:	Análisis de componentes principales
PD:	Patrón Dietético
PICO:	Participants, Inverventions, Control, Outcomes
PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
SACINA:	Self-Administered Children and Infants Nutrition Assessment
SPSS:	The Predictive Analytics Software
zBMI :	Body Mass Index z-score
µg:	microgramos

RESUMEN

Tradicionalmente, el desayuno ha sido identificado como la comida más importante del día; sin embargo, a menudo, niños y adolescentes tienden a omitirlo. Además, ha sido considerado como un componente clave de una alimentación saludable. Sin embargo, actualmente existe cierta discordancia de opiniones sobre la importancia del mismo, principalmente en adultos. El hábito de desayunar se ha asociado con un mejor control del peso, mejor función cognitiva y salud cardio-metabólica. El desayuno se define como "la primera comida del día que rompe el estado de ayuno después del período más largo de sueño y se consume dentro de las 2-3 horas de despertarse; se compone de alimentos y/o bebidas de al menos un grupo de alimentos y puede consumirse en cualquier lugar". Durante la infancia, existe una elevada proporción de consumidores habituales de desayuno, pero disminuye de forma notable con la adolescencia, aumentando en los adultos más jóvenes y aún más en los adultos mayores, donde el porcentaje de la población que consume el desayuno fue similar o superior a la de los niños.

El objetivo general de la presente tesis doctoral es describir el hábito de desayuno y su asociación con otros estilos de vida en niños y adolescentes europeos.

Las revisiones sistemáticas y metaanálisis fueron realizadas de acuerdo a las directrices PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis). En febrero de 2020 se realizó una búsqueda sistemática y exhaustiva de la literatura en tres bases de datos (PubMed, Scopus y Cochrane Library). El metaanálisis se realizó comparando los resultados según el tipo de desayuno consumido (desayunos de cereales listos para comer u otro tipo de desayunos).

Los datos del presente estudio fueron obtenidos de los estudios Feel4Diabetes y HELENA, así como de dos revisiones sistemáticas con metaanálisis. El estudio Feel4Diabetes es un estudio de intervención realizado entre los años 2015-2019 en seis países europeos. La muestra total fue de 11396 niños de entre 5-12 años. Por otro lado, el estudio HELENA se trata de un estudio transversal multicéntrico realizado en 2006-2007 en 10 ciudades europeas. La muestra total de participantes fue de 3528 adolescentes europeos con edades entre 12.5-17.5 años.

Hemos observado que aquellos niños y adolescentes que desayunaban presentaban una mayor ingesta diaria de energía, hidratos de carbono, fibra y proteínas, así como una mayor ingesta de vitaminas y minerales en comparación con los que se saltaban el desayuno. Además, los que desayunaban mostraban

un mayor consumo diario de frutas y verduras, leche y productos lácteos y cereales en comparación con los que se saltaban el desayuno. El desayuno basado en cereales listos para consumir es el tipo de desayuno más consumido por niños y adolescentes. Este tipo de desayuno puede tener efectos beneficiosos en la ingesta diaria de macro- y micronutrientes; sin embargo, es importante conocer el perfil nutricional de los cereales consumidos, ya que suelen tener un alto contenido en azúcares añadidos, y estos componentes deben evitarse. Por otro lado, hemos observado que la mayor proporción de niños eran consumidores de desayuno. La mayor proporción de niños que desayunaban habitualmente se encontró en aquellos cuyas madres eran consumidoras de desayuno. Además, los grupos de alimentos y bebidas consumidos por las madres en el desayuno fueron los mismos que consumieron sus hijos en esta comida. Nuestros resultados pueden sugerir una influencia de la rutina del desayuno de la madre a sus hijos, aunque nuestros análisis no permiten realizar inferencias causales. Las madres pueden ser una influencia importante en el consumo de desayuno de los niños, en términos de comportamiento y también en términos de calidad del desayuno. Además, durante la infancia, el desayuno es un hábito establecido; sin embargo, puede perderse durante la adolescencia porque, a esa edad, cada individuo reafirma su personalidad y toma sus propias decisiones sobre hábitos, elecciones y preferencias alimentarias.

En población adolescente, el consumo regular de desayuno se asoció con un Índice de Calidad de la Dieta (DQI-A) y un Score de Dieta Mediterránea (MDS) más altos, lo que significa que la rutina del desayuno se ha relacionado con mejores puntuaciones de calidad dietética en comparación con aquellos que generalmente se saltan el desayuno. Consumir desayuno regularmente parece ser un buen indicador de hábitos saludables. Finalmente observamos asociaciones significativas entre percepciones de alimentación saludable y diferentes patrones dietéticos (PD), especialmente el PD-Desayuno. Se ha observado que aquellos adolescentes que tenían un patrón dietético caracterizado por el consumo de alimentos consumidos habitualmente en el desayuno percibían su dieta como saludable. El análisis de las relaciones entre las percepciones de una alimentación saludable y el consumo de alimentos y bebidas debería contribuir al desarrollo de estrategias eficaces para aumentar la concienciación sobre estilos de vida saludables entre los jóvenes europeos.

ABSTRACT

Traditionally, breakfast has been identified as the most important meal of the day; however, children and adolescents often tend to skip it. In addition, it has been considered as a key component of a healthy diet. However, there is currently some disagreement of opinions about its importance, mainly in adults. Consuming breakfast has been associated with better weight control, better cognitive function, and cardio-metabolic health. Breakfast is defined as "the first meal of the day that breaks the fast after the longest period of sleep and is consumed within 2-3 hours of waking; It consists of foods and/or drinks from at least one food group and can be consumed anywhere". During childhood, there is a high proportion of habitual breakfast consumers, but it decreases significantly with adolescence, increasing in younger adults and even more in older adults, where the percentage of the population that consumes breakfast was similar or higher than that of children.

The general objective of this doctoral thesis is to describe the breakfast habit and its association with other lifestyles in European children and adolescents.

Systematic reviews and meta-analyses were performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) guidelines. In February 2020, a systematic and exhaustive search of the literature was carried out in three databases (PubMed, Scopus and Cochrane Library). The meta-analysis was performed comparing the results according to the type of breakfast consumed (ready-to-eat cereal breakfasts or other types of breakfast).

The data for this study were obtained from the Feel4Diabetes and HELENA studies, as well as from two systematic reviews with meta-analyses. The Feel4Diabetes study is an intervention study carried out between the years 2015-2019 in six European countries. The total sample was 11,396 children aged 5-12 years. On the other hand, the HELENA study is a multicenter cross-sectional study conducted in 2006-2007 in 10 European cities. The total sample of participants was 3,528 European adolescents aged 12.5-17.5 years.

We have observed that those children and adolescents who ate breakfast had a higher daily intake of energy, carbohydrates, fibre and protein, as well as a higher intake of vitamins and minerals compared to those who skipped breakfast. In addition, breakfast consumers showed higher daily consumption of fruits and vegetables, milk and dairy products, and cereals compared to breakfast skippers. Breakfast based on ready-to-eat cereals is the type of breakfast most consumed by children and adolescents. This type of breakfast can have beneficial effects on the daily intake of macro- and micronutrients;

however, it is important to know the nutritional profile of the cereals consumed, since they tend to have a high content of added sugars, and these components should be avoided. On the other hand, we have observed that the highest proportion of children were breakfast consumers. The highest proportion of children who regularly consumed breakfast was found in those whose mothers were breakfast consumers. In addition, the food and beverage groups consumed by the mothers at breakfast were the same as those consumed by their children at this meal. Our results may suggest an influence of the mother's breakfast routine on her children, although our analyses do not allow causal inferences. Mothers can be an important influence on children's breakfast consumption, in terms of behaviour and also in terms of breakfast quality. Also, during childhood, breakfast is an established habit; however, it can be lost during adolescence because, at that age, each individual reaffirms his personality and makes his own decisions about food habits, choices and preferences.

In the adolescent population, regular breakfast consumption was associated with a higher Diet Quality Index (DQI-A) and Mediterranean Diet Score (MDS), which means that the breakfast routine has been related to better scores of dietary quality compared to those who generally skip breakfast. Consuming breakfast regularly seems to be a good indicator of healthy habits. Finally, we observed significant associations between perceptions of healthy eating and different dietary patterns (DP), especially the Breakfast-DP. It has been observed that those adolescents who had a dietary pattern characterized by the consumption of foods usually consumed at breakfast perceived their diet as healthy. Analysis of the relationships between perceptions of healthy eating and food and drink consumption should contribute to the development of effective strategies to increase perception of healthy lifestyles among young Europeans.

INTRODUCCIÓN

INTRODUCTION

Tradicionalmente, el desayuno ha sido identificado como la comida más importante del día; sin embargo, a menudo, niños y adolescentes tienden a omitirlo (1). Además, el desayuno ha sido considerado como un componente clave de una alimentación saludable (1-4). Sin embargo, actualmente existe cierta discordancia de opiniones sobre la importancia del mismo, principalmente en adultos (5, 6). El hábito de desayunar se ha asociado con un mejor control del peso, mejor función cognitiva y salud cardio-metabólica (3, 7, 8). Por otro lado, el consumo regular del desayuno también ha sido asociado a una mejor calidad de la dieta, a patrones dietéticos más saludables entre los que destaca un mayor consumo de frutas y verduras, un menor consumo de bebidas azucaradas y de comida rápida, mayores niveles de actividad física y menor tiempo de pantalla (1, 9, 10).

DEFINICIÓN, COMPOSICIÓN Y SITUACIÓN ACTUAL DEL DESAYUNO

Definición de desayuno

Literalmente, el desayuno se considera como la comida que rompe el ayuno. Sin embargo, desde el punto de vista científico , no existe actualmente un consenso sobre la definición de desayuno, que tenga en cuenta el tiempo del consumo, su contenido energético y/o nutricional o los grupos de alimentos y/o bebidas incluidos (1). Además, la definición de desayuno varía según los estudios. A continuación, se dan algunos ejemplos:

1) La primera comida del día dentro de las 2h después de despertar, generalmente antes de las 10:00h y cuyo contenido calórico sea del 20 al 35% del requerimiento total diario de energía (11, 12).

2) El consumo de alimentos y/o bebidas entre las 5:00h y las 10:00h (13).

3) En una revisión previa, el desayuno fue definido como “la primera comida del día que rompe el estado de ayuno después del período más largo de sueño, se consume dentro de las 2 a 3 horas de despertarse; se compone de alimentos y/o bebidas de al menos un grupo de alimentos y puede consumirse en cualquier lugar” (1).

En la presente tesis doctoral, se utiliza la tercera definición por ser la más completa y, además, la más utilizada por diferentes autores.

Composición del desayuno

El desayuno y las cantidades de alimentos a consumir deben ser personalizados, dependiendo de la cultura, hábitos y disponibilidad de alimentos, para que se ajusten a un patrón de alimentación saludable (14).

En cuanto a la ingesta energética, no es posible estimar un único valor, ya que la ingesta energética es muy variable entre la población según los requerimientos que cada persona necesite (nivel de actividad física, grupo poblacional…). En un estudio previo (IBRI; International Breakfast Research Initiative), se ha observado que la ingesta calórica media observada en el desayuno entre grupos de edad y países se ajustó a un rango de 15-25% de la ingesta energética diaria, es decir, equivalente a 300-500kcal para una dieta de 2000kcal (3), lo cual se asemeja a lo propuesto por autores previos sobre que el desayuno debería proporcionar al menos el 20% de las necesidades de energía totales diarias (15-18).

Las definiciones oficiales o ejemplos de un desayuno saludable son bastante escasas. La mayoría de las sociedades de nutrición han desarrollado recomendaciones que especifican qué grupos de alimentos deben consumirse, en qué cantidad y con qué frecuencia, dejando al individuo la libertad de ubicar los alimentos recomendados a lo largo de las diferentes comidas del día (19).

Sin embargo, diversos autores establecieron la definición de un desayuno saludable como aquel desayuno que incluya idealmente tres o más grupos de alimentos, con el fin de ayudar a cubrir las necesidades y recomendaciones de consumo de alimentos, así como mejorar los patrones generales de alimentación (1, 12, 15, 20-23):

- Un alimento del grupo de los cereales, preferiblemente entero/integral (pan, cereales de desayuno…), para suministrar energía después de un período prolongado de ayuno. Además, pueden ser una fuente importante de fibra dietética, aumentando la saciedad y mejorando el control del apetito.
- Un producto lácteo (leche, yogur, queso…), ya que son una fuente importante de vitaminas y algunos minerales como calcio, potasio…
- Una pieza de fruta (preferiblemente entera), ya que es una fuente importante de fibra y vitaminas (A, C).

En estudios anteriores se ha observado que consumir estos grupos de alimentos durante el desayuno ayuda a cumplir las recomendaciones dietéticas diarias, especialmente de vitaminas y minerales (20, 24, 25).

Situación actual

En un estudio reciente (IBRI; International Breakfast Research Initiative), realizado en seis países, se observó que una proporción importante de la población consume el desayuno de forma habitual (3). Durante la infancia, existe una elevada proporción de consumidores habituales de desayuno, pero disminuye de forma notable con la adolescencia, aumentando en los adultos más jóvenes y aún más en los adultos mayores, donde el porcentaje de la población que consume el desayuno fue similar o superior a la de los niños (Figura 1) (3). En relación al género, se ha observado que las chicas son las que tienden a omitir con mayor frecuencia el momento del desayuno (26).

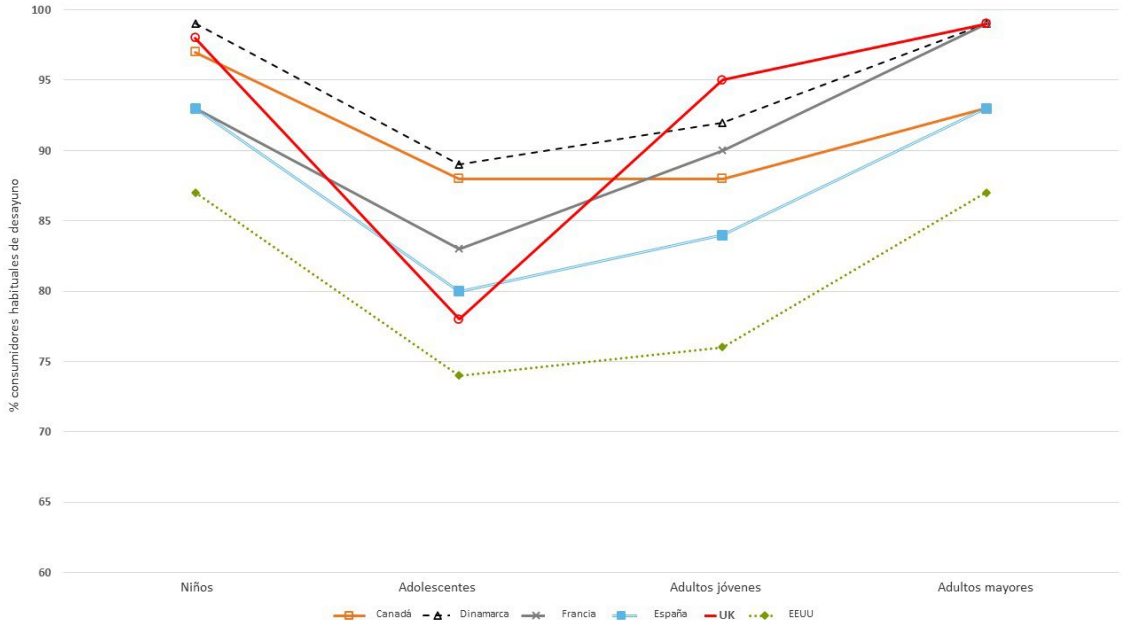


Figura 1. *Proporción de consumidores habituales de desayuno por país y grupo de edad (3).*

En un estudio previo realizado en España (estudio ANIBES), se observó que casi el 85% de la población desayuna de forma habitual, siendo el grupo de los niños (9-13 años) uno de los grupos de edad con un mayor consumo de éste (93% de consumidores habituales). En cambio, los adolescentes (13-17 años) fueron el grupo de edad con una mayor proporción de los mismos con un consumo irregular de desayuno u omisión de este (Figura 2) (27). En Estados Unidos, en la Encuesta Nacional de Salud 2011-2014 (NHANES), el patrón de desayuno fue muy parecido, ya que los niños y los adultos mayores son los que desayunaron con mayor frecuencia; sin embargo, el 25% de los adolescentes y adultos jóvenes no desayunaron de forma habitual (28).

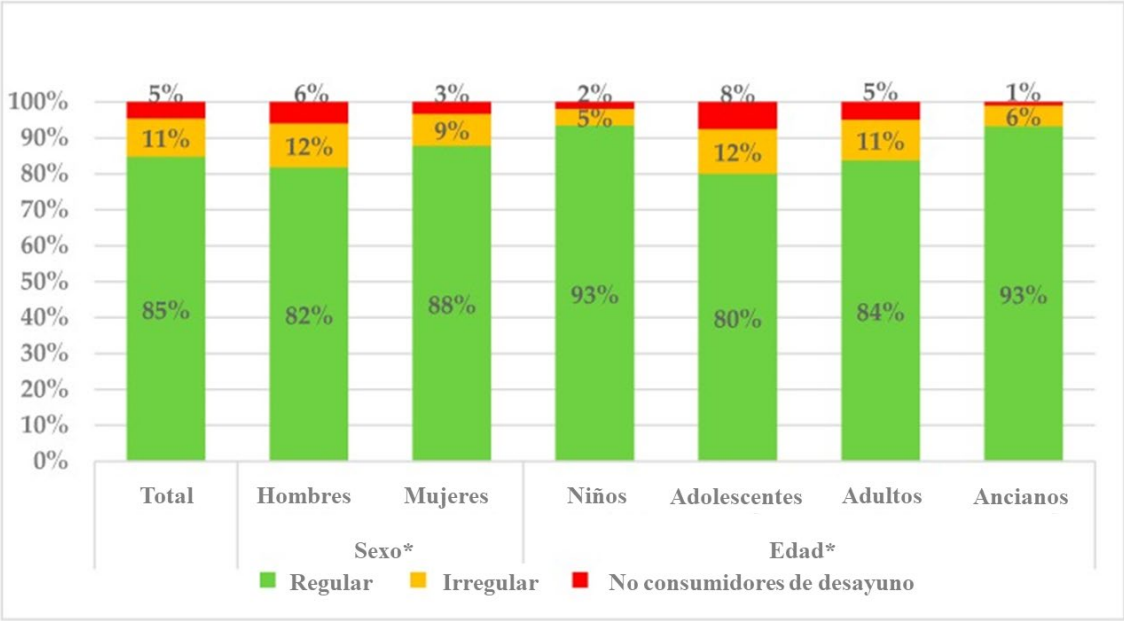


Figura 2. *Regularidad del consumo de desayuno en la población española (Estudio ANIBES) (27).*

INFLUENCIA DEL DESAYUNO EN LA DIETA

Influencia del desayuno en la calidad y composición de la dieta

El desayuno es una buena ocasión para realizar una comida rica en nutrientes debido a su contribución a la energía diaria y a su contribución de vitaminas y minerales (3). Además, la adopción de hábitos regulares de comida parece ayudar a mejorar la calidad total de la dieta (29).

Diferentes autores afirman que, en niños en edad escolar, el desayuno debería constituir el 20% de la ingesta total de energía diaria (18, 30). Siguiendo las recomendaciones internacionales, una buena distribución diaria de macronutrientes estaría compuesta por 55-75% de hidratos de carbono, 15-30% de grasas y 10-15% de proteínas (31). En cambio, en diferentes estudios se ha observado que aquellos niños y adolescentes que no desayunan frecuentemente tenían una menor ingesta diaria tanto de energía como de macronutrientes, en comparación con aquellos niños y adolescentes que sí que desayunaban habitualmente (30, 32-35). Así mismo, en relación con el consumo diario de micronutrientes, el consumo de desayuno también se ha asociado con una mayor ingesta de vitaminas y minerales en población infantil y en adolescentes (24, 36, 37).

En una investigación previa se utilizó una modificación del índice de alimentos ricos en nutrientes (NRF 9.3) adaptado como medida de la calidad general de la dieta. Se observó que el grupo de adolescentes consumidores habituales de desayuno tenía una ingesta significativamente mayor de fibra, vitamina A,

tiamina, riboflavina, vitamina B6, vitamina B12, vitamina C, vitamina D, calcio, hierro, magnesio, potasio y zinc, así como una menor ingesta de colesterol; teniendo además una puntuación NRF 9.3 más alta (37).

Además, se ha observado que aquellos niños y adolescentes que omiten el desayuno de forma frecuente, presentan un patrón dietético menos saludable (10), por lo que el consumo de desayuno parece tener una influencia positiva en las elecciones alimentarias, tanto en niños como en adolescentes (38). Aquellos niños y adolescentes que desayunan de forma frecuente tienen un mayor consumo de frutas y verduras (39, 40), cereales y legumbres (39, 40), lácteos (40) y pescado (39).

DETERMINANTES DEL DESAYUNO

Influencia del entorno familiar en el consumo de desayuno

El entorno social de los niños y los adolescentes parece tener un impacto en los comportamientos relacionados con el estilo de vida, como la alimentación (41, 42). Se ha observado una asociación entre las influencias positivas tanto de los miembros de la familia como de los amigos, y la elevada probabilidad del consumo diario de desayuno (42). La familia es un punto muy importante a la hora del desarrollo de las conductas alimentarias, siendo los padres un punto clave en el establecimiento y mantenimiento de las conductas alimentarias de sus hijos (43). Además, se ha observado que compartir los momentos de las comidas en familia parece promover comportamientos saludables (41). También se ha observado que las madres que tienen una alimentación saludable (consumiendo frutas y verduras habitualmente) mantengan en general unos hábitos y un estilo de vida saludable y como tal, pongan a disposición de sus hijos alimentos saludables y no promuevan el saltarse las comidas (44). En niños y adolescentes, en ambos géneros, algunos estudios observaron que la influencia madre parece estar relacionada en el consumo regular de desayuno (44, 45). Además, en una revisión sistemática, se ha observado que aquellos adolescentes cuyos padres consumen desayuno de forma habitual, tienen una rutina de desayuno establecida, siendo la familia un punto muy importante a la hora de promover el consumo de desayuno en gente joven (46). Además, aunque debido a la edad, los adolescentes son más autónomos, se ha observado que la influencia materna es importante incluso en los entornos en los que la madre no suele estar presente (44).

Influencia del entorno social en el consumo de desayuno

Al igual que la investigación ha demostrado que la influencia de los padres en los comportamientos de salud se mantienen a medida que los niños crecen,

durante la adolescencia, la influencia de los amigos y los compañeros se vuelve cada vez más destacada (47).

Los adolescentes pasan mucho tiempo con sus amigos y, algunos estudios han observado que los adolescentes informan que las actitudes y los comportamientos de sus amigos y compañeros influyen en su elección de alimentos y conductas alimentarias. En cambio, es difícil examinar las influencias sociales a la hora de saltarse las comidas ya que en muchas ocasiones los adolescentes no son conscientes de estas influencias (48, 49). Se ha observado que en chicas adolescentes, aquellas que percibían que su mejor amiga se saltaba alguna comida, tenían más probabilidades de saltarse el desayuno y/o la cena (44). Omitir alguna comida es frecuentemente una estrategia utilizada para la reducción de peso y puede ser influido por las amistades y/o compañeros y por una subcultura que enfatiza la importancia del control de peso, la dieta conjunta y la delgadez (44), siendo las chicas las más propensas a valorar y buscar los ideales corporales así como a interactuar dentro de grupos de amistad que comparten comportamientos dietéticos y alimentarios similares (50, 51). En cambio, cada vez más los chicos se preocupan más por su cuerpo y adoptan patrones de alimentación más desordenados, como saltarse comidas (52-54).

CONSUMO DE DESAYUNO Y OTROS INDICADORES DE SALUD

Función cognitiva y rendimiento escolar

La nutrición es uno de los aspectos modificables del estilo de vida que puede influir más en la maduración cerebral y, en consecuencia, en la función cognitiva y en el rendimiento escolar (55). En una revisión sistemática reciente se observó una relación entre el rendimiento escolar y una mejor calidad de la dieta y unos hábitos alimentarios más saludables, entre los que se encuentra el consumo regular de desayuno (56). Por otro lado, se ha observado que algunos hábitos, como el consumo de desayuno parece estar relacionado con la función cognitiva y el rendimiento escolar, mejorando la concentración y la atención entre los escolares (57, 58). Esto es debido a que los hidratos de carbono consumidos durante el desayuno, aumentan los niveles de glucosa en sangre y el suministro de energía al cerebro, aumentando así la capacidad de atención, estado de alerta, razonamiento lógico y resolución de problemas (57). Además, saltarse el desayuno se ha relacionado con la reducción de diferentes funciones cognitivas (59), como el rendimiento académico y aprendizaje de los niños (60). En varias revisiones sistemáticas previa, los autores concluyeron que el consumo frecuente de desayuno, tanto en niños como en adolescentes, tiene efectos positivos sobre el rendimiento cognitivo en comparación con la omisión del mismo (61, 62). Los resultados de estudio realizado en 42 países mostraron

que una mayor frecuencia del consumo de desayuno estaba relacionada con un mayor rendimiento escolar (63). Además, diferentes estudios concluyeron que los programas de desayuno escolar realizados en diferentes países, aumentaron el rendimiento escolar, pudiendo ser un efecto directo del consumo regular de desayuno (61). El desayuno puede mejorar la actividad neuronal y el control cognitivo, como por ejemplo, la memoria de trabajo y capacidad de atención, lo que a su vez puede influir en el rendimiento escolar (56, 63, 64).

Influencia del desayuno en la composición corporal

La obesidad infantil es uno de los problemas de salud pública más importantes del siglo XXI, ya que presenta una elevada prevalencia y actualmente sigue en aumento (65, 66). El sobrepeso y la obesidad son el resultado de una red compleja en la que interactúan diversos factores, como las implicaciones genéticas, peso al nacer, lactancia materna, obesidad de los padres, actividad física, nivel socioeconómico, edad y sexo (67), pero además, los hábitos dietéticos son una parte fundamental (68), especialmente el consumo de desayuno, ya que juega un papel fundamental importante en el equilibrio energético y la regulación dietética (69). Además, se ha observado que un alto porcentaje de niños y adolescentes con sobrepeso u obesidad, continúan siéndolo durante la edad adulta (66). Existe una consistente evidencia en la asociación del sobrepeso y la obesidad infantil con la mortalidad prematura y morbilidad cardio-metabólica (enfermedades cardiovasculares, diabetes tipo 2 o ciertos tipos de cáncer) (70, 71).

En la actualidad, el consumo o la omisión del desayuno es un tema controvertido de salud pública. En adultos, existe una tendencia a creer que saltarse el desayuno puede ayudar en el control de peso, en cambio, muchos estudios previos han observado que el saltarse el desayuno aumenta la prevalencia de obesidad y las comorbilidades asociadas (11, 22, 72-75). En cambio, en niños y adolescentes, en una revisión sistemática reciente se observó que el saltarse el desayuno estaba asociado con el sobrepeso y/o obesidad en la mayoría de los estudios (76).

En un estudio previo, se analizó la relación entre el consumo de desayuno y la grasa visceral medida por resonancia magnética en niños con sobrepeso, observándose que, aquellos que se no desayunaban presentaban un mayor contenido de tejido adiposo intraabdominal en comparación con aquellos que desayunaban de forma habitual (77). Además, varias revisiones sistemáticas y meta-análisis han demostrado que aquellos niños y adolescentes que tienen una rutina de desayuno establecida tienen un menor riesgo de tener sobrepeso y/o obesidad, asociándose la omisión del desayuno a una desregulación cardiometabólica en este grupo poblacional (8, 76, 78), indicando que el desayuno es crítico para el riesgo de obesidad en todas las edades, tanto en la

infancia como en el periodo adulto (78). En cambio, no se puede explicar todavía por qué la omisión del desayuno se asocia con sobrepeso y/o obesidad; varios autores sugieren que saltarse el desayuno puede verse afectado con la duración y calidad del sueño, los ritmos circadianos, duración del ayuno nocturno y/o niveles más bajos de actividad física (8, 76, 79, 80).

Enfermedades crónicas no transmisibles

La omisión del desayuno ha sido asociada con diferentes enfermedades crónicas no transmisibles, mostrando una mayor prevalencia de hipertensión dislipemia o intolerancia a la glucosa (81-84).

Diferentes estudios sugieren que aquellos adultos que omiten el desayuno tienen un mayor riesgo de sufrir algún tipo de enfermedad cardiovascular en comparación con aquellos que lo consumen de forma frecuente (81, 84, 85). En adultos, diferentes estudios han observado que existe una relación entre el consumo de desayuno y el riesgo de arterioesclerosis y enfermedad coronaria (86), presión arterial elevada (87), síndrome metabólico (88) y accidente cerebrovascular (81). Por otro lado, en niños y adolescentes, se ha observado que aquellos que no desayunaban tenían un peor perfil lipídico y/o una mayor prevalencia de síndrome metabólico (76), observándose niveles más altos de insulina en ayunas, colesterol total, colesterol LDL y triglicéridos, que aquellos que desayunan de forma habitual (5, 89, 90). Además, se han observado también niveles más altos de tensión arterial en aquellos que omitían el desayuno frecuentemente (76, 91).

El consumo de desayuno puede ser favorable para promover la secreción fisiológica de insulina. Además, las alteraciones circadianas y glucometabólicas causadas por la omisión del desayuno junto con la subsiguiente sobre nutrición son preocupantes (Figura 3) ya que, saltarse el desayuno, especialmente cuando se asocia con una mayor ingesta calórica en la cena, se asocia con un reloj circadiano desregulado en el páncreas, lo que impulsa niveles elevados de glucosa en sangre postprandial y, por lo tanto, se relaciona con la incidencia de diabetes mellitus tipo 2 y enfermedades cardiovasculares (92).

Además, un meta-análisis realizado previamente sugiere que saltarse el desayuno se asocia con un riesgo significativamente mayor de sufrir diabetes tipo 2 (93). El desayuno se trata de la primera comida del día y, por tanto, se trata del momento en el que cesa el ayuno prolongado, siendo este consumo de alimentos especialmente saciante y asociado con un menor apetito y con un mejor control del peso (94), especialmente cuando los alimentos consumidos durante el mismo son alimentos ricos en fibra (90). Desayunar de forma frecuente se ha asociado favorablemente con índices de control glucémico en

adultos con riesgo de sufrir diabetes mellitus tipo 2 (95). En niños, se ha observado que aquellos que consumen diariamente el desayuno, tienen niveles más bajos de resistencia a la insulina (96). En un estudio de intervención realizado en niños se observó que el aumento del consumo de desayuno estaba asociado con una disminución de los niveles de insulina en ayunas, un menor índice de resistencia a la insulina (HOMA-IR) y menor HbA1c (97).

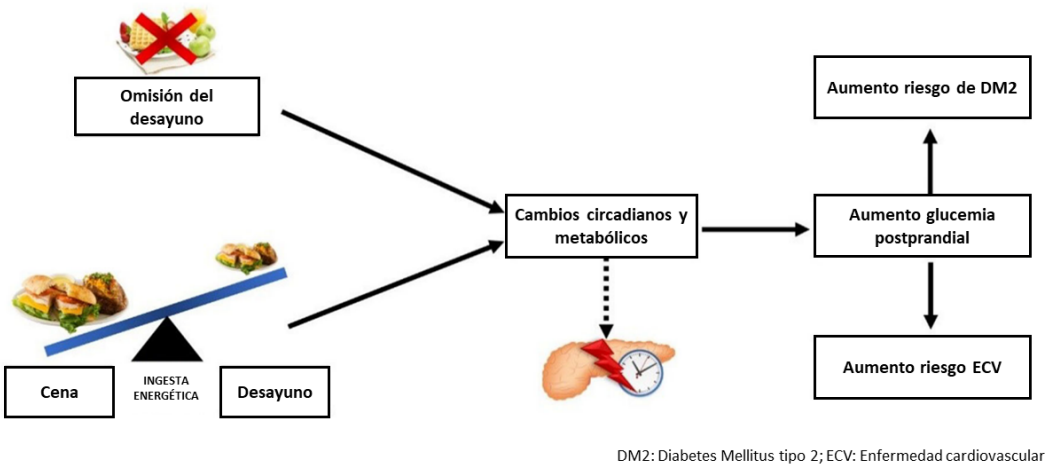


Figura 3. *Alteraciones circadianas y glucometabólicas causadas por la omisión del desayuno junto con la subsiguiente sobre nutrición (92).*

OBJETIVOS

El objetivo general de la presente Tesis Doctoral es describir el hábito de desayuno en niños europeos y su relación con la calidad de la dieta los hábitos alimentarios y la composición corporal.

Los objetivos específicos de los artículos que componen la Tesis Doctoral son los siguientes:

ARTÍCULO I: Investigar las asociaciones entre la frecuencia y las características del consumo de desayuno y su relación con la composición de la dieta diaria en términos de energía, macronutrientes y consumo de alimentos y bebidas.

ARTÍCULO II: Describir las asociaciones entre las características y frecuencia del consumo de desayuno y la composición de la dieta total en términos de ingesta de micronutrientes.

ARTÍCULO III*:* Describir la rutina de desayuno en una muestra de niños europeos y sus madres, analizando si existe una asociación de hábitos de desayuno entre las madres y sus hijos por sexos y si existe una asociación entre el consumo de alimentos y bebidas en el desayuno entre ellos.

ARTÍCULO IV: Analizar las asociaciones entre el consumo de desayuno y la adherencia al índice de calidad de la dieta y a la puntuación del índice de dieta mediterránea en una muestra de adolescentes europeos que participan en el estudio HELENA.

ARTÍCULO V: Identificar los patrones dietéticos en adolescentes europeos y analizar las asociaciones entre varias percepciones de alimentación saludable y los patrones dietéticos obtenidos en una muestra de adolescentes europeos que participan en el estudio HELENA.

OBJECTIVES

The general objective of this Doctoral Thesis is to describe the breakfast habits in European children and their relationship with diet quality, eating habits and body composition.

The specific objectives of each of the five articles included in this Doctoral Thesis are the following:

ARTICLE I: To investigate the associations between frequency and characteristics of breakfast consumption and its relationship with daily diet composition in terms of energy, macronutrients, and foods and beverages consumption.

ARTICLE II: To describe the associations between characteristics and frequency of breakfast consumption and total daily diet composition in terms of micronutrients intake.

ARTICLE III: To describe the breakfast routine in a sample of European children and their mothers, analysing whether there is an association of breakfast habits between mothers and their children by sex and whether there is an association of foods and beverages consumption at breakfast in between them.

ARTICLE IV: To analyse the associations between breakfast consumption and adherence to diet quality index (DQI) and Mediterranean Diet Score (MDS) in a sample of European adolescents.

ARTICLE V: To identify dietary patterns in European adolescents and to analyse the associations between several perceptions of healthy eating and the obtained dietary patterns in a sample of European adolescents.

MATERIAL Y MÉTODOS

MATERIAL AND METHODS

REVISIONES SISTEMÁTICAS Y METAANÁLISIS

(ARTÍCULOS I-II)

Las revisiones sistemáticas y meta-análisis fueron realizadas de acuerdo a las directrices PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) (98). Ambos protocolos fueron publicados y registrados en "Prospero" (Artículo I: CRD42018078112; Artículo II: CRD42020142570). Las preguntas específicas fueron realizadas de acuerdo al principio PICO (Participants, Inverventions, Control, Outcomes) (Tabla 1) (99).

Tabla 1. Criterios PICO (Participants, Inverventions, Control, Outcomes) utilizados para la inclusión y exclusión de estudios.

PICO	Criterios de Inclusión	Criterios de Exclusión
Participantes	Niños y adolescentes mayores de 2 años y menores de 18 años; ambos géneros; todas las nacionalidades.	Niños menores de 2 años y adultos mayores de 18 años. Participantes con algún tipo de enfermedad conocida o notificada.
Intervenciones	Consumidores de desayuno (cereales de desayuno listos para consumir; Otros tipos de desayuno)	No tener datos del consumo de desayuno
Control/Grupo de comparación	No consumidores de desayuno	No tener datos del consumo de desayuno
Resultados	Consumo diario total de ingesta de macronutrientes, alimentos y bebidas (artículo I); Consumo diario total de micronutrientes (Artículo II)	Otros resultados no relacionados con el consumo de desayuno

ESTRATEGIA DE BÚSQUEDA

En febrero de 2020 se realizó una búsqueda sistemática y exhaustiva de la literatura. La búsqueda fue limitada a estudios en humanos publicados tanto en inglés como en español.

La búsqueda se realizó en las bases de datos Pubmed, Scopus y Cochrane con los siguientes términos: ("Breakfast"(Mesh) OR "Breakfast"(tiab)) AND ("Food"(Mesh) OR "Beverages"(Mesh) OR "Diet, Food and Nutrition"(Mesh) OR "Diet"(Mesh) OR "Eating"(Mesh) OR "Feeding Behavior"(Mesh) OR "Nutritional Requirements"(Mesh) OR "Nutritional Status"(Mesh) OR "Nutritive Value"(Mesh) OR "breakfast skipping"(tiab) OR "meal Skipping"(tiab) OR "Fasting"(Mesh) OR "Food preferences"(Mesh) OR "Diet therapy"(Mesh) OR "Energy Intake"(Mesh) OR "nutrient"(Mesh)) AND ("Child, Preschool"(Mesh) OR "Child"(Mesh) OR "Adolescent"(Mesh) OR "breakfast skipping" OR "meal skipping").

CRITERIOS DE SELECCIÓN

Para ser incluido en cualquiera de las dos revisiones, se requería que cada artículo cumpliera con los siguientes criterios (1) artículo de investigación original, (2) los participantes debían ser niños y/o niñas y/o adolescentes mayores de 2 años y menores de 18 años, teniendo en cuenta los años de seguimiento, (3) se debía haber realizado una evaluación del desayuno, (4) el diseño del estudio debía ser uno de los siguientes: estudio transversal, estudio longitudinal o estudio de caso-control. Por el contrario, los artículos fueron excluidos si no cumplían con los criterios de inclusión anteriores y/o si cumplían con alguno de los siguientes criterios: (1) el diseño del estudio era uno de los siguientes: ensayos controlados aleatorios, ensayos clínicos, informes de casos, estudios de intervención, artículos de opinión, revisiones, revisiones sistemáticas o metaanálisis, (2) participantes con alguna enfermedad conocida o informada. Todos los estudios fueron recopilados en un gestor de citas bibliográficas online (EndNote® Online).

PROCESO DE REVISIÓN SISTEMÁTICA, EXTRACCIÓN Y SÍNTESIS DE DATOS

Los títulos y resúmenes fueron evaluados en una primera revisión. Posteriormente, los artículos de texto completo fueron evaluados considerando los criterios de inclusión y exclusión por dos revisores independientes (NGL, PFB). La información extraída incluía autor, año de publicación, país, año de

estudio, diseño de estudio, objetivo, tamaño de la muestra, características de los participantes, fuente de los datos, método de evaluación del desayuno, resultado principal sobre energía, macronutrientes y/o consumo de alimentos y bebidas (Artículo I) y/o micronutrientes (Artículo II). Después de la extracción de datos inicial, un segundo revisor verificó la información, y en caso de desacuerdo, se llegó a un consenso entre ambos con la ayuda de un tercer revisor. Según el resultado encontrado, los estudios se clasificaron en diferentes grupos: macronutrientes y alimentos y bebidas (Artículo I) y micronutrientes (Artículo II). Los resultados del proceso de búsqueda se muestran en el diagrama de flujo (Figura 4).

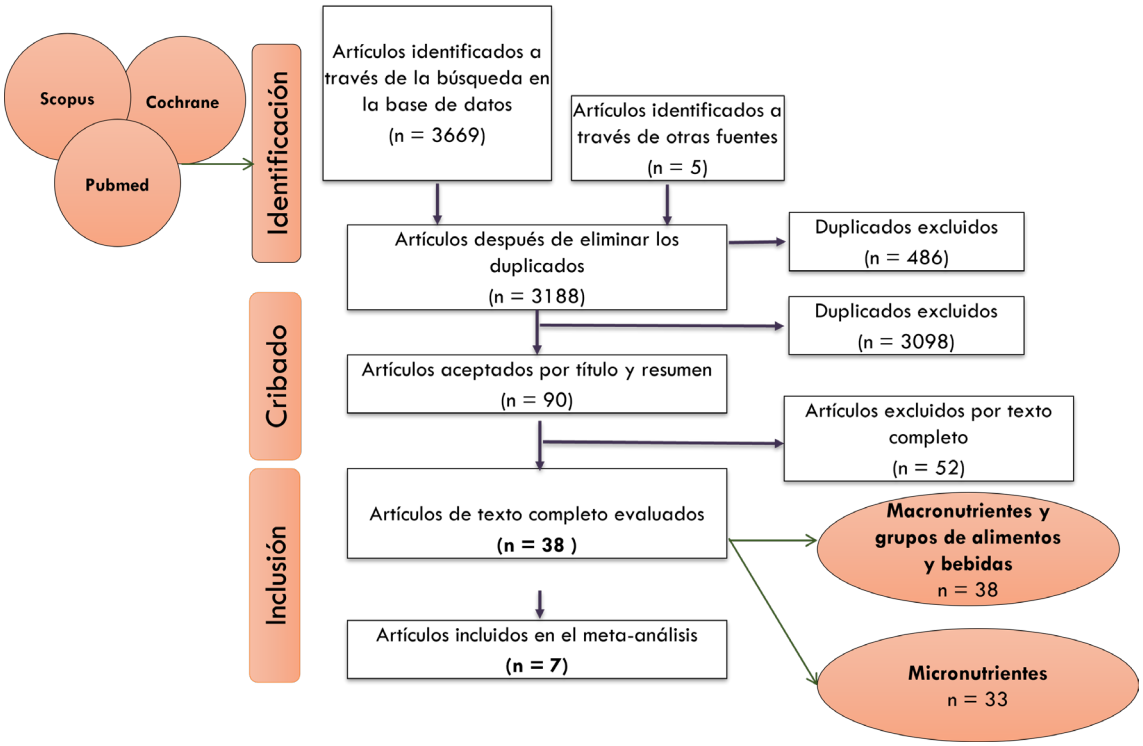


Figura 4. Diagrama de flujo del proceso de revisión de la literatura

EVALUACIÓN DE LA CALIDAD Y EL RIESGO DE SESGO

Se utilizó la herramienta de evaluación para estudios transversales (AXIS: The Appraisal tool for Cross-sectional Studies) para evaluar el riesgo de sesgo y la calidad metodológica de los estudios incluidos (100). Esta herramienta consta de un listado de 20 preguntas, que incluía el diseño del estudio, la población objetivo, el tamaño y la selección de la muestra, el marco muestral, la confiabilidad y la validez de las mediciones, metodología, cuestiones éticas y si existe o no conflicto de interés.

ESTUDIO FEEL4DIABETES

Developing and implementing a community-based intervention to promote behavioural changes and creating a more supportive social and physical environment to prevent diabetes in vulnerable families across Europe

MUESTRA Y DISEÑO DEL ESTUDIO (Artículo III)

El estudio Feel4Diabetes es un estudio de intervención realizado entre los años 2015 y 2019 y que tiene como objetivo promover un estilo saludable y abordar la obesidad y los factores de riesgo metabólico asociados para la prevención de la diabetes tipo 2, entre las familias de grupos vulnerables en seis países europeos (Bulgaria, Hungría, Bélgica, Finlandia, Grecia y España) (101, 102).

Los grupos vulnerables se definieron como: población general en los países de ingresos bajos/medios (Bulgaria y Hungría), familias de barrios de bajo nivel socioeconómico en países de ingresos altos (Bélgica y Finlandia) y los países de ingresos altos que estaban bajo medidas de austeridad durante la implementación del estudio (Grecia y España). En cada país se reclutó para el estudio a los niños de entre 5-12 años, así como a sus padres.

Los padres fueron contactados a través del colegio de sus hijos. Se envió una carta informativa sobre los objetivos e instrucciones del estudio y sobre cómo completar los cuestionarios. Los cuestionarios se entregaron a los padres a través del colegio y los padres y/o tutores los completaron en casa. Los investigadores estaban disponibles para responder a cualquier duda, tanto por correo electrónico como por teléfono. Además, también respondieron cuál de los padres y/o tutores rellenó el cuestionario.

Para el artículo V se han utilizado los datos obtenidos durante el estudio transversal llevado a cabo durante el curso académico 2015-2016. Además, sólo se utilizaron cuestionarios rellenados por madres, ya que representan la gran

mayoría (88.5%).

ASPECTOS ÉTICOS

El estudio Feel4Diabetes se realizó de acuerdo a la Declaración de Helsinki y a las convenciones del Consejo de Europa sobre derechos humanos y biomedicina y fue aprobado por cada uno de los comités de ética locales de los países participantes. Los participantes recibieron una carta informativa en la que se les informó sobre el propósito y desarrollo del estudio. Se obtuvo el consentimiento informado por escrito y firmado por los padres y/o tutores (101). En Aragón, se obtuvo el permiso para la realización de todas las medidas por parte del Comité de Ética de la Investigación de la Comunidad Autónoma de Aragón (CEICA).

MÉTODOS DE MEDIDA

Medidas antropométricas y exploración física

El IMC de los padres se calculó sobre la base de su peso y estatura auto reportados. En cambio, los niños fueron medidos en los colegios por investigadores capacitados. El peso se midió en ropa interior y sin zapatos utilizando una báscula electrónica (SECA 813; SECA, Hamburgo, Alemania), y la altura se midió con un estadiómetro telescópico de medición de la altura (SECA 217; SECA, Hamburgo, Alemania). Se realizaron dos mediciones de peso y altura y se utilizó la media para el análisis. Se realizó una tercera medición si las dos mediciones anteriores diferían >100g en el caso del peso o >1cm en el caso de la altura (103). El índice de masa corporal (IMC) se calculó a partir del peso y de la altura (kg/m^2), y también se calculó el IMC z-score (zBMI) específica por sexo y edad, de acuerdo con Cole et al (104).

Nivel socioeconómico

Para evaluar el nivel socioeconómico de las familias de los niños participantes, se utilizó la educación de la madre como indicador, que fue obtenida mediante un cuestionario autoadministrado completado por las familias. Esta cuestión fue preguntada en una escala de seis puntos que oscilaba desde “menos de 6 años” hasta “más de 16 años” de educación. Había seis posibles respuestas: 6 años o menos (educación infantil); 7-9 años (no he completado la educación primaria); 10-12 años (he completado la educación primaria); 13-14 años (no he completado la educación secundaria); 15-16años (he completado la educación secundaria); más de 16 años (bachillerato, formación profesional, formación universitaria,

formación de postgrado). Estas variables fueron agrupadas y se recategorizaron en dos grupos: ≤12 años de educación y >12 años de educación.

Consumo de desayuno y consumo de alimentos y bebidas en el momento del desayuno

Con el fin de evaluar los hábitos relacionados con la alimentación y actividad física (tiempo total dedicado a la actividad física y actividades de pantalla) se elaboró el cuestionario de conductas relacionadas con el balance energético familiar. Este cuestionario ha sido validado previamente para su uso en países europeos (105). El cuestionario fue completado por los padres y/o tutores con información tanto sobre ellos como sobre sus hijos

Consumo de desayuno

La frecuencia del consumo de desayuno, tanto de madres como de hijos, se evaluó a través de la pregunta "¿Cuántos días desayunas habitualmente tú/tu hijo (a) entre semana y (b) durante el fin de semana?". Para los días entre semana, había seis posibles respuestas que iban desde "nunca/raramente" hasta "cinco días a la semana". Para los días de fin de semana, había tres posibles respuestas que iban desde "nunca/raramente" hasta "dos días/semana". Estas variables fueron agrupadas y se recategorizaron en tres grupos: (a) no consumidores de desayuno (0-1 día/semana); (b) consumidores ocasionales de desayuno (2-5 días/semana) y (c) consumidores de desayuno (6-7 días/semana).

Consumo de alimentos y bebidas en el desayuno

La frecuencia del consumo de alimentos y bebidas en el momento del desayuno tanto de las madres como de sus hijos fue evaluado mediante la pregunta "Teniendo en cuenta la semana anterior, ¿con qué frecuencia consumieron usted y su hijo los siguientes grupos de alimentos/bebidas durante el desayuno?". Los alimentos/ bebidas de desayuno elegidos para el cuestionario estaban relacionados con los objetivos planteados para la intervención Feel4Diabetes. Se incluyeron ocho grupos de alimentos y bebidas: frutas, bayas y verduras, zumos de fruta natural sin azúcar, refrescos y zumos de frutas azucarados, leche o productos lácteos sin azúcar, leche o productos lácteos azucarados, pasteles dulces o salados, cereales bajos en fibra y cereales integrales. Cada grupo tenía cuatro posibles respuestas que iban desde "0 días/semana" hasta "7 días/semana". Estas variables se resumieron y categorizaron en tres grupos para cada grupo de alimentos y bebidas: (a)

nunca (0 días); (b) a veces (1-4 días /semana) y (c) siempre (5-7 días/semana).

Estudio HELENA
(Healthy Lifestyle in Europe by Nutrition in Adolescence)

MUESTRA Y DISEÑO DEL ESTUDIO (Artículos IV-V)

El estudio HELENA (Healthy Lifestyle in Europe by Nutrition in Adolecence) se trata de un estudio transversal multicéntrico realizado en el curso escolar 2006-2007 en 10 ciudades europeas: Atenas, Heraklion (Grecia), Dortmund (Alemania), Gante (Bélgica), Lille (Francia), Pecs (Hungría), Roma (Italia), Estocolmo (Suecia), Viena (Austria) y Zaragoza (España).

La muestra total de participantes es de 3528 adolescentes europeos con edades comprendidas entre 12.5 y 17.5 años.

Para que un sujeto se considerara válido debía: 1) No estar participando simultáneamente en otro estudio clínico; 2) No haber estado enfermo durante la semana anterior a la toma de medidas; 3) Tener medidas de peso y altura; 4) Haber completado al menos el 75% de las pruebas.

La metodología general del estudio así como los procedimientos desarrollados para su realización han sido descritos previamente (106).

De una muestra total de 3528 adolescentes, sólo se incluyeron aquellos adolescentes que tenían dos recordatorios dietéticos de 24h y tenían al menos el 75% del cuestionario de elecciones y preferencias alimentarias completado. En el artículo VI, la muestra es de 2027 adolescentes, en cambio la muestra del artículo V es de 1804, ya que en este artículo únicamente fueron incluidos aquellos adolescentes con datos disponibles sobre el consumo de desayuno, índice de calidad de la dieta (DQI) y score de dieta mediterránea (MDS).

ASPECTOS ÉTICOS

El estudio HELENA se realizó de acuerdo a las guías éticas de la Declaración de Helsinki (1975), y las guías éticas de su revisión de Edimburgo (2000) y también según la legislación de investigación epidemiológica de cada uno de los países

participantes (107). Todos los comités éticos locales de los centros donde se desarrolló el estudio aprobaron el protocolo y el desarrollo del estudio. En Aragón, se obtuvo el permiso para la realización del estudio del Comité de Ética de Investigación de la Comunidad Autónoma de Aragón (CEICA). Además, se recopilaron los consentimientos informados de los adolescentes participantes y de sus padres o tutores.

MÉTODOS DE MEDIDA

Medidas antropométricas y exploración física

Para la medida del peso y la altura, los adolescentes se encontraban en ropa interior y descalzos. El peso se midió con una báscula electrónica (SECA 861, Seca Ltd, Birmingham, UK) con una precisión de 100 gramos, rango 0-150 kg, y la altura con un estadiómetro (SECA 225, Seca Ltd), precisión 0.1 cm, rango 70-200 cm. Además, el IMC se calculó como peso en kilogramos dividido por la altura en metros al cuadrado (kg/m^2) (108). La definición de IMC por edad, de Cole et al. (104).

Nivel socioeconómico

Para evaluar el nivel socioeconómico de las familias de los adolescentes participantes, se utilizó la educación de la madre (Artículo IV) y una versión modificada de la escala de bienestar familiar: Family Afluence Scale (FAS) (Artículo V).

La educación de la madre fue categorizada en educación inferior, educación secundaria inferior, educación secundaria superior y educación superior o título universitario, basado en la información obtenida mediante un cuestionario completado por los adolescentes.

En relación al FAS, los adolescentes completaron un cuestionario en el que se les preguntaba por el número de coches y ordenadores que tenía la familia, si disponían de internet en casa o si los adolescentes tenían o no su propia habitación. El nivel socioeconómico oscilaba entre 0 (muy bajo nivel socioeconómico) y 8 (nivel socioeconómico muy alto). Estos se recategorizaron en tres grupos: una puntuación de 0 a 2 se clasificó como nivel socioeconómico bajo, 3-5 como nivel socioeconómico medio y 6-8 como nivel socioeconómico alto.

Ingesta dietética

Para valorar la ingesta de alimentos se utilizó un recordatorio de 24 horas mediante un programa informático desarrollado para el proyecto, HELENA-DIAT, basado en otro desarrollado previamente, llamado YANA-C (109-111). En

un período de dos semanas, los adolescentes, con el apoyo del equipo investigador, rellenaron en dos ocasiones este cuestionario, en días no consecutivos. Dietistas-nutricionistas entrenados ayudaron a los adolescentes a completar los recuerdos de 24 horas cuya calidad se verificó posteriormente. Los alimentos se agruparon de acuerdo a su composición nutricional en 31 grupos y se calculó el consumo habitual de cada uno de los grupos mediante el multiple source method (MSM), el cual tiene en cuenta la variación intra- e inter-individual. Por motivos logísticos, no se obtuvieron datos de Pécs (Hungría) y Heraklion (Grecia). Se valoró la ingesta de los alimentos mediante las tablas de composición alemanas (German Food Code and Nutrition Database) debido a que son las más completas a nivel europeo en cuanto a nutrientes y alimentos. La ingesta de energía se expresa como kilocalorías (Kcal) por día.

Preferencias de alimentación saludable (Artículo V)

El apartado sobre preferencias de alimentación saludable es parte del cuestionario FCP (Food Choices and Preferences), el cual investiga el grado de acuerdo/desacuerdo a una serie de declaraciones sobre las elecciones, comportamientos alimentarios, alimentación saludable y preferencias alimentarias.

Las frases seleccionadas que fueron respondidas por los participantes fueron las siguientes: 1) Creo que mi dieta es saludable; 2) El picoteo es una parte necesaria de una dieta saludable; 3) Disfruto comiendo frutas y verduras; 4) La comida que como en casa es saludable; 5) A menudo me salto el desayuno; 6) La mayoría de los alimentos de picoteo que como, son saludables; 7) Lo que como ahora tendrá un gran impacto en mi futura salud.

Las categorías de respuesta predefinida fueron: 1) Totalmente en desacuerdo; 2) Moderadamente en desacuerdo; 3) Levemente en desacuerdo; 4) Ni de acuerdo ni en desacuerdo; 5) Ligeramente de acuerdo; 6) Moderadamente de acuerdo; 7) Totalmente de acuerdo. Estas categorías se agruparon en tres grupos: 1) Muy, moderada y levemente en desacuerdo; 2) Ni de acuerdo ni en desacuerdo; y 3) Leve, moderada y totalmente de acuerdo.

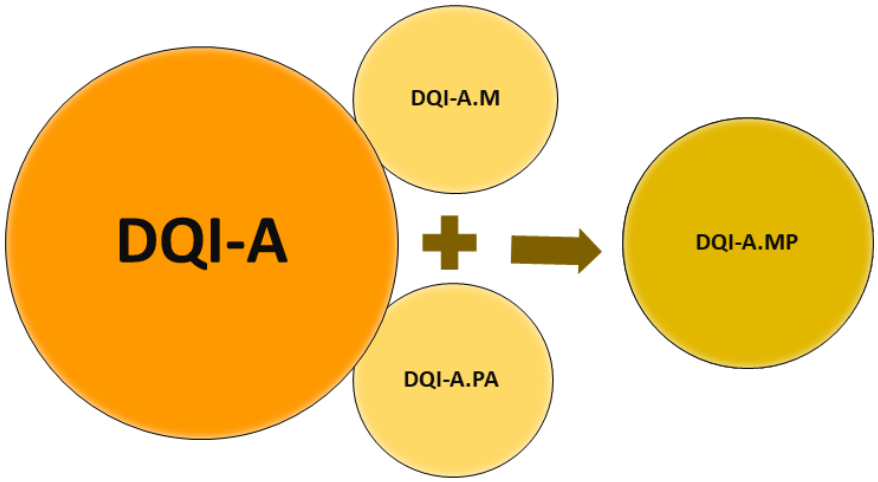
Además, los adolescentes informaron sobre su consumo de desayuno (Artículo V) respondiendo a la siguiente afirmación: “A menudo me salto el desayuno”, recogida en el cuestionario FCP (112). Las posibles respuestas fueron: 1) Totalmente en desacuerdo; 2) Moderadamente en desacuerdo; 3) Levemente en desacuerdo; 4) Ni de acuerdo ni en desacuerdo; 5) Ligeramente de acuerdo; 6) Moderadamente de acuerdo; 7) Totalmente de acuerdo. Estas categorías fueron recategorizadas en tres grupos: a) Consumidores de desayuno (respuestas 1-2); b) consumidores ocasionales de desayuno (respuestas 3-5) y c) no consumidores de desayuno (respuestas 6-7) (113).

Índice de calidad de la dieta (DQI) (Artículo IV)

Un DQI previamente validado, desarrollado originalmente para niños en edad preescolar, para medir su cumplimiento de las pautas dietéticas basadas en alimentos (Flemish food-based dietary guidelines; FBDG), fue adaptado para su uso en adolescentes (DQI-A) (114). El DQI-A consta de tres componentes: calidad, diversidad y equilibrio. Se ha utilizado una versión actualizada del DQI-A que está compuesta por la calidad, diversidad y equilibrio y además, el índice de comida y actividad física (115-117).

La *calidad de la dieta* expresa si el adolescente eligió la calidad óptima de los alimentos dentro de un grupo de alimentos; la *diversidad dietética* expresa el grado de variación de la dieta; el *equilibrio dietético* se calcula a partir de la diferencia entre el componente de adecuación y el componente de exceso (115). El DQI-A fue calculado teniendo en cuenta la calidad, diversidad y el equilibrio de la dieta.

Además, la subsección del Índice de calidad de la dieta que evalúa el número de comidas DQI-A (DQI-A.M) se calculó a partir de las variables de frecuencia de desayuno, almuerzo y cena, que representan el número de días por semana que los adolescentes consumieron estas comidas (116). Por otro lado, la subsección del Índice de calidad de la dieta que evalúa la actividad física DQI-A (DQI-A.PA) se calculó a partir del cuestionario internacional de actividad física para adolescentes y mostraba si los participantes tenían una actividad física baja, moderada, alta o intensa (117). Se calcularon diferentes índices de calidad de la dieta (Figura 5), siendo la única diferencia entre ellos la inclusión o no del DQI-A.M y del DQI-A.PA. DQI-A.M incluye únicamente el índice de comidas, DQI-A.PA incluye únicamente el índice de actividad física y la subsección del Índice de calidad de la dieta que evalúa el número de comidas y la actividad física (DQI-A.MP) incluye ambos, los índices de comida y de actividad física.



DQI-A: DQI adaptado para adolescentes; DQI-A.M: DQI-A que evalúa el número de comidas; DQI-A.PA: DQI-A que evalúa la actividad física; DQI-A.MP: incluye los índices de comida y de actividad física.

Figura 5. Índice de Calidad de la Dieta y subsecciones.

Índice de dieta mediterránea - Mediterranean Diet Score (MDS) (Artículo V)

El índice de dieta mediterránea consta de nueve componentes individuales y una escala que indica el grado de adherencia a la dieta mediterránea tradicional (118). Se calculó y se validó una versión adaptada para adolescentes del índice de dieta mediterránea desarrollada en adultos (119). Se incluyeron siete componentes positivos (frutas, verduras, legumbres, cereales, pescado y marisco, relación grasas monoinsaturadas/ saturadas y productos lácteos) y un componente negativo (carne). El consumo de alcohol no fue considerado puesto que nuestra investigación está enfocada a población adolescente.

ANÁLISIS ESTADÍSTICOS

En los artículos I y II se realizó un meta-análisis con el programa estadístico Open Meta (Analyst). Con los datos obtenidos, en el artículo I, se realizó un meta-análisis de consumo de energía y macronutrientes; sin embargo, no fue posible realizar un meta-análisis para el consumo de alimentos y bebidas debido al número limitado de estudios que proporcionaron resultados que permitieron dicho análisis. Así mismo, se realizó un meta-análisis de consumo de vitaminas y minerales en el artículo II.

En ambos artículos (I y II) se evaluaron dos grupos de comparación, saltarse el desayuno versus desayuno a base de cereales y saltarse el desayuno versus otros tipos de desayuno. Para los datos continuos (energía, macro- y micronutrientes) en kilocalorías (Kcal), gramos (g), miligramos (mg) o microgramos (µg), que comparan el saltarse el desayuno, el desayuno a base de cereales y otros tipos de desayuno, se utilizó la diferencia de medias (DM) con intervalos de confianza del 95 % (IC del 95 %). Se aplicaron estimadores de DerSimonian y Laird utilizando modelos de efectos aleatorios para datos continuos. Se calcularon los tamaños del efecto para cada resultado.

Las fuentes de heterogeneidad se investigaron mediante análisis que compararon los resultados según el tipo de desayuno (saltar desayuno, desayuno a base de cereales y otros tipos de desayuno) cuando la información estaba disponible. La heterogeneidad de los estudios se probó mediante el I^2 estadístico, que describe la varianza entre estudios como una proporción de la varianza total(120). Un valor de <25 % indica heterogeneidad baja, un valor de >50 % a 75 % indica heterogeneidad alta y un valor de >75 % indica heterogeneidad muy alta. También se calculó el valor de *p* asociado de la heterogeneidad de los estudios, con un resultado no significativo que indica ausencia de heterogeneidad.

Para el resto de los artículos, el análisis de datos se utilizó el programa estadístico “The Predictive Analytics Software” (SPSS).

Las características generales y demográficas de los participantes se presentan en forma de porcentajes en el caso de las variables categóricas y como media e intervalo de confianza del 95% (IC 95%) para las variables continuas.

De acuerdo con la naturaleza de las variables estudiadas, se utilizó la prueba de Chi-cuadrado para las variables categóricas y el análisis de varianza (ANOVA)

para las variables continuas, para comparar las características específicas de la muestra por género.

El análisis de covarianza (ANCOVA) junto con el test de Bonferroni se utilizó para analizar el consumo de alimentos y bebidas de aquellas madres y sus hijos que desayunan de forma ocasional o habitual (artículo III). Se ajustó por país, educación e IMC materno (en el caso de las madres) y el zBMI (en el caso del niño). En el artículo IV se utilizó ajustado por edad, educación materna, IMC, país y consumo total de energía para comparar la frecuencia de desayuno y las puntuaciones medias de DQI-A y MDS. En el artículo V se utilizó ajustado por edad, nivel socioeconómico, IMC e ingesta energética, para comparar los patrones dietéticos y las percepciones de alimentación saludable

En el artículo III, se utilizaron tablas de contingencia, incluyendo la prueba de Chi-cuadrado para analizar la rutina de desayuno y la frecuencia del consumo de grupos de alimentos y bebidas entre madres e hijos.

En el artículo IV se utilizaron modelos de regresión lineal mixtos para examinar la relación entre el consumo de desayuno y los índices calculados (DQI y MDS), incluyendo como covariables la edad, la educación materna, IMC, país y la ingesta total de energía. Los valores se presentan como valores de β ajustados (coeficientes de regresión no estandarizados estimados) e IC 95%. Se consideró como grupo de referencia al grupo de adolescentes que se saltan el desayuno.

En el artículo V se realizó un análisis de componentes principales (PCA) con rotación varimax para obtener los patrones dietéticos de la muestra. Se trata de una técnica que se utiliza a menudo en la reducción de datos para identificar un pequeño número de factores que explican la mayor parte de la varianza observada en un número mucho mayor de variables mediante la definición de conjuntos altamente interrelacionados. Cada patrón dietético obtenido representa una combinación lineal de todos los grupos de alimentos, que se ponderan por su carga factorial (aquellos con un valor absoluto de >0.3 se consideraron contribuyentes importantes para cada patrón dietético). Se utilizaron los siguientes criterios al decidir el número de componentes a retener: valor propio >1, gráfico de sedimentación (presentación gráfica de los valores propios) y la interpretabilidad de cada componente.

En todos los artículos un nivel de significación igual o menor de 0.05 se consideró estadísticamente significativo.

En cada uno de los artículos que componen la presente Tesis Doctoral aparece la información detallada sobre cada uno de los análisis estadísticos empleados en cada uno de ellos.

RESULTADOS

RESULTS

Los resultados de la presente Tesis Doctoral se presentan en los siguientes artículos científicos.

The results of this Doctoral Thesis are presented in the following research manuscripts.

MANUSCRIPT I

Breakfast Characteristics and Their Association with Energy, Macronutrients, and Food Intake in Children and Adolescents: A Systematic Review and Meta-Analysis.

nutrients

MDPI

Review

Breakfast Characteristics and Their Association with Energy, Macronutrients, and Food Intake in Children and Adolescents: A Systematic Review and Meta-Analysis

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Abstract: Breakfast plays an important role in health because it has been associated with overall health, which includes a high daily nutrient intake and a low risk of chronic diseases. For this reason, we investigated the associations between breakfast consumption and daily energy, macronutrients, and food and beverage consumption. We systematically searched peer-reviewed articles in three datasets (Pubmed, Scopus, and Cochrane). Two independent reviewers evaluated 3188 studies against the inclusion criteria using the Appraisal tool for Cross-Sectional Studies (AXIS) critical appraisal and Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodologies. The meta-analysis was performed by comparing results based on type of breakfast consumed (ready to eat cereal breakfasts or other types of breakfasts). Ultimately, 38 studies were included in the review and 7 of them in the energy and macronutrients intake meta-analysis. In the Systematic Review, breakfast consumers had higher energy intake (EI), fibre intake, and higher consumption of fruits and vegetables and lower consumption of soft drinks than breakfast skippers. In the Meta-Analysis, breakfast consumers had a higher carbohydrates intake (MD, −8.21; 95%CI: −11.37, −5.05) and fibre intake (MD, −8.43; 95%CI: −12.63, −4.23) than breakfast skippers. However, breakfast consumers had a lower fat intake (MD, 4.59; 95%CI: 2.04, 7.15). Our review suggests that breakfast consumption is associated with better macronutrient intake and healthier food and beverage consumption.

Keywords: breakfast; energy; macronutrient; food consumption; beverages consumption

1. Introduction

Traditionally, breakfast has been identified as the "most important meal of the day" and is considered an important component of a healthy diet [1,2]. However, breakfast is the most often missed meal by children and adolescents [3]. Currently, there is no consensus about a definition of breakfast [1] that takes into consideration the time of consumption, its energy content, or the included foods and beverages. For instance, in a previous review, breakfast was defined as "the first meal of the

day that breaks the fasting status after the longest period of sleep, it is consumed within 2 to 3 h of waking; and it is comprised of food or beverage from at least one food group, and may be consumed at any location" [1,4]. Breakfast consumption has developed along time depending on culture, eating habits, and food availability [5]. Also, different breakfast dietary habits are adopted across the world. For example, in Mexico, most children may have tortillas and beans for breakfast [6], whereas in the United States (US), Ready To Eat Cereals (RTEC) are the most prevalent children's breakfast foods [7].

Breakfast has been associated with overall health, which includes a high daily nutrient adequacy [8] and a low risk for chronic diseases (type 2 diabetes, cardiovascular diseases, etc.) [9,10]. Optimal total energy intake (EI) distribution throughout the day is still in debate; nevertheless, some authors indicate that in school-age children, breakfast should provide 20% of total daily EI [11,12]. In the study of Faci et al. [12], in which children were compared according to consuming less or more than 20% of total calories at breakfast, they observed that children who consumed more than 20% of total calories at breakfast had a better total macronutrient distribution, which is in concordance with international recommendations, including a good distribution of macronutrients (55–75% of carbohydrate, 15–30% of fat, and 10–15% of protein) [13].

Some studies have reported associations between skipping breakfast and adiposity in children [14–17]. For instance, in European adolescents, those who are used to regularly consuming breakfast had a low body fat percentage and healthy cardiovascular profile as compared with those who skipped breakfast, especially in males [18]. Breakfast composition has also been analyzed by several authors, including dairy products, the most frequently consumed food at breakfast by children and adolescents [19,20]. In a previous study, authors also suggested that characteristics of a healthy dietary pattern (DP) includes the regular consumption of fruits at breakfast [21]. However, only around 3% of children and adolescents are used to consuming fruits at breakfast [19]. Skipping breakfast has also been linked with several reduced cognitive functions [19,22], such as academic learning achievement in children, due to learning difficulties in literacy and mathematics [23].

The purpose of this review is to investigate the associations between frequency and characteristics of breakfast consumption and its relation to daily diet composition in terms of energy, macronutrients, and food and beverage consumption.

2. Methodology

2.1. Protocol

The systematic review (SR) and meta-analysis were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [24]. The SR protocol was published in "Prospero" CRD42018078112. A specific question was constructed according to the PICO (Participants, Interventions, Control, Outcomes) principle (Table 1) [25]. Systematic Review Registration: PROSPERO registration no. CRD42018078112.

Table 1. PICOS (Participants, Interventions, Control, Outcomes) criteria used for the inclusion and exclusion of studies.

PICOS	Inclusion Criteria	Exclusion Criteria
Participants	Children and adolescents older than 2 and younger than 18 years; both sexes; all nationalities	Children younger than 2 years and adults older than 18 years. Participants with any reported or known illness.
Interventions	Breakfast consumers (RTEC (Ready To Eat Cereals), other types of breakfast)	Not having breakfast data
Control/Comparator group	Breakfast skippers	Not having breakfast data
Outcome	Total daily intake of energy, macronutrients, and foods and beverages.	Other outcomes not related with breakfast consumption

2.2. Search Strategy

A systematic and comprehensive search of the literature was performed in February 2020. The search was limited to human studies, published in English and Spanish.

The following search terms were used during the systematic searching of databases Pubmed, Scopus, and Cochrane: ("Breakfast"(Mesh) OR "Breakfast"(tiab)) AND ("Food"(Mesh) OR "Beverages"(Mesh) OR "Diet, Food and Nutrition"(Mesh) OR "Diet"(Mesh) OR "Eating"(Mesh) OR "Feeding Behavior"(Mesh) OR "Nutritional Requirements"(Mesh) OR "Nutritional Status"(Mesh) OR "Nutritive Value"(Mesh) OR "breakfast skipping" (tiab) OR "meal Skipping"(tiab) OR "Fasting" (Mesh) OR "Food preferences"(Mesh) OR "Diet therapy"(Mesh) OR "Energy Intake"(Mesh) OR "nutrient"(Mesh)) AND ("Child, Preschool"(Mesh) OR "Child"(Mesh) OR "Adolescent"(Mesh) OR "breakfast skipping" OR "meal skipping").

2.3. Selection Criteria

To be included in this review, each article was required to meet the following criteria: (1) original research paper, (2) participants had to be male and/or female children and/or adolescents older than 2 and younger than 18 years, taking into consideration the years of follow up, (3) an assessment of breakfast had to have been performed, (4) the study design had to be one of the following: cross-sectional study, longitudinal study, or a case control study. Articles were excluded if they did not meet the previous inclusion criteria and if they met any of the following criteria: (1) the study design was one of the following: randomized control trials, clinical trials, case reports, intervention studies, opinion articles, reviews, SR, or meta-analysis, (2) participants with any reported or known illness.

All studies were compiled into an online citation manager (EndNote® Online).

2.4. Systematic Review Process, Data Extraction, and Synthesis

Titles and abstracts were assessed for complete retrieval. Full text articles were assessed considering the inclusion and exclusion criteria by two independent reviewers (NGL and PFB). Information extracted included author, year of publication, country and year of study, study design, aim, sample size, characteristics of participants, data source, breakfast method of assessment, principal outcome on energy, macronutrients, and/or food and beverage consumption. After the initial data extraction, the information was verified by a second reviewer. In cases of disagreement, consensus was reached with the help of a third reviewer. According to the outcome found, the studies were classified into two groups: macronutrients and foods and beverages. The search process results are highlighted as a flow diagram in Figure 1.

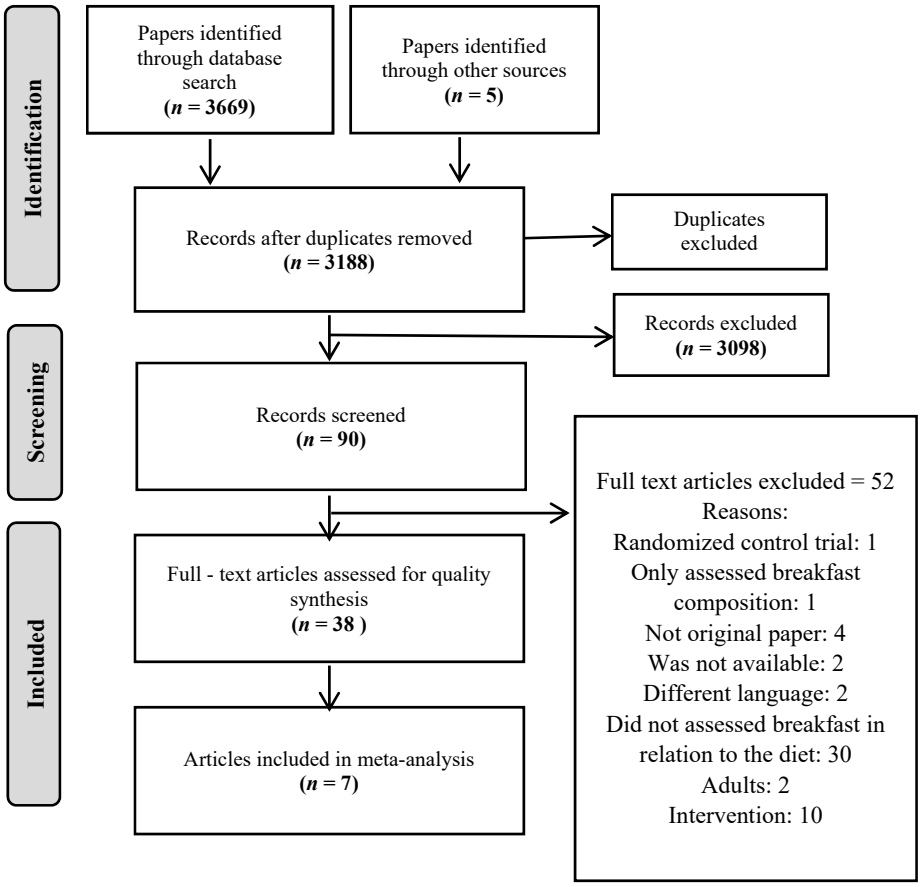

Figure 1. Flow diagram of the literature search process.

2.5. *Quality and Risk of Bias Assessment*

Quality assessment of the individual studies was performed by two independent reviewers (NGL, PFB), using the Appraisal tool for Cross-Sectional Studies (AXIS tool), as presented in Table 2, which summarized the results of the included studies.

The Axis tool is a validated quality appraisal tool that evaluates the methodological quality and risk of bias of cross-sectional studies for systematic reviews using 20 criteria [26] (Table S1). The AXIS tool does not provide an aggregated score on quality due to the fact that certain unfulfilled criteria may compromise quality to a greater or lesser extent in different articles [26]. The general and overall quality of studies is left at the discretion of the author to make rationale judgements.

Table 2. Appraisal Tool for Cross-Sectional Studies (AXIS).

Assessment Criteria	No. of Satisfactory Studies
1. Were the aims/objectives of the study clear?	38
2. Was the study design appropriate for the stated aim(s)?	38
3. Was the sample size justified?	23
4. Was the target/reference population clearly defined? (Is it clear who the research was about?)	38
5. Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?	29
6. Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?	26
7. Were the measures undertaken to address and categorise non-responders?	1
8. Were the risk factor and outcome variables measured appropriate to the aims of the study?	36
9. Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialled, piloted, or published previously?	16
10. Is it clear what was used to determine statistical significance and/or precision estimates? (e.g., P values, Cis)	38
11. Were the methods (including statistical methods) sufficiently described to enable them to be repeated?	38
12. Were the basic data adequately described?	29
13. Does the response rate raise concerns about non-response bias?	1
14. If appropriate, was information about non-responders described?	0
15. Were the results internally consistent?	38
16. Were the results for the analyses described in the methods presented?	37
17. Were the authors´ discussions and conclusions justified by the results?	38
18. Were the limitations of the study discussed?	25
19. Were there any funding sources or conflicts of interest that may affect the authors´ interpretation of the results?	22
20. Was ethical approval or consent of participants attained?	32

2.6. Statistical Analyses

With the data obtained, meta-analysis for energy and macronutrients intake was carried out; however, meta-analysis for food and beverage consumption was not possible due to the limited number of studies providing results allowing such an analysis. Two comparison groups were assessed, skip breakfast versus RTEC breakfast and skip breakfast versus other types of breakfast. For continuous data (EI and macronutrients) in kilocalories (Kcal) or grams (g) comparing skip breakfast, RTEC breakfast, and other types of breakfast, the mean difference (MD) with 95% confidence intervals (95%CI) was used. DerSimonian and Laird estimators using random effects models were applied for continuous data. Effect sizes were calculated for each outcome.

Sources of heterogeneity were investigated by analyses comparing results based on type of breakfast (skip breakfast, RTEC breakfast, and others type of breakfast) when information was available. All analyses were performed using Open Meta (Analyst) software.

The heterogeneity of the studies was tested using the I^2 statistic, which describes the variance among studies as a proportion of the total variance [27]. A value of <25% indicates low heterogeneity, a value of >50% to 75% indicates high heterogeneity, and a value of >75% indicates very high heterogeneity. The associated p value of the heterogeneity of the studies was also calculated, with a non-significant result indicating absence of heterogeneity.

3. Results

3.1. Literature Search and Screening

Figure 1 shows the study selection process. In total, 3674 potentially eligible articles were identified: 2544 from PubMed, 620 from Scopus, 505 from Cochrane, and 5 were identified through other sources.

Out of 3674 potentially eligible articles, 3188 were obtained after removing duplicates. Finally, 38 full-text articles were included in the SR and 7 of them were considered for meta-analysis (Figure 1).

3.2. Study Design Characteristics

From the included studies, 65.8% (n = 25) were related to macronutrients intake, 10.5% (n = 4) to specific foods and food or beverage groups, and 23.7% (n = 9) included information on macronutrients and food or beverage consumption. All the included studies were published in English and Spanish. Most of the included studies were cross-sectional (92.1%, n = 35) and only 3 of them were longitudinal (7.9%).

Table 3 shows detailed information of the included studies, which showed the impact of breakfast on energy, specific macronutrients, and food or beverage groups intake in the daily diet. The included studies were conducted between 1977 and 2015. From all articles, 16 were carried out in Europe (combined European countries [28–30], United Kingdom [31–35], Spain [12,36,37], Greece [38], Ireland [39], Belgium [40], Cyprus [28], France [41], and Norway [42]), 15 in America (US [7,43–52], México [6], and Canada [22,53,54]), 3 in Oceania (Australia [55–57]), and 4 in Asia (Iran [58], Malaysia [59], China [60], and Japan [61]). Data came from three sources: 55.3% (n = 21) of them were data from National Health Surveys [6,7,22,31,33,34,42–45,47,48,50–57,61], 36.8% (n = 14) were original studies [12,32,35–41,46,49,58–60], and 7.9% (n = 3) were European multicenter studies [28–30]. Of the selected articles, 34.2% (n = 13) included data from children [6,7,28,33,35–37,45,46,49–51,59], 21.1% (n = 8) from adolescents [12,29,30,38–40,42,60], and 44.7% (n = 17) from both age groups [22,31,34,36,37,41,43,44,48,52–58,61]. The questionnaires were fulfilled depending on the age of participants. The person who fulfilled the questionnaires depended on the age of participants. The most common type of questionnaire was self-reported (n = 14; 36.9%). Meanwhile, 11 studies used a questionnaire collected by an interviewer (28.9%), 4 studies used a caregiver-reported questionnaire (10.5%), and 9 of them (23.7%) used the combination of a self-reported questionnaire and a caregiver-reported questionnaire.

Table 3. Characteristics, description, and summary of outcomes of studies included in the system review on breakfast and energy, macronutrients, and food intake.

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Affenito, S. et al. 2005 [43]	United States, N.A. Longitudinal	To examine the association between BF frequency and Calcium and fiber intake	n = 2379 Girls. 9–19 years	National Heart, Lung, and Blood Institute Growth and Health Study 3 days-FR	Frequent BF was associated with more intake of fiber, regardless of the total amount of energy consumed ($p < 0.001$).	N.A.
Affenito S. et al. 2013 [44]	United States, 2004–2005 Cross-sectional	To examine the association of RTEC consumption and dietary nutrient intake.	n = 2298 5–18 years	The third School Nutrition Dietary Assessment Study 1 day—24 h-DR	Non-RTEC consumers consumed more protein, sugars, and cholesterol than BF skippers. BF skippers consumed more total fat and SFA than the other groups. BF consumption improves intake of fiber ($p < 0.05$).	Students who were eating RTEC BF had a higher consumption of whole grains ($p < 0.05$) than students who ate non-RTEC BF. The diet of children and adolescents who consumed BF, with or without RTEC, was higher in whole grains ($p < 0.05$).
Afeiche, M. et al. 2017 [6]	Mexico, 2012 Cross-sectional	To compare BF dietary patterns with BF skipping and the associations with total-day diet energy and nutrient intake	n = 3760 4–13 years	Mexican National Health and Nutrition Survey 1 day—24 h-DR	BF skippers consumed less total energy, carbohydrates, fat, protein, and added sugars than BF consumers. Sandwiches and quesadillas BF pattern was associated with higher daily EI than the other dietary patterns. The lowest intake at BF and for the total day were the sweetened beverages BF dietary pattern. The sweetened beverages and milk and sweetened breads dietary patterns had the highest intakes of added sugars and lowest intakes of fiber at BF.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Albertson A. et al. 2003 [7]	United States, 1998–1999 Cross-sectional	To assess the relationship between RTEC frequency and nutrient intake in children	n = 603 4–12 years	American households survey 14 days—FR	RTEC frequency of consumption was not related to energy, carbohydrates, sugar, SFA, and protein. Lowest intake of fat and cholesterol were found on the highest tertile of RTEC consumption ($p < 0.001$).	N.A.
Albertson A. et al. 2008 [45]	United States, 1987 Longitudinal	To assess the association between RTEC consumption and energy and nutrient intake	n = 2379 9–10 years	The National Heart, Lung, and Blood Institute Growth Health Study 1 day—24 h-DR	RTEC consumption was associated with lower intake of fat ($p < 0.001$) and higher intake of fiber and carbohydrates compared to non-RTEC consumption ($p < 0.05$). RTEC consumers did not differ from non-RTEC consumers in sugar and protein intake (N.S).	Girls are 5.6 times more likely to consume milk when they have BF RTEC, (OR, 5.6; 95%CI 5.2–6.1). Girls are 2.4 more likely to consume sugars and sweets in BF that do not include RTEC, (OR, 0.41; 95%CI, 0.39–0.43). Girls who eat non-RTEC BF consume more rolls and buns (OR, 0.44; 95%CI, 0.41–0.48); soda (OR, 0.68; 95%CI, 0.63–0.74); and meat and eggs (OR, 0.24; 95%CI, 0.22–0.26). Fruit consumption was lower during RTEC BF than non-RTEC BF (OR, 0.70; 95%CI, 0.66–0.74).

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Balvin Frantzen, L. et al. 2013 [46]	United States 2001–2004 Longitudinal	To assess the association between frequency of RTEC consumption and nutrient intakes	n = 625 Mean age = 9.13 years	BIENESTAR Study 3 days—24 h-DR	Significant associations between frequency of RTEC consumption and total EI, carbohydrate, fat, and saturated fat and dietary fiber intake were not observed in the baseline data analysis. There was a significant decrease in cholesterol intake with increased days of RTEC consumption ($p < 0.05$).	N.A.
Barr, S. et al. 2014 [53]	Canada 2004 Cross-sectional	To assess the effect of skipping BF, consuming BF, and consuming BF with RTEC on intake of nutrients	n = 12281 4–18 years	Canadian Community Health Survey, 2004. 1 day—24 h-DR	RTEC consumers had a higher intake of carbohydrates and fiber than other-BF consumers and non-BF consumers. RTEC consumers had a lower intake of total fat than other-BF consumers and BF skippers. RTEC consumers had lower intakes of PUFA and cholesterol and a higher intake of sugars compared with non-RTEC consumers and BF skippers.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Barr, SI. et al. 2018 [22]	Canada 2015 Cross-sectional	To compare daily energy and nutrient intakes of BF consumers and BF skippers.	n = 2331 6–12 years n = 2026 13–17 years	Canadian Community Health Survey-Nutrition 1 day—24 h-DR	In children, BF consumers had a higher intake of carbohydrates and fat than skippers ($p < 0.001$). In adolescents, BF consumer had a higher EI than skippers ($p < 0.001$). In both groups, children and adolescents, BF skippers had a lower fiber intake than BF consumers.	N.A.
Barton, B. et al. 2005 [47]	United States 1985 Cross-sectional	To assess the association of BF and RTEC consumption with intake of nutrients.	n = 2379 9–19 years	National Heart, Lung, and Blood Institute Growth and Health study 3 days—24 h-DR	RTEC consumption increases the intake of fiber. On RTEC consumption days, fiber intake was significantly higher than non-RTEC consumption days ($p < 0.001$). On RTEC consumption days, total fat and cholesterol intakes were significantly lower than non-RTEC consumption days ($p < 0.001$).	N.A.
Coulthard, J. et al. 2017 [31]	United Kingdom 2008–2012 Cross-sectional	To assess differences in nutrients intake between BF skippers and BF consumers.	n = 1686 4–18 years	National Diet and Nutrition Survey 4 days—FR	The mean intake of energy and carbohydrate increases significantly with an increasing number of BF days ($p < 0.001$). The mean of fat intake decreases significantly with an increasing number of BF days ($p = 0.005$). In BF days, significantly higher mean intakes of energy and carbohydrate and significantly lower mean intakes of protein was observed compared with non-BF days.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Deshmukh-Taskar, P. et al. 2010 [48]	United States, 1999–2006 Cross-sectional	To assess the relationship between skipping BF or having lunch with nutrient intake, nutrient adequacy, and adiposity.	*n* = 930 9–13 years *n* = 1805 14–18 years	National Health and Nutrition Examination Survey 1 day—24 h-DR	In children and adolescents, EI was higher in BF consumers than in BF skippers. Carbohydrate and sugar intake was higher in RTEC consumers than in BF skippers and other-BF consumers. BF skippers had a higher intake of added sugars than the other groups. RTEC consumers had lower fat (mono and polyunsaturated) intake than the other groups. Protein intake was not different across the children groups, but in the group of adolescents, it was significantly lower in the group of skippers. Children who consumed RTEC at BF had a lower intake of added sugars than BF skippers, but higher than other-BF consumers. Adolescents who skipped BF had a higher SFA consumption than RTEC and other-BF consumers.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Faci, M. et al. 2001 [12]	Spain, N.A. Cross-sectional	To study the relationship between BF and overall dietary habits in school children	n = 152 11–13 years	5 days—24 h-DR	60% of adolescents consumed a BF that provided less than 20% of total daily EI and thereby were low-quality BF consumers. Total EI was high in the group of adolescents that consumed at least 20% of total EI at BF. Adolescents that consumed a BF with 20% or more of the total EI presented a better caloric profile and a lower intake of proteins and lipids and a higher intake of carbohydrates ($p <$ 0.05).	Children who consumed a more balanced BF also had better overall dietary habits: higher intake of RTEC (172.0 ± 62.7 vs. 206.6 ± 88.9) and higher intake of dairy products (357.7 ± 174.0 vs. 449.4 ± 192.4) ($p < 0.01$). No significant differences were observed in eggs, sugar, fats and oils, vegetables, legumes, fruits, fish, beverages, alcohol, and precooked food.
Fayet-Moore, F. et al. 2016 [55]	Australia, 2007 Cross-sectional	To assess the impact of BF skipping, BF with RTEC, and BF without RTEC on nutrient intake.	n = 4487 2–16 years	Australian National Children's Nutrition and Physical Activity Survey 2 days—24 h-DR	Total fat intake was lower in BF consumers than in skippers. RTEC consumers also had higher intakes of carbohydrates, total sugars, and fiber ($p < 0.001$). BF consumers and to a higher degree, RTEC consumers, were more likely to meet the EAR of fiber than BF skippers ($p < 0.001$).	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Fayet-Moore, F. et al. 2017 [56]	Australia, 2011–2012 Cross-sectional	To investigate the impact of BF skipping, BF with RTEC, and BF without RTEC on daily nutrient intake.	n = 2821 2–18 years	National Nutrition and Physical Activity Survey 1 day—24 h-DR	BF skippers had lower daily energy, carbohydrate, and fiber intake, whereas higher total fat, SFA, added sugar, and free sugar intake than BF consumers ($p < 0.001$). RTEC consumers had a higher sugar intake than non-RTEC consumers ($p < 0.001$).	N.A.
Fulgoni, VL. et al. 2019 [52]	United States 2011–2014 Cross sectional	To compare diet quality and nutrient intake among children consuming an oatmeal-containing BF versus those of children consuming other popular BF	n = 5876 2–18 years	NHANES 1–24 h dietary recall	Children and adolescents who consumed an oatmeal BF had a significantly higher intake of energy, protein, and fibre than BF skippers. Oatmeal consumers had higher intake fibre than consumers of "Doughnuts, sweets rolls and pastries", "Eggs and omelettes", and "RTEC, higher sugar"	Children and adolescents who consumed an oatmeal BF had a significantly higher consumption of dairy products, whole grain, and fruits than BF skippers. BF skippers had a significantly higher consumption of refined grains. Oatmeal consumers had higher consumption of whole grains than other types of BF.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Gibson, S. et al. 1995 [32]	United Kingdom N.A. Cross-sectional	To examine the relationship between RTEC frequency of consumption and total daily nutrient intake.	n = 2705 10–15 years	7 days—day weighed records	For both boys and girls, frequency of RTEC consumption was positively associated with energy and carbohydrates intake and negatively associated with energy from fat intake ($p < 0.05$).	N.A.
Gibson, S. et al. 1999 [33]	United Kingdom, N.A. Cross-sectional	To examine associations between RTEC consumption and iron intake.	n = 904 1.5–4.5 years	UK National Diet and Nutrition Survey 4 days—day weighed records	Low RTEC consumers had significantly higher EI than high RTEC consumers ($p < 0.0001$).	N.A.
Gibson, S. et al. 2003 [34]	United Kingdom N.A. Cross-sectional	To examine the impact of RTEC on micronutrient status.	n = 1688 4–18 years	The National Diet and Nutrition Survey of Young People 7 days—24 h-DR	In both boys and girls, higher consumers of RTEC had significantly lower fat intake than moderate and low consumers of RTEC. In girls, lower consumers of RTEC had significantly lower protein, carbohydrate, and total sugars intake than moderate and higher consumers of RTEC. Moderate consumers of RTEC had significantly higher EI than lower consumers of RTEC. In boys, moderate RTEC consumers had a significantly higher EI than higher RTEC consumers. Moderate RTEC consumers had a significantly higher carbohydrate intake than lower consumers of RTEC.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Gikas, A. et al. 2003 [38]	Greece, 2000 Cross-sectional	To determine the prevalence of BF skipping in adolescents and assess the possible association with other unhealthy habits	n = 513 15–18 years	1 day—FFQ	N.A.	The % of adolescents consuming fruit and vegetables/salads daily was considerably higher among BF eaters compared with BF skippers (27.9% vs. 16.0%) (p = 0.017). BF eaters reported more frequent consumption of legumes (39.0% vs. 32.0%) (p = 0.044) and fish (27.9% vs. 24.5%) (p = 0.001). BF skippers consume meat more often (2.5% vs. 8.6%) (p = 0.002) and surpass BF eaters in the consumption of alcohol (3.0% vs. 12.6%) (p = 0.000) and soft drinks (19.9% vs. 34.4%) (p = 0.002).

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Matthys, C. et al. 2007 [40]	Belgium, 1997 Cross-sectional	To describe BF consumption patterns and overall nutrient profiles	n = 341 13–18 years	Food Consumption Survey 7 days—24 h-DR	In boys, there were no significant differences in the total energy, protein, carbohydrate, and fat intake between the two kinds of BF consumers. Girls with good quality BF had a significantly higher intake of energy and protein ($p < 0.001$) and had a significantly lower intake of fats ($p < 0.05$).	Good quality BF consumers had higher intakes of bread, fruits, vegetables, milk and milk products, and fruit juice ($p < 0.05$); while intake of soft drinks was significantly lower than in consumers of low-quality BF ($p < 0.05$). Girls that usually eat a good quality BF have a higher intake of RTEC, cheese, and water ($p < 0.05$).There were no significant differences in both groups in the potatoes, eggs, cake and biscuits, poultry, nuts, sugar, fats, and meat intakes.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
McNulty, H. et al. 1996 [39]	Ireland, 1990 Cross-sectional	To establish the contribution of RTEC to the overall nutrient intake.	n = 1015 12 and 15 years	1 day—24 h-DR	Boys who consumed more than 40 g/day RTEC and girls who consumed more than 20 g/day RTEC had a significantly lower percentage contribution of fat to total EI than non-RTEC consumers or lower consumers of RTEC. Higher RTEC consumption was associated with higher carbohydrate intake in boys and younger girls.Fiber intake increased with increasing RTEC consumption in girls and was higher in boys who consumed more than 40 g/day of RTEC.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Medin, A.C. et al. 2019 [42]	Norway 2015 Cross-sectional	To examine the diet quality of BF days and non BF days	n = 689 12–14 years	National dietary survey UNGKOST 3 4 days FR (web-based)	In adolescents, intakes of energy and fiber were significantly higher on days with BF ($p < 0.001$). There were no significant associations between BF consumption and fat, protein, and carbohydrate intake.	In adolescents, consumption of fruits and berries, juice, and smoothies was significantly higher on days with BF than days without BF. The consumption of discretionary foods was higher on days with BF. There were no significant associations between BF and consumption of vegetables and sugar-sweetened foods.
Michels, N. et al. 2015 [30]	Europe, 2006–2007 Cross-sectional	To analyze the association of RTEC consumption frequency with dietary intake.	n = 1215 12.5–17.5 years	HELENA Study 1 FFQ 2 days—24 h-DR	EI, carbohydrates, fat, protein, and fiber intake was not significantly different between RTEC consumers and non-RTEC consumers ($p > 0.05$).	RTEC consumers had a more frequent intake of milk/yoghurt and fruit ($p < 0.001$). RTEC consumers had a higher quantity (200 mL/day more) of milk/yoghurt intake over the whole day compared to non-RTEC consumers ($p < 0.001$).

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Mielgo-Ayuso, J. et al. 2017 [29]	European countries 2006–2007 Cross-sectional	To examine the association between BF consumption patterns and vitamins	n = 1058 12.5–17.5 years	HELENA Study 2 days—24 h-DR	EI was not significantly different between BF skippers and occasional or BF consumers (p > 0.05).	N.A.
Mohd Nasir, M.T. et al. 2017 [59]	Malaysia 2013 Cross-sectional	To compare foods consumed at breakfast and nutrient intake for the total day between RTEC consumers and non-RTEC consumers	n = 1819 6–12 years	MyBreakfast study Children 6–9 years: 2 day food records Children 10–12 years: 2–24 h dietary recalls	RTEC consumers had a higher daily intake of carbohydrates and total sugar than non-RTEC consumers (p < 0.05). Non-RTEC consumers had a higher intake of fat than RTEC consumers (p < 0.05). No significant associations in energy and protein were found between RTEC consumers and non-RTEC consumers.	N.A.
Morgan, K.J. et al. 1981 [49]	United States 1977 Cross-sectional	To assess BF consumption pattern and relate it with nutrients intake	n = 657 5–12 years	7 days—FR	BF had a significant contribution to children's daily nutrient intake. RTEC consumers of 3 or more times per week had a lower intake of fat and cholesterol (p = 0.001) and higher intake of fiber (p = 0.001) than those that did not eat RTEC at all for BF.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Murakami, K. et al. 2018 [61]	Japan 2012 Cross-sectional	To assess BF consumption and its association with daily dietary intake of nutrients, food groups, and overall diet quality.	n = 1444 6–11 years n = 1134 12–17 years	National Health and Nutrition Survey 2012 1 day—FR	In adolescents, BF consumers had a higher intake of energy (p < 0.001) and fiber (p < 0.05). In both groups, children and adolescents, BF consumers had a higher protein intake than BF skippers (p < 0.05). There were no significant associations between BF consumption and fat and carbohydrates intake.	In adolescents, BF consumers had a higher consumption of bread, dairy products (p < 0.05), vegetables, and vegetables juices (p = 0.002). BF skippers had a higher consumption of soft drinks (p = 0.01). In both groups, children and adolescents, BF consumers had a higher consumption of fruits and eggs (p < 0.05). BF skippers had a higher consumption of confectioneries (p < 0.05).

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Ortega, RM. et al. 1996 [36]	Spain, N.A. Cross-sectional	To analyze the influence of RTEC consumption at BF upon dietary habits.	n = 200 9–13 years	4 days—24 h-DR	EI, proteins, lipids, and fiber intake was not significantly different between RTEC consumers and non-RTEC consumers. RTEC consumers had higher carbohydrate intake ($p < 0.05$) than non-RTEC consumers.	RTEC consumers demonstrated better BF habits by consuming a wider range of food stuffs ($p < 0.05$; 2.12 food groups) than non-RTEC consumers children (1.56 food groups). C children consumed greater amounts of dairy products (NS), RTEC (NS), fats and oils (NS), legumes (NS), fish (NS), precooked food (NS), and fruits (NS) and lower amounts of beverages (74.6 ± 9.3 vs. 104.8 ± 10.2 g/day, $p < 0.05$), vegetables (NS), eggs (NS), and meat (NS) than NC children.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Ortega, RM. et al. 1998 [37]	Spain, N.A Cross-sectional	To assess the association between Calcium and milk products consumed at BF with their total daily intake.	*n* = 200 9–13 years	7 days—24 h-DR	N.A	95.5% of the subjects included dairy at BF. BF that supplied <20% of total EI included lower intake of dairy products than did larger BF and furthermore, they consumed fewer dairy products over the rest of the day.
Papoutsou, S. et al. 2014 [28]	Cyprus, 2007–2008 Cross-sectional	To investigate the association of BF pattern consumption with children´s diet quality.	*n* = 1558 4–8 years	IDEFICS Study 1 day—24 h-DR	Compared with RTEC consumers, milk consumers had a lower intake of energy and fiber, and milk and pastry consumers had a lower intake of proteins. Other-BF, milk, and pastry consumers had lower intakes of carbohydrates and fat. Milk consumers consumed less fiber than the other groups.	N.A.
Pourrostami, K. et al. 2019 [58]	Iran, 2014–2015 Cross-sectional	To investigate whether there is any association between fruit and vegetable intake with skipping main meals in children and adolescents.	*n* = 14274 4–18 years	CASPIAN-V Study 1—FFQ	N.A.	Children and adolescents with a low intake of vegetables were more likely to be breakfast skippers ($p < 0.05$). There were significant associations between low fruit and vegetables intake and skipping breakfast.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Preziosi, P. et al. 1999 [41]	France, N.A Cross-sectional	To examine the associations between the intake of different types of BF and dietary intakes.	*n* = 1108 2–18 years	1 day—24 h-DR	RTEC consumers eat significantly more carbohydrates than non-RTEC consumers. RTEC consumers had a lower fat intake than non-RTEC consumers. High-energy BF was significantly higher in carbohydrates but lower in fat and saturated fat.	N.A.
Ramsay, SA. et al. 2018 [50]	United States, 2005–2012 Cross-sectional	To examine food intake, nutrient intakes, and overall diet quality among BF consumers and skippers.	*n* = 8590 2–12 years	NHANES 1 day—24 h-DR	BF skippers in both age groups consumed less energy, protein, carbohydrate, fat, and fiber than BF consumers. Younger children who skipped BF had a higher EI from added sugars than BF consumers.	N.A.
Ruxton, CH. et al. 1996 [35]	United Kingdom Scotland Cross-sectional	To provide new data on the BF habit of children	*n* = 136 5–9 years	7 days—24 h-DR	The overall diets of children in the high RTEC group were higher in total carbohydrates and total sugars. % of energy from carbohydrates was higher and % of fat was lower in the group of high RTEC consumers.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Vatanparast, H. et al. 2019 [54]	Canada 2015 Cross-sectional	To evaluate how RTEC consumption contributed to daily energy and nutrient intakes and then compare them with non-consumers	n = 3810 6–12 years n = 2379 12–18 years	The Canadian diet, the recent nationally representative dietary survey, the Canadian Community Health Survey 1–24 h dietary recall	In both children and adolescents, RTEC consumers had significantly higher intake of carbohydrates and fibre than non-RTEC consumers. In adolescents, RTEC consumers had a higher intake of total sugars than non-RTEC consumers. In both children and adolescents, non-RTEC consumers had a significantly higher intake of fat, MUFA, PUFA, and cholesterol than RTEC consumers. In children, non-RTEC consumers had a higher intake of SFA than RTEC consumers.	N.A.

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Wang, M. et al. 2016 [60]	China, 2012 Cross-sectional	To describe the frequency of BF consumption among school-aged adolescents	*n* = 19542 Adolescents 13–16 years	1—FFQ	N.A.	Compared to those who never had BF, daily BF consumers were 3.32 times (OR = 3.32, 95%CI, 2.52–4.36) more likely to consume vegetables at least twice in a day and 2.06 times (OR = 2.06, 95% CI, 1.55–2.72) more likely to consume milk at least three days in a week. Daily BF consumption was significantly associated with a decreased probability of soft drink consumption at least once in a day (AOR = 0.59, 95% CI, 0.41–0.85) and fast food consumption at least two days in a week (OR = 0.43, 95% CI, 0.31–0.60).

Table 3. *Cont.*

Author	Country, Year, and Type of Study ¥	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast	Principal Outcome about Energy and Macronutrients	Principal Outcome about Food and Beverages
Williams, BM. et al. 2009 [51]	United States 1999–2002Ç Cross-sectional	To assess if BF dietary patterns are associated with nutrients intake and nutritional adequacy.	n = 1389 2–12 years	NHANES 1 day—24 h-DR	RTEC consumers had the highest intake of carbohydrates and sugars and the lowest intake of fat compared with the group of skippers and non-RTEC BF consumers ($p < 0.05$). RTEC BF consumers had less fat and cholesterol intake than those who consumed other types of BF ($p < 0.05$).	N.A.
Williams, P. et al. 2007 [57]	Australia, 1995 Cross-sectional	To assess the contribution of BF to the nutrition of Australian children and adolescents.	n = 3007 2–18 years	National Health Survey 1 day—24 h-DR 1 day—FFQ	In children (8–11 years old), BF consumers had a higher intake of energy, protein, fat, carbohydrates, total sugars, and dietary fiber than BF skippers. In adolescents (12–15 years old), no differences were observed between BF skippers and BF consumers. In adolescents (16–18 years old), BF consumers had a significantly higher intake of dietary fiber than BF skippers.	N.A.

¥ = The type study of the main study presented results that in some cases are from baseline analysis. £ = All the studies included boys and girls in their analysis, except those in which it was specified that only one gender was included. Abbreviations: N.A: Not available; BF: Breakfast; FR: Food record; RTEC: Ready to eat cereal; 24 h-DR: 24 h Dietary Recall; SFA: Saturated fatty Acids; EI: Energy intake; OD: Odds ratio; 95%CI: 96% Confidence intervals; PUFA: Polyunsaturated fatty acids; FFQ: Food frequency questionnaire; NS: Not significant; MUFA: Monounsaturated fatty acids; EAR: Estimated average requirement; SNDA-III: Data from the third School Nutrition Dietary Assessment Study; HELENA: Healthy Lifestyle in Europe by Nutrition in Adolescence; IDEFICS: Identification and prevention of dietary-and lifestyle-induced health effects in children and infants; NHANES: National Health and Nutrition Examination Survey.

3.3. Reporting Practices

A comprehensive SR of studies addressing breakfast and diet characteristics was conducted.

Results in Table 3 are presented in alphabetic order per author´s last name. Comparison groups according to breakfast consumption and/or type of breakfast consumed were the following: (n = 8) "frequency of consumption of RTEC" [7,32–35,39,46,49], (n = 7) "RTEC consumers vs. non-RTEC consumers" [30,36,41,45,47,54,55,59], (n = 5) "breakfast Skippers vs. breakfast consumers vs. RTEC consumers" [44,48,51,53,56], (n = 12) "frequency of breakfast consumption (breakfast skippers vs. breakfast consumers)" [22,29,31,38,42,43,50,55,57,58,60,61], (n = 3) comparisons between different types of breakfast [6,28,52], (n = 3) comparisons between nutritional composition of breakfast [12,37,41], and one of them compared depending on the breakfast quality (n = 1) [40]. Two studies had two comparison groups according to breakfast consumption [41,55].

Outcome variables were analyzed differently across all the included studies. The 24 h-DR or diet history method, which includes the 24 h-DR questionnaire, was the most frequently used tool (n = 27). FR was the questionnaire chosen in 9 of the studies and Food Frequency Questionnaires (FFQ) were used in 5 of them. One study used both questionnaires (24 h-DR and FR), depending on the age of the participants. Two studies assessed diet with both dietetic questionnaires, 24 h-DR and FFQ.

The questionnaires were filled out by the participant, the caregiver, or the interviewer, depending on the age of the participants and on the methodology and questionnaires used.

Associations between breakfast consumption and daily energy, macronutrients, and food and beverage intake are presented in Table 3. Associations between breakfast consumption and total EI were evaluated in 30 studies and 18 presented significant associations. Eight studies concluded that breakfast consumers had a higher daily energy intake than breakfast skippers [22,31,42,48,50,51,57,61]. According to several included studies, RTEC consumption is positively associated with total carbohydrate intake (n = 12) [7,28,31,32,35,41,45,48,51,53,55,56]. Overall, breakfast consumption was found to be associated with higher fiber intake [22,31,42,43,50,55,57,61], but specially RTEC consumption, as concluded in different studies [28,39,44,45,47–49,53,54,56].

17 studies assessed breakfast consumption and total sugar intake and 14 of them showed significant associations. Further, 10 studies concluded that RTEC consumers have a higher intake of this nutrient [34,35,39,48,51,53–56,59] than non-RTEC consumers, 3 studies found no relationship, and one found that consumers not consuming RTEC were the group with the highest level of sugar intake [44]. Regarding added sugars, only 7 studies assessed the intake of added sugars and only 4 of them showed significant associations.

Associations of breakfast and overall protein intake were not significant in many studies (n = 14). Six studies concluded that RTEC consumers had a higher protein intake than non-RTEC consumers [28,34,39,44,48,49], four studies observed that breakfast consumers had a higher protein intake in comparison with breakfast skippers [50,51,57,61], and another study concluded that breakfast consumption is related with low protein intake [31]. Fat intake was evaluated in 30 studies and 22 of them observed significant associations. Then, 11 studies found that RTEC consumers had a lower fat intake than non-RTEC consumers [7,32,34,35,39,44,45,47,53,54,59].

Five studies found that breakfast consumption was associated with low total fat intake [31,48,51,55,56]. One study observed that those adolescents with a high quality breakfast had a lower fat intake than those adolescents who usually skip breakfast or had a low quality breakfast [40]. However, three studies showed that breakfast consumers had a higher fat intake than breakfast skippers [22,50,57]. The intake of saturated fatty acids (SFA) was evaluated in 18 studies, but only 6 studies showed significant associations. Four studies observed that breakfast consumers had a lower SFA intake than breakfast skippers [44,48,51,56]. However, one study concluded that breakfast consumers had a higher SFA intake than breakfast skippers [50]. Monounsaturated fatty acids (MUFA) intake was assessed in 10 studies and 6 of them observed significant associations. Three studies observed that those children and adolescents who usually skip breakfast had a higher intake of MUFA [40,48,51]. Polyunsaturated fatty acids (PUFA) were assessed in 10 studies and 7 of them

observed significant associations. Three studies observed than non-RTEC consumers had a higher total PUFA intake than RTEC consumers [51,53,54]. Total cholesterol intake was evaluated in 13 studies and in only two studies, authors did not observe significant associations. Nine studies observed that RTEC consumers had a lower cholesterol intake than non-RTEC consumers [7,44,46–49,51,53,54].

Regarding associations between breakfast consumption and food and beverage intake, milk and dairy product consumption were assessed in eight studies, and seven of them observed significant associations. Two studies observed that RTEC consumers had a higher intake of milk and dairy products than non-RTEC consumers [30,45]. On the other hand, three studies showed that breakfast consumers had a higher daily consumption of dairy products than breakfast skippers [40,60,61].

Consumption of cereals or bread was evaluated in six studies and three of them concluded that breakfast consumption was positively associated with cereals and bread intake [12,40,61]. The association between breakfast consumption and legumes intake was evaluated in three studies, but only Gikas et al. found positive associations [38].

The majority of the studies found significant association between breakfast consumption and fruit and vegetable intake. Different authors observed that breakfast consumers had a higher intake of fruits [38,42,52,58,60,61] and vegetables [38,58,60,61] than breakfast skippers. Matthys et al. [40] found that having a better quality breakfast was significantly associated with higher fruits and vegetables consumption. Soft drink consumption was evaluated in six studies and five of them observed significant associations. Four studies concluded that breakfast skippers had a higher consumption of soft drinks than breakfast consumers [38,40,60,61].

Fast food consumption was evaluated in four studies, however only Wang et al. [60] found that skipping breakfast was positively associated with a higher consumption of fast food.

Meta-analysis: measurement of the effect of relationships between type of breakfast and macronutrients intake.

3.4. Differences between Skipping Breakfast and RTEC Breakfast

Figure 2 shows the individual study results and plots the global effect of skipping breakfast and RTEC breakfast.

As shown in Figure 2A, children who usually skip breakfast had a lower daily EI (Kcal) than children who usually eat RTEC breakfast (MD, −7.00; 95%CI: −11.51, −2.49). Nevertheless, heterogeneity among studies was high (I^2 = 99.95%; $p < 0.001$).

On the other hand, as shown in Figure 2B, children who usually skip breakfast had a significantly lower carbohydrate intake than children who usually consume RTEC breakfast (MD, −9.28; 95%CI: −13.44, −5.12). The heterogeneity among included studies was high (I^2 = 99.9%; $p < 0.001$). In the same way as shown in Figure 2C, RTEC breakfast consumers had a significantly higher fibre intake than breakfast skippers (MD, −6.67; 95%CI: −11.02, −2.32). The heterogeneity among studies was high (I^2 = 99.95%; $p < 0.001$). In the case of proteins intake (Figure 2D), skippers consumed less protein than those children who usually consume RTEC breakfast (MD, −3.03; 95%CI: −4.61, −1.45). The heterogeneity among studies was high (I^2 = 99.88%; $p < 0.001$). Finally, children who usually skip breakfast had a significantly higher fat intake than children who usually eat RTEC breakfast (Figure 2E) (MD, 11.10; 95%CI: 7.15, 15.04). The heterogeneity among studies was high (I^2 = 99.84%; $p < 0.001$).

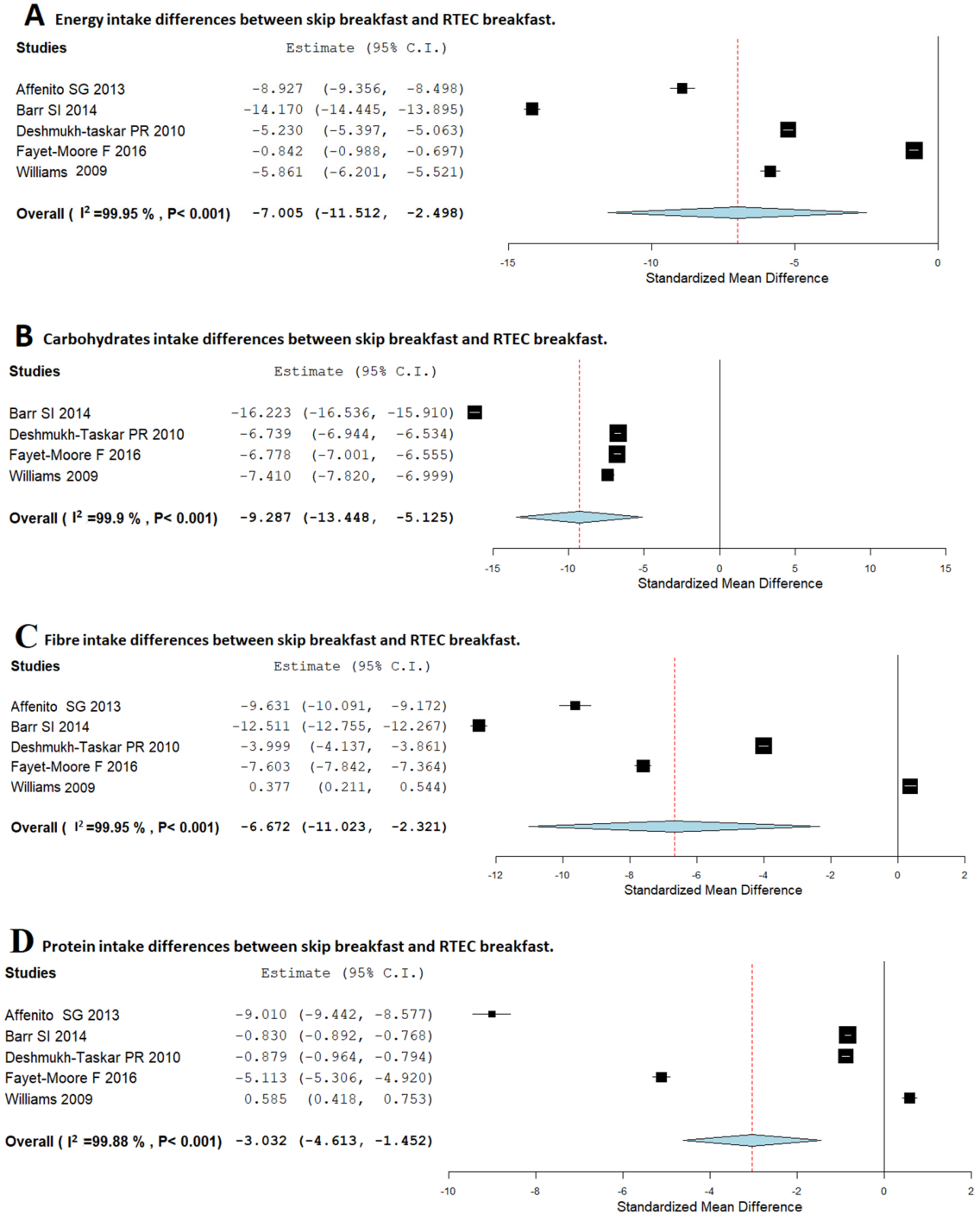

Figure 2. *Cont.*

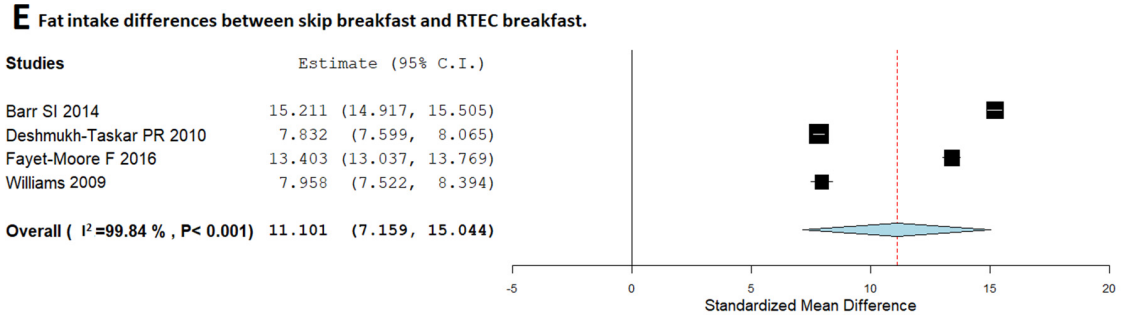

Figure 2. Random-effects meta-analysis of the effects of relationships between skipping breakfast and RTEC breakfast regarding energy (**A**), carbohydrates (**B**), fibre (**C**), protein (**D**) and fat (**E**) intake.

3.5. Differences between Skipping Breakfast and Other Types Of Breakfast

Figure 3 shows the individual study results and plots the global effect of skipping breakfast and others types of breakfast.

Figure 3A shows that children skippers have a lower total EI than children who usually consume other types of breakfast (MD, −5.41; 95%CI: −8.12, −2.70). The heterogeneity among studies was high (I^2 = 99.94%; $p < 0.001$). On the other hand, as shown in Figure 3B, children who usually skip breakfast had a significantly lower carbohydrate intake than children who usually consume other types of breakfast (MD, −8.21; 95%CI: −11.37, −5.05). The heterogeneity among the included studies was high (I^2 = 99.85%; $p < 0.001$). In the case of fibre (Figure 3C), children who usually consume breakfast had a higher intake in respect to those who usually skip breakfast (MD, −8.43; 95%CI: −12.63, −4.23). However, the heterogeneity among studies was high (I^2 = 99.97%; $p < 0.001$). In the case of protein intake (Figure 3D), skippers consume less protein than those children who usually consume other types of breakfast (MD, −6.05; 95%CI: −8.35, −3.75). The heterogeneity among studies was high (I^2 = 99.94%; $p < 0.001$). On the other hand, skippers had a higher daily fat intake than breakfast consumers (Figure 3E) (MD, 4.59; 95%CI: 2.04, 7.15). The heterogeneity among studies was high (I^2 = 99.93%; $p < 0.001$).

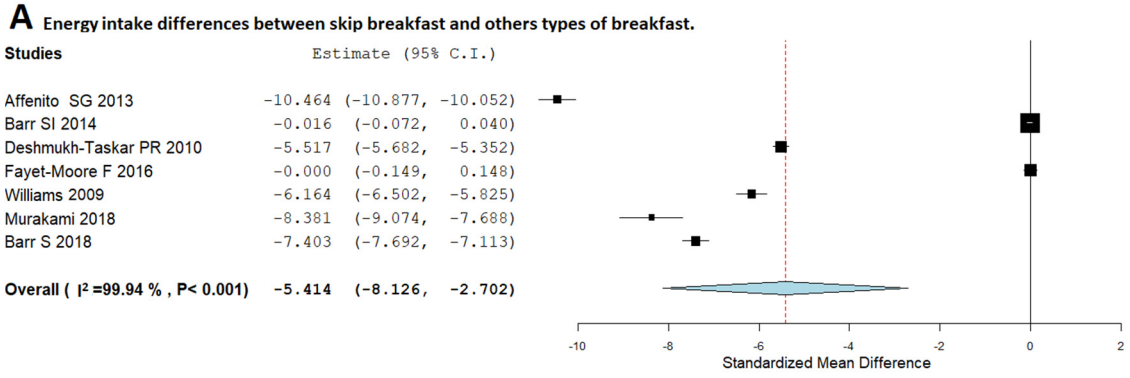

Figure 3. *Cont.*

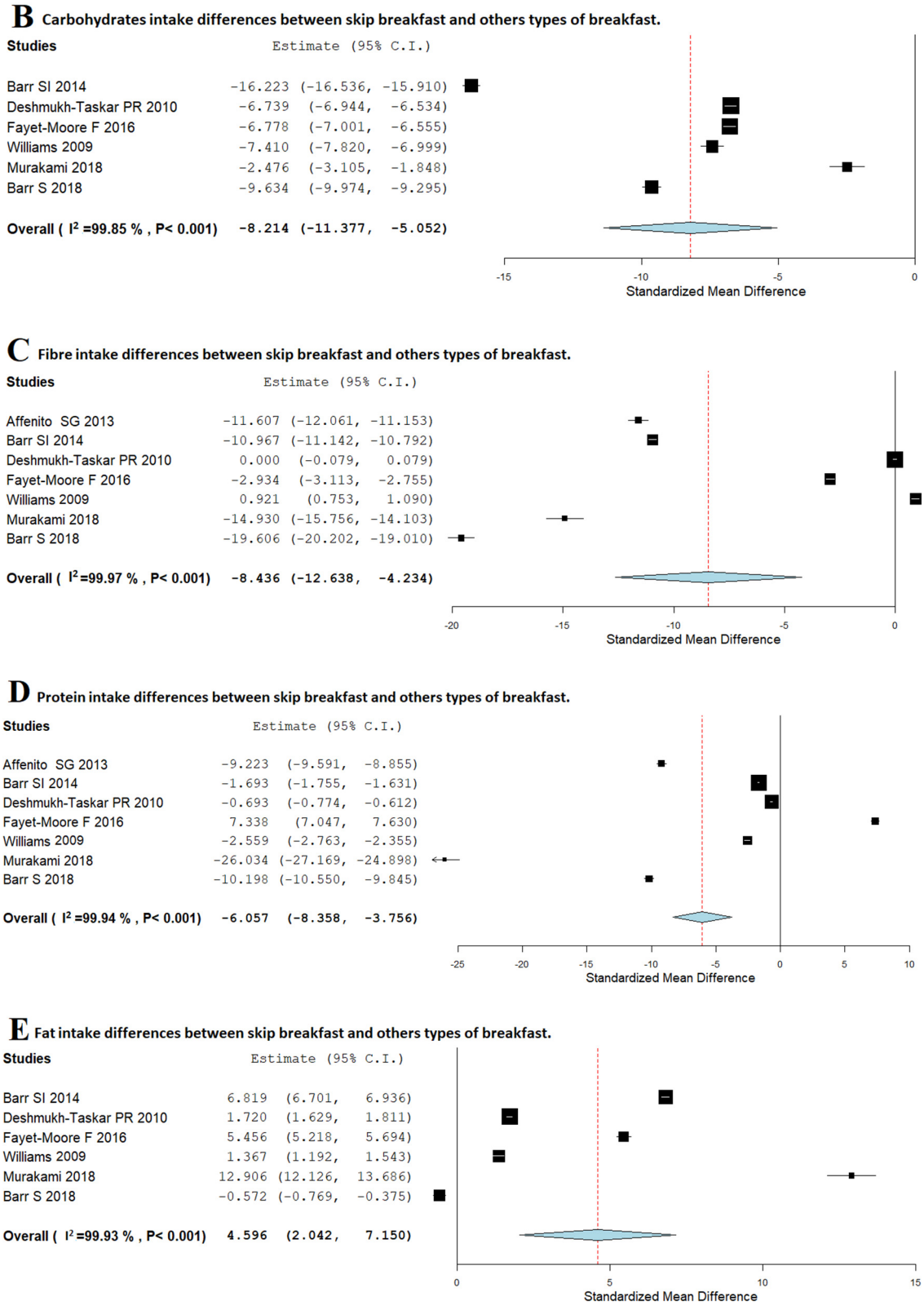

Figure 3. Random-effects meta-analysis of the effects of relationships between skipping breakfast and others types of breakfast regarding energy (**A**), carbohydrates (**B**), fibre (**C**), protein (**D**) and fat (**E**) intake.

4. Discussion

A comprehensive SR of studies addressing breakfast frequency and characteristics and its relation to diet composition in terms of energy, macronutrients, and food and beverage consumption was performed. Cultural diversity of the populations assessed across the included articles was reflected on several differences between breakfast components; most European and North American studies had RTEC, milk, and bread [54,62–65] as their main components, whereas traditional local foods were consumed in other countries; for instance, in Mexican children, tortillas and beans were the most frequently consumed foods at breakfast [6] and in Japan, a typical breakfast is based on rice or bread accompanied by other foods such as fruits and vegetables, dairy products, pulses, eggs, and tea or coffee [66].

Articles evaluated used 24 h-DR, FR, and FFQ or the combination of some of them. Besides the dietary questionnaire used, it is important to assess how nutritional components were evaluated and it is necessary to mention that most included studies did not report the food composition tables used for the analyses.

Most articles compared breakfast consumption with breakfast skipping or different types of breakfasts consumed, such as an RTEC based breakfast. Of the 38 included articles, the major topic was RTEC consumption at breakfast (n = 22). To the author's knowledge, no previous SR has taken into consideration the association between breakfast consumption and daily dietary intake (quality and macro nutrient composition). There is only one previous review published in 1997 by Ruxton et al. [67] suggesting a relationship between breakfast consumption and better lipid profile due to the high carbohydrate and low fat content of breakfast foods, like bread and breakfast cereals.

RTEC can be defined as a cereal food that is processed to the point where it can be eaten without further preparation, although milk or dairy products are usually added [62]. RTEC are usually high in carbohydrates, polysaccharides, and sugar and low in fat. Some RTEC breakfast have a high content of fibre and others, because of fortification, have a high content of vitamins and minerals [47,68]. Song et al. [69] suggested in their review that RTEC consumption was prevalent among breakfast consumers and it is possible that RTEC in itself promotes breakfast consumption. However, it could be interesting for future studies to investigate the type of cereal consumed (e.g., muesli or oats) given that not all cereals can be good sources of fibre and micronutrients [55].

4.1. Breakfast Consumption and Energy and Macronutrients Intake

Thirty studies investigated the relationship between breakfast consumption and EI. Eighteen studies found significant positive associations between breakfast consumption and daily EI. Eight of them reported that those children and adolescents that usually eat breakfast consumed more energy than breakfast skippers [22,31,42,48,50,51,57,61]. Gibson et al. [32,34] reported in two studies that frequency of RTEC consumption was positively associated with energy in both children and adolescents. In our meta-analysis, we observed that those children who usually consumed breakfast (RTEC or another type of breakfast) had a higher daily EI than those who usually skip breakfast. In our SR, we did not find any evidence to support the hypothesis that skipping breakfast leads to increased overall daily EI due to compensatory overeating later in the day as it was previously reported [70]. Regarding EI, as a single value, with no additional individual information, it is difficult to make interpretations because EI depends mainly on lean body mass and physical activity, which are the main determinants of energy expenditure [71].

Twenty-eight studies investigated the relationship between breakfast consumption and daily carbohydrate intake and twenty-two of them found positive associations. Meta-analysis showed that those children who usually consume breakfast (RTEC or other types of breakfast) had a higher carbohydrate intake than those children who usually skip breakfast. In the International Breakfast Research Initiative (IBRI), authors observed that the analyses of breakfast patterns in the studied countries showed breakfast consistently being a carbohydrate-rich eating occasion [71,72]. Furthermore, the observed association is reasonable for RTEC breakfast as they have a high carbohydrate content [68].

Regarding fibre, 21 studies investigated the relationship between breakfast consumption and daily fibre intake. Ten studies showed that those children and adolescents who usually consume RTEC breakfast had a higher daily fibre intake [28,39,44,45,47–49,53,54,56]; this could be due to breakfast cereals, especially whole grain cereals, usually having a high fibre content [68]. A previous study showed that RTEC consumption made up 10% of total daily fibre intake [73]. In the same way, in our meta-analysis, we observed that those children who usually eat breakfast (RTEC or other types of breakfast) had a higher fibre intake than those children who usually skip breakfast.

Twenty-eight studies investigated the relationship between breakfast consumption and protein intake, from which 14 observed significant associations. Four of them observed that those subjects that usually consume breakfast had a higher daily protein intake than those who usually skip breakfast [50,51,57,61]. Our meta-analysis showed that those children who usually consume breakfast had a higher protein intake than those who usually skip breakfast (RTEC or other type of breakfast). This can be explained by the fact that milk products are one of the most commonly consumed foods by children at breakfast in the US, Canada, and Europe [74] and milk and other dairy products, including cheese or yogurt, provide high amounts of protein [75]. This is in line with other authors who have also observed that frequent dairy consumption is associated with a high protein intake and with better nutrient intake in children, adolescents, and adults [76–78].

Thirty articles investigated the relationship between breakfast consumption and fat intake. Some authors observed that those children and adolescents who usually skip breakfast had a higher daily intake of fat [31,48,51,55,56], SFA [44,48,51,56], and MUFA [40,48,51] than those adolescents who usually consume breakfast. However, other authors observed a modest difference in total daily fat intake [22]. Also, 11 studies showed that those children and adolescents who usually do not eat RTEC cereals at breakfast had a higher daily fat intake [7,32,34,35,39,44,45,47,53,54,59] than those who usually consume RTEC at breakfast, and nine studies observed higher cholesterol intake [7,44,46–49,51,53,54]. However, the study by Preziosi et al. observed that RTEC consumers ate significantly more fat than non-RTEC consumers [41]. Our meta-analysis showed that those children who usually consume breakfast (RTEC or other types of breakfast) had a lower daily fat intake than those children who usually skip breakfast. Regarding a RTEC breakfast, lower fat intake could be possible due to RTEC usually having a lower fat content [67,68]. In addition, skipping breakfast could promote hunger in the morning and as a result, increase snack food consumption [79]; however, the majority of snacks consumed by children and adolescents are high in fat and added sugars and low in vitamins and minerals; for this reason, this could be linked with a less healthy DP [40,80].

4.2. Association between Breakfast Consumption and Intake of Foods and Beverages

Breakfast consumption has been identified as a strong indicator of a healthy diet and a positive influence on children and adolescents' food choices [38,81]. For the association between breakfast and food and beverage consumption, it was not possible to perform a meta-analysis due to the insufficient available literature.

Thirteen studies investigated the relationship between breakfast consumption and food and beverage intake. In our SR, we found evidence to support the hypothesis that breakfast consumption may help to follow healthy habits, due to different authors observing positive associations between those usually eating breakfast and fruit [38,40,42,52,58,60,61], vegetable [38,40,58,60,61], legume [38], fish [38], bread and cereals [12,40,61], milk and dairy products [40,60,61], and fruit and vegetable juice [42,61] consumption, compared with those children and adolescents that usually skip breakfast or consume a low quality-breakfast. However, breakfast skippers seem to have unhealthy DPs [82] and in this regard, negative associations were also observed between breakfast consumption and soft drink consumption [38,40,60,61], alcoholic beverages [38], meat [38], and fast food [60]. In a previous article, authors suggested than the adoption of regular meal habits could help adolescents improve their diet quality [81].

Focusing on specific foods and beverages consumed at breakfast, several authors observed that those children and adolescents who usually consume a RTEC breakfast showed healthier habits due to RTEC consumers having a high consumption of whole grain [44], milk and dairy products [30,45], and fruits [30]. Regarding the high daily consumption in RTEC consumers, previous studies suggested that RTEC consumption could facilitate milk and dairy consumption due to the fact that RTEC are usually consumed with milk or yoghurt [45,55,83]. In the same way, different authors observed that the majority of the subjects included dairy products at breakfast [37,84].

On the other hand, RTEC consumption was negatively associated with unhealthy food consumption, such as sugar and sweets [45], quick breads [45], meat [45], eggs [45], soft drinks [45], and others type of beverages [36]. In this way, several studies documented that RTEC consumption contributes to a healthier diet [7,51,64,85,86], but in a previous review, authors recommended that it should differentiate between different types of cereals and it is important to recommend RTEC with the best nutrient and functional profiles [87]. In the same way, in another review, authors suggested that RTEC consumption was associated with healthier DP, however sometimes these products were also high in sugar [86].

4.3. Potential Influencing Factors of Heterogeneity

In our study, important heterogeneity was found for both skipping breakfast versus RTEC breakfast and skipping breakfast versus other types of breakfast. We suggest that this heterogeneity can be explained, at least in part, by the large range of the participant's age (2–16 years old), the large range of the sample (188–1471 participants), and the type of questionnaire used (24 h-DR, FR, or FFQ). Also, additional extra factors that could influence the heterogeneity could be based on the person who responds to the questionnaire (child, adolescent, or parents) and the cultural aspects involved. A meta-analysis was performed by subgroups, taking into consideration the age-groups, showing similar results and no differences in the heterogeneity.

4.4. Strengths and Limitations

Some limitations should be acknowledged in the present study. Firstly, the design of most of the included studies was cross-sectional, which do not determine cause-effect related associations.

The methods for the assessment of dietary intake have their own limitations. Some of the included studies assessed dietary intake with a single 24 h-DR, which is not considered to be representative of the usual diet at an individual level. However, this methodology is adequate for surveying intake in a large group and estimating group mean nutrients intake. Also, dietary intake reporting has its own limitations, given that specific related bias and person specific bias is always present. Moreover, comparison groups in the included studies present high variability. For this reason, the inclusion of a large number of studies in the meta-analysis was difficult and only those with similar characteristics were included.

To our knowledge, this is the first SR analysing the associations between breakfast consumption and its relation to diet composition in terms of energy, macronutrients, and food and beverage consumption. In this sense, the included studies were developed in four continents, which is interesting in order to overspread the current findings across the world. Moreover, the studied populations included both children and adolescents, which let us assess the relationship between breakfast and macronutrients and food and beverage consumption across the lifetime. Also, several aspects of diet have been analysed as main outcomes, including macronutrients, and some relevant foods such as dairy, whole grains, fruits, and vegetables.

5. Conclusions

In children and adolescents, those consuming breakfast showed higher daily EI, carbohydrate, fiber, and protein intake as compared with those who skip breakfast. Furthermore, those consuming breakfast showed higher daily intake of fruit and vegetables, milk and dairy products, and cereals as compared with those who skip breakfast. Breakfast based on RTEC is the most commonly consumed

type of breakfast by children and adolescents; consumption of a RTEC based breakfast may have beneficial effects in daily macronutrient intake. However, each type of cereal should be considered due to RTEC usually having a high sugar content. In order to improve the quality of macronutrients and food consumption in children and adolescents, breakfast consumption should be promoted. However, additional studies are needed to investigate breakfast consumption and composition and its impact on overall health and diet quality.

Supplementary Materials: The following are available online at http://www.mdpi.com/2072-6643/12/8/2460/s1, Table S1. Quality appraisal findings.

Author Contributions: N.G.-L., A.M.S.-P., and L.A.M. had the idea for the article; N.G.-L. and P.F.-B. performed the literature search and data analysis, N.G.-L. and M.L.M.-B. performed the meta-analysis, N.G.-L., P.F.-B., A.M.S.-P., M.L.M.-B., and L.A.M. drafted the manuscript, N.G.-L., P.F.-B., A.M.S.-P., M.L.M.-B., and L.A.M. critically revised the work. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

24 h-DR	24 h Dietary Recall
95%CI	95% Confidence Intervals
BF	Breakfast
DP	Dietary Pattern
EAR	Estimated Average Requirement
EI	Energy Intake
FFQ	Food Frequency Questionnaire
FR	Food Record
G	grams
IBRI	International Breakfast Research Initiative
Kcal	Kilocalories
MD	Mean Difference
N.A	Not Available
NS	No Significant
OD	Odds Ratio
PRISMA	Preferred Reporting Items For Systematic Reviews and Meta-Analysis.
PUFA	Polyunsaturated Fatty Acids
RTEC	Ready To Eat Cereal
SFA	Saturated Fatty Acids
SR	Systematic Review
US	United States
WHO	World Health Organization

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MANUSCRIPT II

Breakfast Characteristics and Its Association with Daily Micronutrients Intake in Children and Adolescents-A Systematic Review and Meta-Analysis.

nutrients

MDPI

Review

Breakfast Characteristics and Its Association with Daily Micronutrients Intake in Children and Adolescents–A Systematic Review and Meta-Analysis

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Abstract: Breakfast is an important source of key nutrients in the diet. For this reason, the aim of this review was to investigate the associations between breakfast consumption and daily micronutrients intake in both children and adolescents (aged 2–18 years). A peer-reviewed systematic search was conducted in three datasets (PubMed, Scopus and Cochrane Library) in February 2020 in English and Spanish. Two independent reviewers evaluated 3188 studies considering the AXIS critical appraisal and PRISMA methodologies. Meta-analysis was carried out comparing results according to type of breakfast consumed (Ready to eat cereals (RTEC) breakfast or other types of breakfast) and breakfast skipping. Thirty-three articles were included in the systematic review (SR) and 7 in the meta-analysis. In the SR, we observed that those children and adolescents who usually consume RTEC at breakfast had a higher consumption of B-vitamins than those not consuming RTEC at breakfast. Breakfast consumers had a higher mineral intake (iron, calcium, magnesium, potassium, zinc, and iodine) than breakfast skippers. In the Meta-Analysis, RTEC consumers had significantly higher vitamin C intake than breakfast skippers (Standard Mean Difference (SMD), −4.12; 95% confidence intervals (CI): −5.09, −3.16). Furthermore, those children who usually consume breakfast had significantly higher daily intake of calcium than breakfast skippers (SMD, −7.03; 95%CI: −9.02, −5.04). Our review proposes that breakfast consumption seems to be associated with higher daily micronutrients intake than breakfast skippers.

Keywords: breakfast; nutrient; micronutrient intake; children; adolescents

1. Introduction

Breakfast is extensively recognized as an important component of a healthy lifestyle and represents an important source of key nutrients in the diet for both adults and young population groups [1–5], showing several benefits of its consumption [2–4]. The International Breakfast Research Initiative (IBRI), developed in six countries, observed that there was a general breakfast pattern. In children, the proportion of breakfast consumers was very high (from 87.4% in US to 98.9% in Denmark) but declined with adolescence (from 74.2% in US to 87.9% in Canada) [6].

Breakfast consumption showed a protective effect against obesity and overweight [7]; for this reason, breakfast consumption is important because of its inverse association with body fat [8,9]. For instance, previous authors observed that children with obesity were more likely to skip breakfast [9–11], and these children had a high risk of chronic diseases as type 2 diabetes [12–14], dyslipidemia or cardiovascular diseases [7,8,15]. Likewise, previous authors observed that some vitamin deficiencies could be associated with fatness and other diseases, [16–18] and can be considered a critical public health issue [19,20]. Some studies also observed that in both children and adolescents, breakfast consumption has a positive effect on cognitive performance [21]. Nevertheless, breakfast is the meal that they most frequently skipped [22,23].

It has been suggested that children should consume about 20% of their daily energy intake (EI) at breakfast [24–26]. Different studies showed that those who often skip breakfast had lower EI and macronutrient's intake compared with those who usually consumed breakfast [16,27–29]. Breakfast consumption has been associated with a better intake of vitamins and minerals in both children and adolescents [30]. In the same way, it has been observed that those adolescents who usually consume breakfast are more likely to meet recommended intakes of some minerals such as iron, calcium, zinc, magnesium, and copper, and vitamins A, B_6, B_1, C, D, E, and folate [31]. However, no systematic analysis of these associations was previously performed.

Nowadays, ready-to-eat-cereals (RTEC) at breakfast have become increasingly popular due to the desire for an easy alternative [32]. RTEC are increasingly consumed, and children and adolescents prefer RTEC instead of other cereal-based foods, such as bread [33,34]. In a previous Spanish study, RTEC consumption was associated with a low risk for inadequate micronutrients intake in children, adolescents and young adults [35].

To the authors' knowledge, this is the first systematic review (SR) regarding the association between breakfast consumption and daily micronutrients intake. However, a recent SR and meta-analysis observed that breakfast consumption is associated with healthier food and beverages consumption and also better macronutrient intake [36].

The aim of this SR is to observe the associations between characteristics and frequency of breakfast consumption and total daily diet composition in terms of micronutrients intake.

2. Methodology

2.1. Protocol

This SR is the follow up of a previous SR that has been published [36]. Both SR shared the same methodology, including different studies taking into consideration the specific aims of each one. This SR has been performed following the criteria and methodology established by the Preferred Reporting Items for Systematic reviews and Meta-Analyses Protocols (PRISMA) [37]. The SR was registered in 'Prospero' CRD42020142570. Using the PICO principle (Participants, Intervention, Control, Outcomes), a specific question was constructed (Table 1) [38].

2.2. Search Strategy

Journal articles were identified by searching in electronic databases and scanning references and lists of articles. The search strategy was applied to PubMed, Scopus and the Cochrane Library databases in February 2020. The search strategy used to identify the article was as follows: ("Breakfast"(Mesh) OR "Breakfast"(tiab)) AND ("Food"(Mesh) OR "Beverages"(Mesh) OR "Diet, Food and Nutrition"(Mesh) OR "Diet"(Mesh) OR "Eating"(Mesh) OR "Feeding Behavior"(Mesh) OR "Nutritional Requirements"(Mesh) OR "Nutritional Status"(Mesh) OR "Nutritive Value"(Mesh) OR "breakfast skipping" (tiab) OR "meal Skipping"(tiab) OR "Fasting"(Mesh) OR "Food preferences"(Mesh) OR "Diet therapy"(Mesh) OR "Energy Intake"(Mesh) OR "nutrient"(Mesh)) AND ("Child, Preschool"(Mesh) OR "Child"(Mesh) OR "Adolescent"(Mesh) OR "breakfast skipping" OR "meal skipping").

Table 1. Inclusion and exclusion criteria based on PICOS (Participants, Intervention, Control, Outcomes) principles.

PICOS	Inclusion Criteria	Exclusion Criteria
Participant	Population older than 2 years and younger than 18 years; both sexes; all nationalities	Population with different ages. Participants with any reported or known illness.
Intervention	Breakfast consumers (Ready to Eat Cereals (RTEC), other types of breakfast)	Not having breakfast data
Control/Comparator group	Breakfast skippers	Not having breakfast data
Outcome	Total daily intake of micronutrients.	Other outcomes not related with breakfast consumption

2.3. Selection Criteria

The following inclusion criteria were used: (1) types of studies: cross-sectional, longitudinal, descriptive study or case control study, (2) participants between 2–18 years, (3) original studies in which assessment of breakfast has been done/performed, and (4) publications in English and Spanish.

All articles were collected into an online citation manager (EndNote®Online, EndNote X9.1, Clarivate Analytics) and were screened for potential relevance according to title and abstract based on inclusion and exclusion criteria. The full text of all those studies fulfilling the inclusion criteria were collected and were evaluated for relevance according to the aim of the SR. In doubtful cases, studies were discussed with the SR team. Detailed information regarding publication's year, study design, setting, participants, and results on micronutrient outcomes were extracted. The literature search was not limited by any range of years.

2.4. Systematic Review Process and Data Extraction, and Synthesis

Two reviewers independently (NGL and PFB) evaluated all studies. Titles and abstracts were examined, and full relevant articles were obtained and assessed using the mentioned inclusion and exclusion criteria. Inter-reviewer disagreements were resolved by consensus, and in some cases, a third reviewer was consulted to solve disagreements. Figure 1 shows in a flowchart the search results.

2.5. Quality and Risk of Bias Assessment

The Appraisal tool for Cross-sectional Studies (AXIS) was used to assess the risk of bias and the methodological quality of included studies [39]. The tool consists of a 20-question-list, which included the study design, target population, sample size and selection, sampling frame, reliability and validity of the measurements, methodology, ethical issues, and conflict of interest. The details of the assessment of each included study are shown in the supplementary section, Table S1. Given that the tool does not provide an accumulated score on quality, the results have been summarized on Table 2 in order to obtain a general view of the quality of all the included studies.

2.6. Statistical Analyses

All analyses were performed using Open Meta (Analyst) software (open-source, cross-platform software for advanced meta-analyst). Two possibilities for comparison groups were assessed: RTEC breakfast versus skip breakfast, and other types of breakfast versus skip breakfast. Mean difference (MD) with 95% confidence intervals (95%CI) was used for comparing micronutrients (in milligrams (mg) or micrograms (μg)) between skip breakfast, RTEC breakfast and other types of breakfast. Also, for continuous data, random effects models with DerSimonian and Laird values were applied. For each outcome, effect sizes were calculated.

When information was available, the I2 statistic and its associated *p* value was used to test the heterogeneity, which describes as a proportion of the total variance the variance between studies [40]. Low heterogeneity was indicated with a value of <25%; high heterogeneity was indicated with a value of >50% to 75%, and high heterogeneity was indicated with a value of >75%. The absence of heterogeneity was determined with a non-significant *p* value.

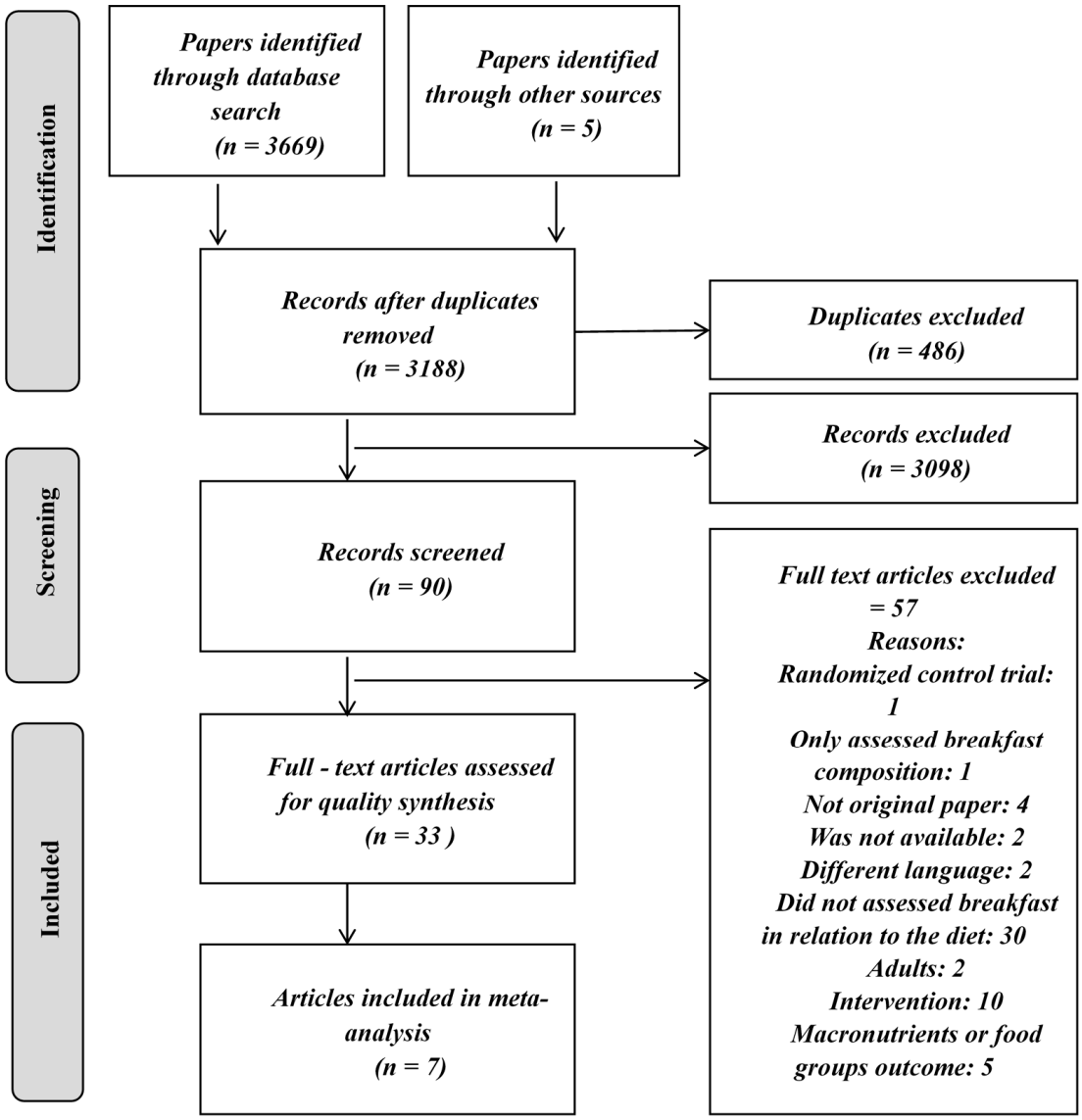

Figure 1. Flowchart diagram of study selection and search.

Table 2. Appraisal Tool for Cross-Sectional Studies (AXIS).

Assessment Criteria	No. of Satisfactory Studies
1. Were the aims/objectives of the study clear?	33
2. Was the study design appropriate for the stated aim(s)?	33
3. Was the sample size justified?	22
4. Was the target/reference population clearly defined? (Is it clear who the research was about?)	33
5. Was the sample frame taken from an appropriate population base so that it closely represented the target/reference population under investigation?	27
6. Was the selection process likely to select subjects/participants that were representative of the target/reference population under investigation?	24
7. Were the measures undertaken to address and categorize non-responders?	1
8. Were the risk factor and outcome variables measured appropriate to the aims of the study?	32
9. Were the risk factor and outcome variables measured correctly using instruments/measurements that had been trialed, piloted or published previously?	13
10. Is it clear what was used to determine statistical significance and/or precision estimates? (e.g., *p* values, Cis)	33
11. Were the methods (including statistical methods) sufficiently described to enable them to be repeated?	33
12. Were the basic data adequately described?	25
13. Does the response rate raise concerns about non-response bias?	1
14. If appropriate, was information about non-responders described?	0
15. Were the results internally consistent?	33
16. Were the results for the analyses described in the methods presented?	32
17. Were the authors' discussions and conclusions justified by the results?	33
18. Were the limitations of the study discussed?	23
19. Were there any funding sources or conflicts of interest that may affect the authors' interpretation of the results?	22
20. Was ethical approval or consent of participants attained?	28

3. Results

3.1. Literature Search and Screening

The included studies are summarized in Figure 1. A total of 3674 eligible papers were identified: 2544 from PubMed, 620 from Scopus, 505 from the Cochrane Library, and 5 were identified through other sources (Figure 1).

After duplicates exclusion and title reading, 3188 articles were assessed for eligibility. Finally, only 33 full-text articles met the inclusion criteria and 7 of them were considered for meta-analysis.

3.2. Study Design Characteristics

All the included articles were published in English and Spanish. From the 33 included articles, only 3 articles (9.1%) were longitudinal versus 90.9% of the studies (n = 30), which were cross-sectional. From the 33 included studies, 17 were performed in representative samples of the correspondent population [16,28,41–55]. Table 3 shows details of the articles, which included the impact of breakfast consumption on micronutrients intake. The studies were conducted between 1981–2018 in the following countries: United States (US) (n = 11) [30,41,44,49,51,52,55–59], United Kingdom (UK) (n = 5) [3,29,47,60,61], Canada (n = 3) [42,43,54], Spain (n = 2) [62,63], Australia (n = 3) [45,46,53], México (n = 1) [28], Ireland (n = 1) [64], Belgium (n = 1) [65], Cyprus (n = 1) [66], France (n = 1) [50], Malaysia (n = 1) [67], Japan (n = 1) [68], and 3 were combined European countries [16,48,66]. Data came from three sources: most of them were national health studies (60.6%) [3,28,30,41–47,51–57,59,61,68], 30.3% were original studies [29,49,50,58,60,62–65,67] and the rest were European multi-center studies (9.0%). Results of the studies have been differentiated according to the age of the participants, ranging

from 2–12 years for children, and from 13–18 years for adolescents. Included studies were performed in children 39.3% (n = 13) [28,29,47,49,51,52,56–58,62,63,66,67], 12.1% (n = 4) adolescents [16,48,64,65], and both children and adolescents 48.4% (n = 16) [3,30,41–46,50,53–55,59–61,68].

3.3. Reporting Methods

Results are presented in Table 3 in alphabetic order per author's last name.

Outcome variables were analyzed using 24 h Dietary Recalls (24 h-DR) (n = 26) or Food Records (FR) (n = 8). Two studies assessed diet with both 24 h-DR and Food Frequency Questionnaire (FFQ) questionnaires. Fulfilling of questionnaires was dependent on the methodology, the questionnaires used and on the age of the participants (interview with parents or caregivers, reported by parents or caregivers or self-reported by the children or adolescents).

Several articles assessing the consumption of RTEC were included (n = 22, 66.6%). Frequency and quantity consumed per week were assessed as well as the association of its consumption with different behaviors and health outcomes. Comparison groups according to breakfast consumption and/or type of breakfast consumed were the following: (n = 8) 'frequency of consumption of RTEC' [29,47,49,56,58,61,64,69], (n = 8) 'RTEC consumers versus non-RTEC consumers' [46,48,50,54,57,59,62,67], (n = 5) 'breakfast skippers versus breakfast consumers versus RTEC consumers' [41,42,44,45,52], (n = 8) 'frequency of breakfast consumption (breakfast skippers versus breakfast consumers) [3,16,30,43,46,51,53,68], (n = 3) comparisons between different types of breakfast [28,55,66], (n = 2) comparisons between nutritional composition of breakfast [50,63], and one of them considered breakfast quality [65]. Two studies had two comparison groups according to breakfast consumption.

Of the relevant studies (n = 30), 90.9% showed associations between breakfast consumption and daily vitamins intake. Breakfast consumption and vitamin C intake was the most evaluated relationship in the vitamins group, which was analyzed in 27 studies; from which 15 showed significant associations.

Breakfast consumption and B vitamins' associations were widely analyzed and in most of the studies, positive significant associations were found. Thiamin intake was found to be positively associated with breakfast consumption in 19 out of 22 studies, riboflavin in 19 out of 22, niacin in 12 out of 20, pyridoxine in 16 out of 20, folate in 18 out of 22, and cobalamin in 11 out of 15. Pantothenic acid (vitamin B5) intake was only assessed in two studies, from which positive and significant associations with breakfast consumption were also found.

Vitamin A and vitamin D were positively associated with breakfast consumption in 12 studies. On the other hand, intake of vitamin E was evaluated in 11 studies and most of them (9 studies) did not find significant associations. Vitamin K was evaluated in four studies, and in three of them the authors did not find significant associations.

Breakfast consumption and mineral dietary intakes were assessed in 32 studies. The association between breakfast consumption and calcium intake was the most frequent relationship, evaluated in 31 studies in the minerals group. Positive associations were found between breakfast consumption and iron intake (26/29), sodium (11/20) and zinc (14/18). Iodine was evaluated in two studies and both showed significant associations. Magnesium and potassium intakes were positively associated with breakfast consumption in 15 studies. Regarding phosphorous, only one author found significant associations (1/12). However, every study found significant associations between breakfast consumption and copper and manganese intake.

Table 3. Characteristics, description and summary of outcomes of articles included in the systematic review (SR) on breakfast and micronutrients intake.

Author	Country, Year and Type of Study	Aim	Sample and Characteristics of Participants [£]	Data Source and Dietary Assessment of Breakfast (BF)	Principal Outcome about Micronutrients
Affenito, S. et al. 2005 [30]	United States (US) N.A Longitudinal	To examine the association between BF frequency and Ca and fiber intake.	n = 2379 Girls. 9–19 y	National Heart, Lung, and Blood Institute Growth and Health Study 3 day-Food records	Frequent BF consumption was associated with more intake of Ca regardless of the total amount of EI consumed ($p < 0.001$).
Affenito S. et al. 2013 [41]	US 2004–2005 Cross-sectional	To examine the association of RTEC consumption and dietary nutrients intake.	n = 2298 5–18 y	The third School Nutrition Dietary Assessment Study 1–24 h dietary recall	BF consumption improves the intake of vitA, Ca and Fe ($p < 0.05$).
Afeiche, M. et al. 2017 [28]	Mexico, 2012 Cross-sectional	To compare BF dietary patterns (DP) with BF skipping and the associations with total-day diet energy and nutrients intake.	n = 3760 4–13 y	Mexican National Health and Nutrition Survey 1–24 h dietary recall	BF skippers consumed less B vitamins (riboflavin, niacin, pyridoxine, folate and cobalamin), Ca, vitD, Fe, Zn, Na, and K than BF consumers. The sweetened beverages and milk and sweetened breads DP had the lowest intakes of Fe, Zn and K at BF.
Albertson A. et al. 2003 [56]	US 1998–1999 Cross-sectional	To assess the relationship between RTEC frequency consumption and nutrients intake in children.	n = 603 4–12 y	American household surveys 14–Food records	RTEC frequency of consumption was not associated to Na, vitE, but it was associated with high intake of vitA, pyridoxine, vitC, thiamin, riboflavin, niacin, folate, Ca, Mg, Fe and Zn (p = 001).
Albertson A. et al. 2008 [57]	US 1987 Longitudinal	To assess the association between RTEC consumption and energy and nutrients intake.	n = 2379 9–10 y	The National Heart, Lung, and Blood Institute Growth Health Study 1–24 h dietary recalls	RTEC consumers did not differ from non-RTEC consumers in Na intake (N.S).
Balvin Frantzen, L. et al. 2013 [58]	US 2001–2004 Longitudinal	To assess the association between frequency of RTEC consumption and nutrients intake.	n = 625 Mean age = 9.13 y	BIENESTAR Study 3–24 h dietary recalls	Baseline data analysis concludes that frequency of RTEC consumption was positively associated with the intake of vitD, vitC, riboflavin, niacine, cobalamin, Ca, Fe, and K. ($p < 0.05$).
Barr, S. et al. 2014 [42]	Canada 2004 Cross-sectional	To assess the effect of skipping BF, consuming BF and consuming BF with RTEC on intake of nutrients.	n = 12,281 4–18 y	Canadian Community Health Survey, 2004. 1–24 h dietary recall	RTEC consumers had a higher intake of thiamin, pyridoxine, vitD, Ca, Fe, Mg, P, and K than other-BF consumers and non-BF consumers. Both BF consumers and RTEC consumers had higher intakes of vitA, folate and vitC compared with BF skippers. RTEC consumers had higher intakes of riboflavin than non-RTEC consumers and BF skippers. Other-BF consumers had higher intake of niacin than other groups ($p < 0.05$).
Barr, SI. et al 2018 [43]	Canada 2015 Cross-sectional	To compare daily EI and nutrients intake of BF consumers and BF skippers.	n = 2331 6–12 y n = 2026 13–17 y	Canadian Community Health Survey-Nutrition 1–24 h dietary recall	Children and adolescents who usually consume BF had a higher intake of thiamin, vitC, Fe, and Mg ($p < 0.5$). In adolescents, BF consumers had a high intake of vitA, riboflavin, cobalamin, vitD and K ($p < 0.01$), pyridoxine, Ca ($p < 0.01$), and Zn ($p < 0.5$).

Table 3. *Cont.*

Author	Country, Year and Type of Study	Aim	Sample and Characteristics of Participants [£]	Data Source and Dietary Assessment of Breakfast (BF)	Principal Outcome about Micronutrients
Barton, B. et al. 2005 [59]	US 1985 Cross-sectional	To assess the association of BF and RTEC consumption with intake of nutrients.	n = 2379 9–19 y	National Heart, Lung and Blood Institute Growth and Health study 3–24 h dietary recalls	RTEC consumption increases the intake of Ca, Fe, folate, vitC, and Zn.
Coulthard, J. et al. 2017 [3]	United Kingdom (UK) 2008–2012 Cross-sectional	To assess differences in nutrients intake between BF skippers and BF consumers.	n = 1686 4–18 y	National Diet and Nutrition Survey 4–Food records	Children and adolescents had significantly higher mean intakes of folate, Ca and I, and significantly lower mean intakes of Na for days on which BF was consumed compared with non-BF days. Frequency of BF consumption was positively associated with folate, Na, Ca, Fe, and I ($p < 0.05$).
Deshmukh-Taskar, P. et al. 2010 [70]	US 1999–2006 Cross-sectional	To assess the relationship between skipping BF or having lunch with nutrients intake, nutrient adequacy and adiposity.	n = 930 9–13 y n = 1805 14–18 y	NHANES [Ω] 1–24 h dietary recall	In both children and adolescents, BF skippers had a lower intake of vitA, vitC, riboflavin, cobalamin, folate, Ca, P, Mg, K, and Zn than the other groups ($p < 0.05$). RTEC consumers had lower Na intake than the other groups ($p < 0.05$). Thiamine, niacin, pyridoxine and Fe intake was significantly higher in the RTEC consumers group ($p < 0.05$).
Fayet-Moore, F. et al. 2016 [46]	Australia 2007 Cross-sectional	To assess the impact of BF skipping, BF with RTEC and BF without RTEC on nutrient intake.	n = 4487 2–16 y	Australian National Children's Nutrition and Physical Activity Survey 2–24 h dietary recall	BF consumers had a higher intake of total Ca, folate, Mg and Zn than BF skippers. RTEC consumers had higher intake of Fe, P, K, I, and Na ($p < 0.001$). BF consumers, and to a higher degree RTEC consumers, were more likely to meet the EAR of Ca and Fe than BF skippers ($p < 0.001$).
Fayet-Moore, F. et al. 2017 [45]	Australia 2011–2012 Cross-sectional	To investigate the impact of BF skipping, BF with RTEC and BF without RTEC on daily nutrients intake.	n = 2821 2–18 y	National Nutrition and Physical Activity Survey 1–24 h dietary recall	BF skippers had lower niacin, Fe, thiamin, riboflavin, folate and Ca, intake whereas they had a higher Na intake than BF consumers ($p < 0.001$).
Fulgoni, VL. et al. 2019 [55]	US 2011–2014 Cross sectional	To compare diet quality and nutrient intake among children consuming an oatmeal-containing BF versus those of children consuming other popular BF.	n = 5876 2–18 y	NHANES [Ω] 1–24 h dietary recall	Oatmeal consumers had a significantly higher intake of Ca, Fe, Mg, K, folate, vitA, and vitD than BF skippers. In children and adolescents, RTEC consumers had a higher intake of Ca, Fe, Mg, K, vitA, and vitE than those who usually consume "Doughnuts, sweets rolls and pastries"; higher intake of Mg and K than those who usually consume "Pancakes, waffles, French toast" and higher intakes of Ca, Fe and Mg than consumers of "Eggs and omelettes". RTEC consumers (lower and higher sugar) had a higher intake of Fe and folate than those children and adolescents who usually consume oatmeal BF.

Table 3. *Cont.*

Author	Country, Year and Type of Study	Aim	Sample and Characteristics of Participants [£]	Data Source and Dietary Assessment of Breakfast (BF)	Principal Outcome about Micronutrients
Gibson, S. et al. 1995 [60]	UK N.A Cross-sectional	To examine the relation ship between RTEC frequency of consumption and total daily nutrients intake.	n = 2705 10–15 y	7-day weighed records	Frequency of RTEC consumption in boys and girls was positively associated with Ca, Fe, thiamin, riboflavin, niacin, and pyridoxine intake.
Gibson, S. et al. 1999 [47]	UK N.A Cross-sectional	To examine associations between RTEC consumption and iron intake.	n = 904 1.5–4.5 y	UK National Diet and Nutrition Survey 4 day weighed records	High RTEC consumers had significantly higher Fe intakes than low cereal consumers. ($p < 0.0001$). They did not have a significantly higher intake of Ca compared to the other groups ($p = 0.06$).
Gibson, S. et al. 2003 [61]	UK N.A Cross-sectional	To examine the impact of RTEC on micronutrient status.	n = 1688 4–18 y	The National Diet and Nutrition Survey of Young People 7–24 h dietary recalls	The highest tertile of RTEC intake had 20–60% higher intake of iron, B vitamins and vitD, compared with the first tertile. A positive association between Fe, thiamin, riboflavin and folate was observed across tertiles of RTEC consumption ($p < 0.001$).
Matthys, C. et al. 2007 [65]	Belgium 1997 Cross-sectional	To describe BF consumption patterns and overall nutrients profile.	n = 341 13–18 y	Food Consumption Survey 7–24 h dietary recalls	Good quality of BF was associated with higher intake of Ca, Mg, thiamin, riboflavin and vitC and P compared to low quality of BF consumers ($p \leq 0.001$). Specifically, girls with good quality of BF had a significantly higher intake of Ca, P, Fe, Mg, thiamin, riboflavin, and vitC ($p < 0.001$).
McNulty, H. et al. 1996 [64]	Ireland 1990 Cross-sectional	To establish the contribution of RTEC to the overall nutrients intake.	n = 1015 12–15 y	1–24 h dietary recall	Higher RTEC consumption was associated with higher cobalamin intake, except for boys aged 12 years. Folate intake significantly increased with increasing intake of fortified BF cereals in the younger adolescents ($p < 0.05$). Ca intake increased with increasing BF cereals intake in all age and sex groups ($p < 0.05$).
Michels, N. et al. 2015 [48]	Europe 2006–2007 Cross-sectional	To analyze the association of RTEC consumption frequency with dietary intake.	n = 1215 12.5–17.5 y	HELENA Study [Ω] 1 Food Frequency Questionnaire 2–24 h dietary recalls	Ca, P, K, riboflavin, pantothenic acid, biotin, and VitD intakes were significantly higher in the RTEC consumers group ($p < 0.05$).
Mielgo-Ayuso, J. et al. 2017 [16]	European countries 2006–2007 Cross-sectional	To examine the association between BF consumption patterns and vitamins intake	n = 1058 12.5–17.5 y	HELENA Study [Ω] 2–24 h dietary recalls	BF consumption was associated with high intakes of vitD and folate in both sexes, with high intakes of pyridoxine and vitE in girls ($p < 0.05$).
Mohd Nasir, M.T. et al. 2017 [67]	Malaysia 2013 Cross-sectional	To compare foods consumed at breakfast and nutrient intake for the total day between RTEC consumers and non-RTEC consumers	n = 1819 6–12 y	MyBreakfast study Children 6–9 y: 2 day food records Children 10–12 y: 2–24 h dietary recalls	RTEC consumers had a higher daily intake of vitC, thiamine, riboflavin, niacin, Ca, and Fe ($p < 0.05$). Non-RTEC consumers had a higher intake of Na than RTEC consumers ($p < 0.05$). No significant associations in vitA and P were observed between RTEC consumers and non-RTEC consumers.

Table 3. *Cont.*

Author	Country, Year and Type of Study	Aim	Sample and Characteristics of Participants [£]	Data Source and Dietary Assessment of Breakfast (BF)	Principal Outcome about Micronutrients
Morgan, K.J. et al. 1981 [49]	US 1977 Cross-sectional	To assess BF consumption pattern and relate it with nutrients intake	n = 657 5–12 y	7 day food records	BF had a significant contribution to child's daily nutrients intake. RTEC consumers for 3 or more times per week had higher intake of Fe and B vitamins ($p < 0.001$) than non-RTEC consumers.
Murakami, K. et al. 2018 [68]	Japan 2012 Cross-sectional	To assess BF consumption and its association with daily dietary intake of nutrients, food groups and overall diet quality.	n = 1444 6–11 y n = 1134 12–17 y	National Health and Nutrition Survey 2012 1 Dietary record	BF consumers had higher intakes of vitK, folate, vitC, Ca, Mg, and P in both age groups. Children who usually consumed BF had a higher intake of vitA, vitK and vitC than BF skippers ($p < 0.05$). In adolescents, BF consumers had a higher intake of K and Fe than BF skippers ($p < 0.05$). In both children and adolescents, BF skippers had a lower intake of pyridoxine, folate, pantothenic acid, Ca, Mg, P, and Zn than BF consumers ($p < 0.05$).
Ortega, RM. Et al. 1996 [62]	Spain N.A Cross-sectional	To analyze the influence of RTEC consumption at BF upon dietary habits.	n = 200 9–13 y	4–24 h dietary recalls	The intake of thiamine, pyridoxine, folate, β-carotene ($p < 0.05$), riboflavin, and I ($p < 0.1$) was higher in the group of RTEC consumers.
Ortega, RM. et al. 1998 [63]	Spain N.A Cross-sectional	To assess the association between Ca and milk products consumed at BF with their total daily intake.	n = 200 9–13 y	7–24 h dietary recalls	BF with <20% of total EI included lower quantities of Ca than larger BF ($p < 0.05$). These adolescents also consumed less Ca over the rest of the day.
Papoutsou, S. et al. 2014 [66]	Cyprus 2007–2008 Cross-sectional	To investigate the association of BF pattern consumption with children's diet quality in a sample from Cyprus.	n = 1558 4–8 y	IDEFICS Study [Ω] 1–24 h dietary recall	Milk and pastry consumers had lower intake of Fe, Na, thiamin, riboflavin, and pyridoxine than RTEC consumers. Other—BF, milk and pastry consumers had lower intakes of vitA and vitC. Milk consumers had a lower intake of Mg than the other groups. Milk and pastry consumers had a higher intake of Mg and P ($p < 0.05$).
Preziosi, P. et al. 1999 [50]	France N.A Cross-sectional	To examine the associations between the intake of different types of BF and dietary intakes.	n = 1108 2–18 y	1–24 h dietary recall	Percent of RDA for Ca, P, magnesium, and Fe were exceeded in non-RTEC and RTEC consumers but was significantly higher in the group of RTEC consumers ($p < 0.05$). RDA for thiamine and riboflavin were also reached in both groups but RTEC consumers had higher intakes of both nutrients ($p < 0.001$ and $p < 0.01$). Percent of RDA for magnesium, Zn, copper, pyridoxine, folate, vitC, vitA, and vitE were also higher in the RTEC group.

Table 3. *Cont.*

Author	Country, Year and Type of Study	Aim	Sample and Characteristics of Participants £	Data Source and Dietary Assessment of Breakfast (BF)	Principal Outcome about Micronutrients
Ramsay, SA. Et al. 2018 [51]	US 2005–2012 Cross-sectional	To examine food intake, nutrients intake and overall diet quality among BF consumers and BF skippers.	n = 8590 2–12 y	NHANES Ω 1–24 h dietary recall	BF skippers did not meet the average amount of nutrients of children who consumed BF. BF skippers consumed less vitA, folate, Fe, and Ca than those who consumed BF.
Ruxton, CH. et al. 1996 [29]	UK Scotland 1991–1992 Cross-sectional	To provide new data on the BF habit of children	n = 136 5–9 y	7–24 h dietary recall	The overall diets of children in the high RTEC group were higher in micronutrients than the other groups. Folate and Fe in the low RTEC group were below recommendations.
Vatanparast, H. et al. 2019 [54]	Canada 2015 Cross-sectional	To evaluate how RTEC consumption contributed to daily energy and nutrient intakes and then compare them with non-consumers	n = 3810 6–12 y n = 2379 12–18 y	The Canadian diet, the recent nationally representative dietary survey 1–24 h dietary recall	Children and adolescents who usually consume RTEC had significantly higher intake of pyridoxine, vitD, riboflavin, thiamine, K, Ca, Fe, and Mg than non-RTEC consumers. In children, RTEC consumers had a higher intake of cobalamin and Zn than non-RTEC consumers. In adolescents, RTEC consumers had a lower intake of Na than non-RTEC consumers.
Williams, B.M. et al. 2009 [52]	US 1999–2002 Cross-sectional	To assess if BF dietary patterns are associated with nutrients intake and nutritional adequacy.	n = 1389 2–12 y	NHANES Ω 1–24 h dietary recall	RTEC consumers had a higher intake of vitA, cobalamin, thiamine, riboflavin, folate, and Fe ($p \leq 0.05$).
Williams, P. et al. 2007 [53]	Australia 1995 Cross-sectional	To assess the contribution of BF to the nutrition of Australian children and adolescents.	n = 3007 2–18 y	National Health Survey 1–24 h dietary recall 1 FFQ	Higher RTEC consumption was associated with higher cobalamin intake, except for boys aged 12 years. Folate intake significantly increased with increasing intake of RTEC in younger adolescents. ($p < 0.05$). Ca intake increased with increasing BF cereal intake in all age and sex groups. ($p < 0.05$).

£ = All the studies included boys and girls in their analysis, except those in which it was specified that only one gender was included. Abbreviations: N.A: Not available; BF: Breakfast; Y = Years; EI: Energy intake; RTEC: Ready to eat cereal; DP: Dietary Pattern; RDA: recommended dietary allowances; vitA: vitamin A; vitC: vitamin C; vitE: vitamin E; vitD: vitamin D; vitK: vitamin K; Mg: magnesium; Zn: zinc; Ca: Calcium; Na: Sodium; K: potassium; Fe: iron; I: Iodine; P: Phosphorus; Ω = IDEFICS—Identification and prevention of dietary- and lifestyle-induced health effects in children and infants; HELENA—Healthy Lifestyle in Europe by Nutrition in Adolescence.; NHANES—National Health and Nutrition Examination Survey; FFQ: Food Frequency Questionnaire.

3.4. Meta-Analysis Results: Measurement of the Effect of the Relationship between Type of Breakfast and Micronutrients Intake

Differences in vitamins and minerals consumption between RTEC breakfast consumers and breakfast skippers are shown in Figure 2 (vitamins) and Figure 3 (minerals).

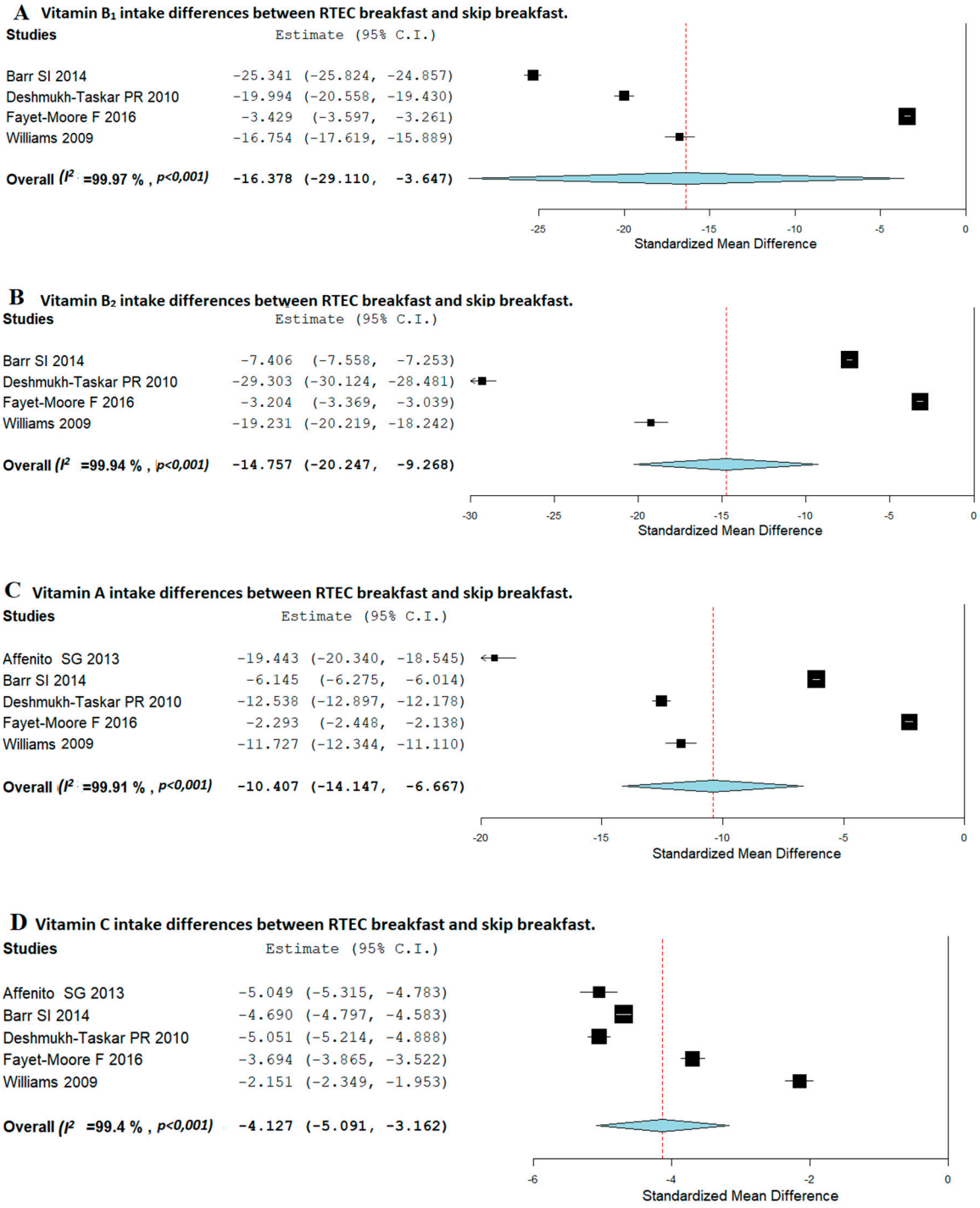

Figure 2. Random-effects meta-analysis of the effects of relationships between Ready to Eat Cereal (RTEC) breakfast and breakfast-skipping concerning vitamin B1 (**A**), vitamin B2 (**B**), vitamin A (**C**), and vitamin C (**D**) intake. CI: confidence intervals.

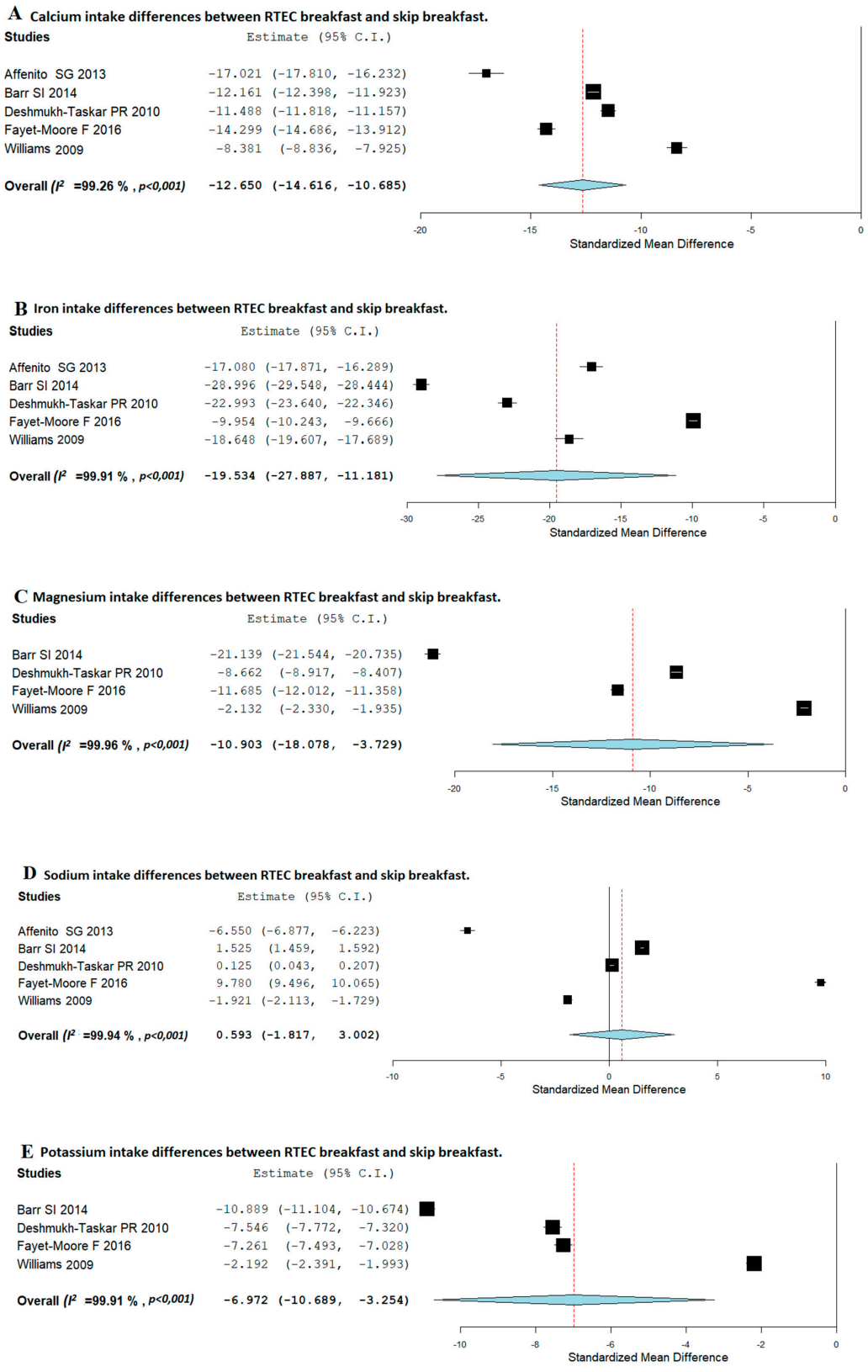

Figure 3. Random-effects meta-analysis of the effects of relationships between RTEC breakfast and breakfast-skipping concerning calcium (**A**), iron (**B**), magnesium (**C**), sodium (**D**), and potassium (**E**) intake.

Regarding vitamins intake, as presented in Figure 2A, in children, RTEC consumers had significantly higher daily consumption of thiamine (vitamin B1) than children who usually skip breakfast (SMD, −16.378; 95%CI: −29.110, −3.647). However, heterogeneity amongst studies was high (I^2 = 99.97%; $p < 0.001$). Figure 2B shows that RTEC consumers had significantly higher daily intake of riboflavin (vitamin B2) than children who usually skip breakfast (SMD, −14.757; 95%CI: −20.247, −9.268). Heterogeneity amongst studies was very high (I^2 = 99.94; $p < 0.001$). Analyzing the consumption of Vitamins A and C, Figure 2C,D shows that those children who usually consume RTEC had a significantly higher intake in both vitamins than those who usually skip breakfast (SMD, −10.407; 95%CI: −14.147, −6.667 and SMD, −4.127; 95%CI: −5.091, −3.162), respectively, the heterogeneity amongst studies being very high (I^2 = 99.91; $p < 0.001$ and I^2 = 99.4; $p < 0.001$, respectively).

Regarding minerals consumption, Figure 3A,B shows that children who usually ate RTEC breakfast had significantly higher daily consumption of calcium and iron than children who skipped breakfast (SMD, −12.650; 95%CI: −14.616, −10.685 and SMD, −19.534; 95%CI: −27.887, −11.181, respectively), the heterogeneity between studies being very high (I^2 = 99.26; $p < 0.001$ and I^2 = 99.91; $p < 0.001$, respectively). Likewise, as it is shown in Figure 3C,E, RTEC consumers had a significantly higher magnesium and potassium intake than breakfast skippers (SMD, −10.903; 95%CI: −18.078, −3.729) and (SMD, −6.972; 95%CI: −10.689, −3.254), respectively. The heterogeneity between studies was high (I^2 = 99.96; $p < 0.001$ and I^2 = 99.91; $p < 0.001$, respectively). Concerning sodium, no significant associations were observed between those children who usually consume RTEC breakfast and breakfast skippers (Figure 3D).

Differences in vitamins and minerals intake between consumption of other types of breakfast and skipping breakfast are shown in Figure 4 (vitamins) and Figure 5 (minerals).

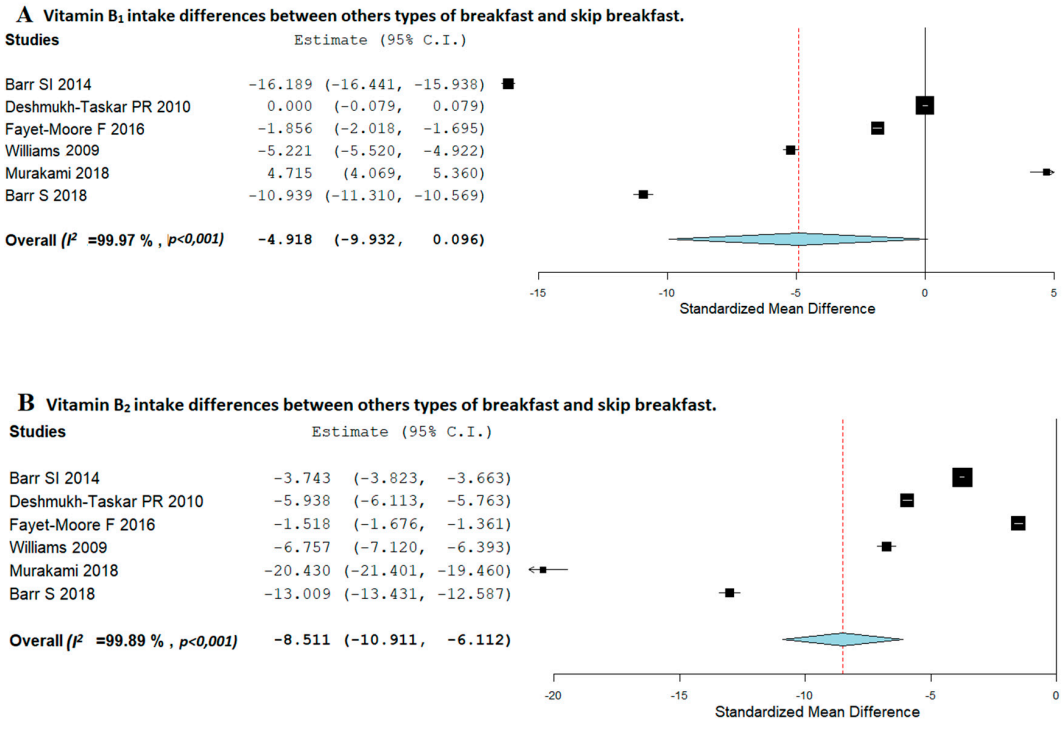

Figure 4. *Cont.*

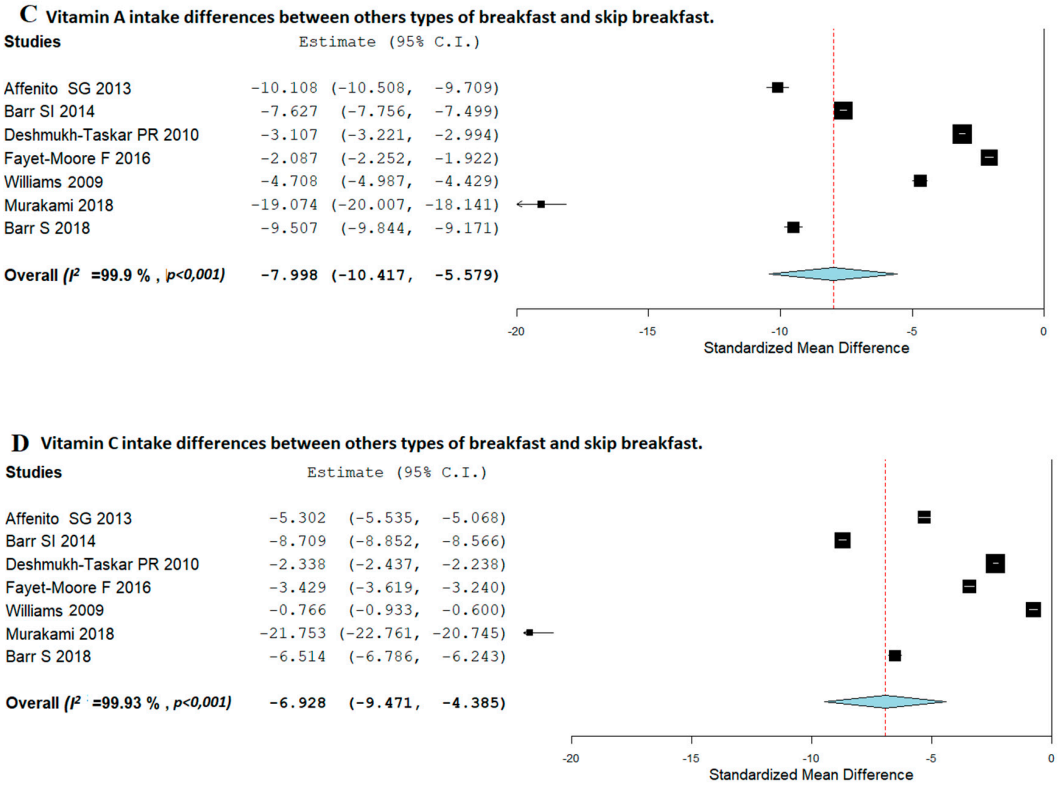

Figure 4. Random-effects meta-analysis of the effects of relationships between consumption of other types of breakfast and breakfast-skipping concerning vitamin B1 (**A**), vitamin B2 (**B**), vitamin A (**C**), and vitamin C (**D**) intake.

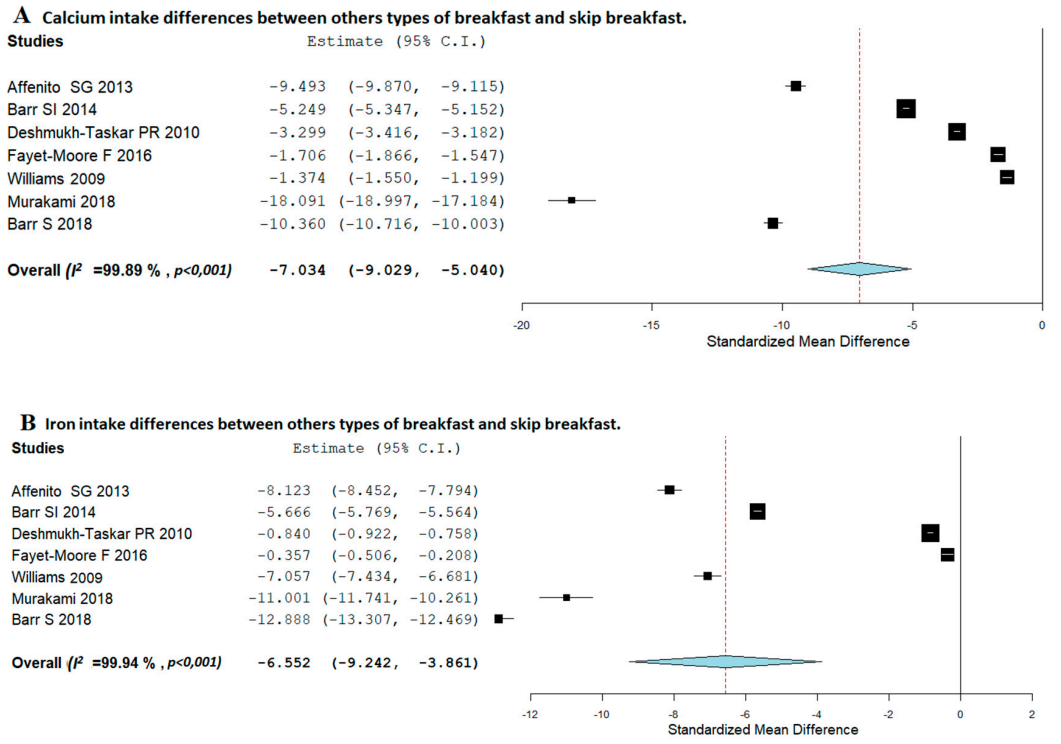

Figure 5. *Cont.*

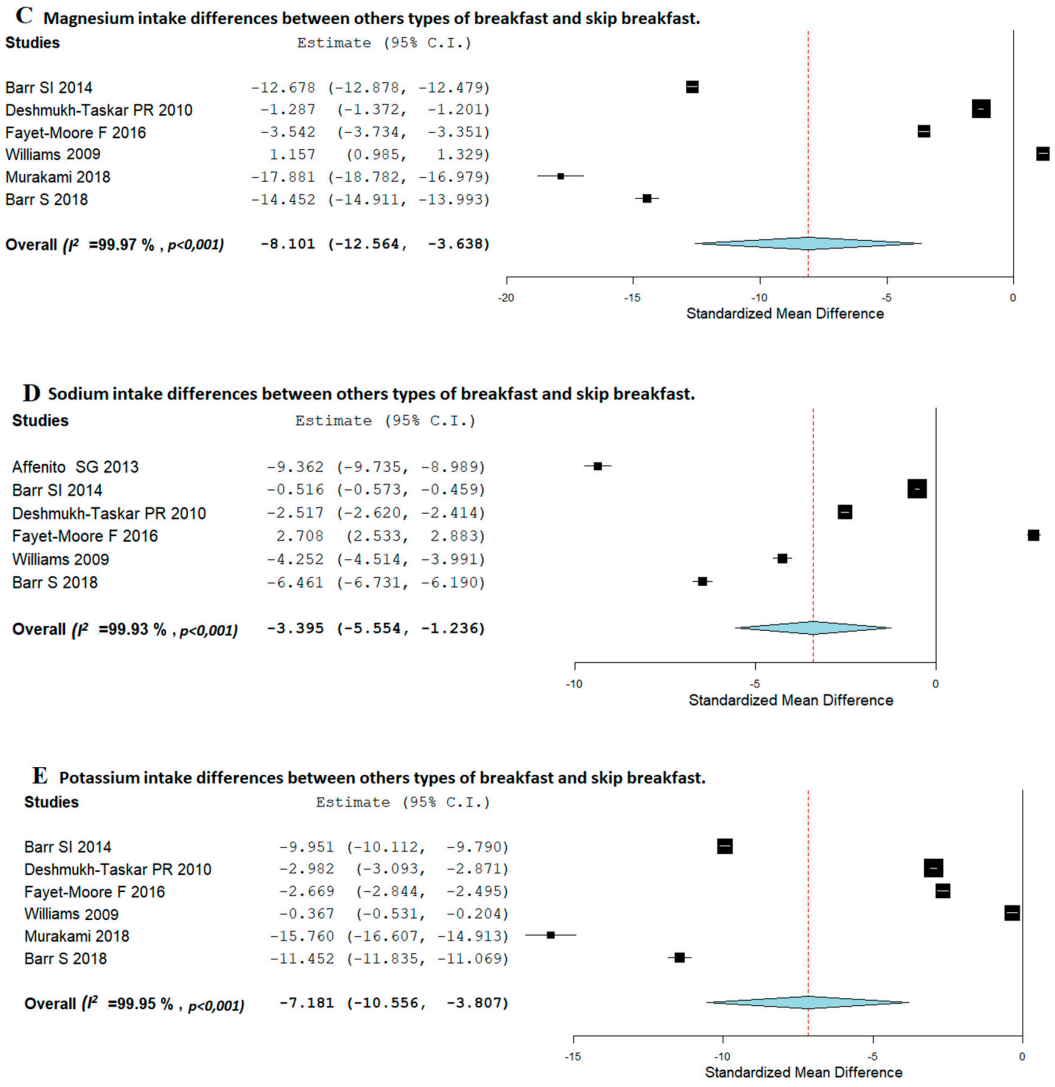

Figure 5. Random-effects meta-analysis of the effects of relationships between consumption of other types of breakfast and breakfast-skipping concerning calcium (**A**), iron (**B**), magnesium (**C**), sodium (**D**), and potassium (**E**) intake.

Regarding thiamine (vitamin B1), no significant associations were observed between breakfast consumers and those children skipping breakfast (Figure 4A). Nevertheless, those children who eat breakfast had a higher significantly daily riboflavin (vitamin B2) consumption than those children who usually skip breakfast (SMD, −8.511; 95%CI: −10.911, −6.112) (Figure 4B). The heterogeneity between studies was high (I^2 = 99.89%; $p < 0.001$).

Regarding Vitamin A and C, Figure 4C,D shows that breakfast consumers had a significantly higher consumption of vitamin A and C than those children who usually skip breakfast (SMD, −7.998; 95%CI: −10.417, −5.579 and SMD, −6.928; 95%CI: −9.471, −4.385, respectively). The heterogeneity amongst studies was high, (I^2 = 99.9%; $p < 0.001$) and (I^2 = 99.93%; $p < 0.001$), respectively.

When analyzing minerals intake, Figure 5A,B shows that those who usually consume breakfast had significantly higher daily intake of calcium and iron than breakfast skippers, (SMD, −7.034; 95%CI: −9.029, −5.040) and (SMD, −6.552; 95%CI: −9.242, −3.861), respectively. The heterogeneity between studies was high, (I^2 = 99.89%; $p < 0.001$) and (I^2 = 99.94%; $p < 0.001$), respectively. Regarding magnesium intake (Figure 5C), breakfast consumers had a higher consumption in respect to breakfast

skippers (SMD, −8.101; 95%CI: −12.564, −3.638). Nevertheless, the heterogeneity between studies was high (I^2 = 99.97%; $p < 0.001$).

Likewise, as shown in Figure 5D,E, it was observed that breakfast consumers had higher consumption of sodium and potassium in respect to breakfast skippers, (SMD, −3.395; 95%CI: −5.554, −1.236) and (SMD, −7.181; 95%CI: −10.556, −3.807), respectively. The heterogeneity amongst studies was high, (I^2 = 99.93%; $p < 0.001$) and (I^2 = 99.95%; $p < 0.001$), respectively.

4. Discussion

To the author's knowledge, this is the first SR taking into consideration the association between breakfast consumption and daily micronutrients intake. The most important finding was the association between breakfast consumption and a higher daily vitamins and minerals intake in both children and adolescents.

Articles included assessed diet using individual or combined FR, 24h-DR, and FFQ. The most common strategy to collect dietary information was through face-to-face interview (n = 11; 33.33%). Nine studies (27.27%) included a self-reported questionnaire, five studies included caregiver-reported questionnaires (15.15%), and eight studies (24.24%) a combination of self- and caregiver-reported questionnaires. Likewise, when assessing dietary intake, it is important to evaluate how nutrients were computed; however, only a few studies (n = 7) reported the reference of the used food composition tables [28,50,62,63,65,67,68].

Most of the studies included in this SR compared the dietary intake of breakfast consumers or consumers of different types of breakfast, for instance RTEC-based breakfast with breakfast-skippers. Actually, of the 30 included studies, the main issue was breakfast's RTEC consumption (n = 22; 66.66%). RTEC include many types of cereals, refined, whole grain, sweetened, and unsweetened, but in the markets and industry predominantly exists RTEC refined and sweetened. Several previous studies recognized that RTEC consumption at breakfast is associated with a healthier diet [32,52,54,56,67,71] but, in a previous review, authors suggested that RTEC with functional and best nutrient profiles should be developed [72]. In another review, RTEC consumption was related with a healthier dietary pattern (DP), nevertheless, total sugar intake was also high [73]. Some RTEC have high fiber content and have been fortified with essential nutrients as vitamins and minerals, but usually they are low in fat and high in carbohydrates, polysaccharides and sugar [59,74]. Previous studies suggested that RTEC could promote breakfast consumption as RTEC consumption was frequent among breakfast consumers [75]. Nevertheless, for future studies it would be important to investigate or differentiate the cereal consumed e.g., oats, muesli or RTEC sweetened, as not all types of cereals are good sources of micro- and macro-nutrients [46].

4.1. Breakfast Consumption and Vitamins Intake

Taking into consideration some specific foods consumed at breakfast, such as RTEC, some studies compared children or adolescents' RTECs with non-RTEC consumers at breakfast. Some authors showed associations between RTEC consumption and vitamins intake. Five articles showed that RTEC consumers, both in children and adolescents [44,50,53,56,58], had a higher vitamin A intake than those who usually skip breakfast. Papoutsou et al. showed that those who eat milk and pastries or other types of breakfast had lower intakes of vitamin A [66] than those children who eat regularly RTEC at breakfast. Regarding B vitamins intake, Morgan et al. [49] observed that children who eat RTEC three or more times per week had a higher intake of the B vitamins group. Also, children and adolescents who usually consume RTEC had a high intake of the following B-vitamins: thiamine [42,50,52,54,56,60–62,67], riboflavin [42,44,48,50,52,54,56,58,60–62,67], niacin [42,44,56,58,60,67], pyridoxine [42,44,50,54,56,60,62], biotin [48], folate [29,42,44,50,52,53,56,59,61,62,64], and cobalamin [44,52–54,58,64]. Furthermore, our meta-analysis showed similar results for the difference in micronutrients intake between children consuming RTEC breakfast and those skipping breakfast. In children, those who usually consume RTEC had a high intake of thiamine, riboflavin, vitamin A, and vitamin C.

In the same way, in both children and adolescents, RTEC consumers compared with those who consume other types of breakfast had higher intakes of thiamine, riboflavin, pyridoxine, folate, vitamin A, and vitamin C [42,66]. These results are in line with the frequent fortification of RTEC with vitamins and other micronutrients [59,74]. Previous research showed that the fortified cereal's consumption with milk produces some benefits in terms of the vitamins and iron intake, and significant improvement in biomarkers of nutritional status [76].

Different authors observed significant associations between breakfast consumption and vitamins intake. Breakfast consumers had a higher intake of vitamin A [41,43,51,68], thiamine [16,43,46,51,68], riboflavin [16,43,46,51], niacin [16,46,51], folate [16,46,51,68], and vitamin D [16,43] than breakfast skippers. Furthermore, an additional included study observed that regular breakfast consumption is associated with higher intakes and higher blood concentrations of some vitamins [16]. Additionally, our meta-analysis presented similar results. Breakfast consumers had a higher intake of riboflavin, vitamin A and vitamin C.

Breakfast consumption has been consistently associated with a better favorable nutrient intake [16,42]; in this sense, a previous study observed that breakfast skippers were significantly less likely to eat the recommended five servings of fruits and vegetables a day [16,77]. Furthermore, those children who usually consume breakfast usually consume more healthful breakfast foods like fruits, cereals, bread or milk [77].

4.2. Breakfast Consumption and Minerals Intake

Thirty-two articles (96.96%) investigated the association between breakfast consumption and minerals intake. Considering specific food groups consumed at breakfast, some authors observed a positive association between RTEC consumed at breakfast and the following minerals: calcium [42,44,48,50,54,56,58–60,67], iron [29,42,44,46,47,49,50,52,54,56,58–61,67], sodium [46], magnesium [42,50,54,56], zinc [50,54,56,59], potassium [42,46,48,54,58], phosphorous [42,46,48,50], iodine [46,62], and copper [50]. Also, two additional studies showed that calcium intake increased with cereal consumption [53,64]. Milk and dairy products used to be the major breakfast constituents in most of the countries [78,79] and provide a high source of vitamins and minerals such as calcium, vitamin D, magnesium, or phosphorous [80–82]. Furthermore, two articles showed that those who usually consume RTEC had a high consumption of milk and dairy products [48,57]. In contrast, Ortega et al. presented that dairy breakfast consumption was associated with high daily calcium intake, but this does not depend solely on breakfast consumption [63].

Children and adolescents who usually consume breakfast had higher intakes of calcium [3,30,41,43,45,46,68], iron [3,41,43,45,68], potassium [43,68], magnesium [43,68], zinc [43,68], and iodine [3] than breakfast skippers. In agreement with our SR, our meta-analysis presents similar results, breakfast consumers had a higher consumption of iron, calcium and magnesium. In the same way, Mattys et al. showed that adolescents with good quality breakfast consumed a higher intake of iron, magnesium and phosphorous [65].

It is important to mention that in a previous intervention study, [24] authors observed that adolescents who used to consume breakfast had more adequate vitamins and minerals intakes than those used to skip breakfast. It is worth noticing that approximately 92% of all RTEC are fortified with essential nutrients, however, in different previous studies, authors showed that children and adults who regularly consume RTEC increase their daily vitamins and minerals intake [31,83].

4.3. Potential Influencing Factors of Heterogeneity

We have to acknowledge that important heterogeneity was found for both types of analyzed groups, skipping breakfast versus RTEC breakfast or consumption of others types of breakfast. The high heterogeneity can be explained by the large range of subject's age (2–16 years) and sample size of the included studies (min. 200, max. 12,281 participants) and the used dietary assessment method (24 h-DR, FR or FFQ). Responses may vary depending on the respondent of these questionnaires (children, adolescents, parents or caregivers) and the socio-cultural desirability. To address these

differences, the included meta-analysis was done by age subgroups, showing no differences in their heterogeneity.

4.4. Strengths and Limitations

Our study has some limitations. Firstly, the studies' design, as most of the included articles were cross-sectional, and it is not possible to determine cause–effect associations between exposure and outcome variables. Half of the studies were not performed in representative samples of the correspondent population, compromising their representativeness. Furthermore, the methodology has its own limitations, for example, some of the included articles evaluated the dietary intake with one 24 h-DR, which is not representative of the habitual diet. Nevertheless, this method is accepted for studying the intake in a large sample of the population and estimating the mean nutrients intake. Reported dietary intake could provide biased results (under or over-reporting) due to social desirability. Furthermore, we only included publications in English and Spanish, and we had to refuse two studies wrote in other different languages (Chinese and Korean). On the other hand, the number of comparison groups is large, making it difficult to obtain conclusions. Only one study analyzed the association between breakfast consumption and blood vitamins concentrations, and it was no possible to compare the results [16].

One of the strengths of the current manuscript is that, to our knowledge, this is the first systematic review and meta-analysis analyzing the associations between breakfast consumption and overall daily micronutrients intake. Also, the included studies were developed in four different continents (America, Asia, Europe and Oceania), which is interesting because they offer a global perspective. On the other hand, the population included in the studies were children and adolescents, and it is important because this means breakfast consumption during youth. Finally, some of the studies were included in the meta-analysis allowing to weight the effect of breakfast on micronutrient intake in young population.

5. Conclusions

Breakfast consumption seems to be associated with higher vitamins and minerals intake. On the other hand, the most frequent food consumed at breakfast was RTEC, and RTEC consumption at breakfast might have beneficial effects in daily vitamins and minerals intake. However, it is important to know the nutritional profile of the RTEC consumed, as they usually have a high-added sugars and/or fat content, and these components should be avoided.

Dietary habits change over the years, and therefore breakfast foods tend also to change. In this sense, it is essential to develop new studies to recognize breakfast consumption impact and its relationship with overall health. Additional studies should be developed to investigate the relationship of the different foods and beverages consumed at breakfast in terms of vitamins and minerals intake and their status.

Supplementary Materials: The following are available online at http://www.mdpi.com/2072-6643/12/10/3201/s1. Table S1. Quality appraisal findings.

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Abbreviations

95%CI	95% confidence intervals
24 h-DR	24 h-dietary recalls
µg	Microgram
AXIS	The Appraisal tool for Cross-sectional Studies
BF	Breakfast
DP	Dietary Pattern
EI	Energy Intake
FFQ	Food Frequency Questionnaire
FR	Food Records
IBRI	International Breakfast Research Initiative
MD	Mean Difference
mg	Milligrams
MUFA	Monounsaturated Fatty Acids
N.A	Not Available
PICO	Participants, Intervention, Control, Outcomes
PRISMA	Preferred Reporting Items For Systematic Reviews and Meta-Analysis.
PUFA	Polyunsaturated Fatty Acids
RTEC	Ready to eat cereal
SF	Saturated fat
SR	Systematic Review
UK	United Kingdom
US	United States
y	Years

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MANUSCRIPT III

Cross-Sectional Associations Between Mothers and Children's Breakfast Routine-The Feel4Diabetes-Study.

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Cross-Sectional Associations between Mothers and Children's Breakfast Routine—The Feel4Diabetes-Study

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Abstract: Positive influences of family members have been associated with a high probability of children's daily breakfast consumption. Therefore, the aim of this study was to scrutinize the association of breakfast routines between mothers and their children. The baseline data of the Feel4Diabetes-study was obtained in 9760 children (49.05% boys)–mother pairs in six European countries. A parental self-reported questionnaire gauging the frequency of breakfast consumption and of breakfast' foods and beverages consumption was used. Agreement in routines of mothers and their children's breakfast consumption was analyzed in sex-specific crosstabs. The relationship of breakfast routine and food groups' consumption between mothers and their children was assessed with analysis of covariance. The highest proportion of children who always consumed breakfast were those whose mothers always consumed it. Children consuming breakfast regularly had a higher intake of milk or unsweetened dairy products and all kind of cereal products (low fiber and whole-grain) than occasional breakfast consumers ($p < 0.05$). The strong similarity between mothers and children suggests a transfer of breakfast routine from mothers to their children, as a high proportion of children who usually consume breakfast were from mothers also consuming breakfast. All breakfast foods and beverages consumption frequencies were similar between children and their mothers.

Keywords: breakfast; children; mother; mother's influence

1. Introduction

Breakfast is an essential part of a healthy diet [1] because it has been associated with general health and well-being in both adults and children [2]. Recent systematic reviews and meta-analyses observed that breakfast consumption was associated with better daily macro- and micronutrient intake in children and adolescents. [3,4]. It has been reported that children and adolescents who ate breakfast regularly had a healthier food pattern compared with breakfast skippers [5]. Moreover, breakfast consumption has been associated with the daily consumption of healthier foods and beverages, such as fruits and vegetables, dairy products, and cereals [4]. Most children who often skip breakfast usually do not meet the daily recommendations for fruits and vegetables [6]. Different studies observed that skipping breakfast also had reduced intakes of many nutrients, like vitamins, minerals, or dietary fiber [7,8], and a high prevalence of nutrient inadequacy [9]. In agreement with this, previous systematic review and meta-analysis observed that skipping breakfast was associated with worse macronutrient intake and lower micronutrient intake [3,4].

Breakfast characteristics have changed over time depending on culture and food availability in different countries [1]. The breakfast routine should be part of a healthy lifestyle, and it is essential to be personalized according to eating preferences, habits, and culture [2]. Omission of breakfast or its irregular consumption has been associated with increased cardiovascular [10,11] or type 2-diabetes risk factors in adults and children [12,13]. Skipping breakfast has also been associated with increased appetite and a high risk of weight gain [14,15] and, as a consequence, overweight and obesity [16]. Breakfast consumption plays a protective role in preventing excess adiposity in children and adolescents [17,18], and in adolescents, it has been associated with high quality of daily nutrition also [4,8]. On the other hand, in children, it was observed that those who ate breakfast daily, particularly a high fiber cereal breakfast, had lower levels of insulin resistance [8]. Furthermore, in European adolescents, it was observed that regular breakfast consumption was associated with a healthier cardiovascular profile [19].

The social environment supporting children and adolescents has an impact on lifestyle behaviors, such as diet [20,21]. Positive influences from both friends and family members are found to be associated with a high probability of daily breakfast consumption [21]. In Australian families, those parents who shared meals with their children promoted healthy behaviors in their families [20]. Parental breakfast consumption has been associated with adolescent's breakfast consumption routine in a recent review [22]. In children and adolescents, in both sexes, some studies observed that maternal encouragement and eating behaviors influenced regular consumption of breakfast [23,24]. In adolescents, it was observed that girls tended to skip breakfast more often than boys [25]. Furthermore, girls who perceived their family relationships as negative were more likely to skip meals [26]. In a longitudinal study, it was found that family cohesion was positively associated with girl's breakfast consumption over a 10-year period [27]. However, to our knowledge, there is no information on associations between mothers and their children on breakfast routines and food consumption for breakfast.

The aim of our study was therefore to describe the breakfast routine in children and their mothers, analyzing (i) whether there is an association of breakfast habits between mothers and their children by sex, and (ii) whether there is an association of foods and beverages consumption at breakfast in between them. The study comprised a large sample of families from six European countries.

2. Materials and Methods

2.1. Study Design and Data Collection

The current study considered the baseline data of the Feel4Diabetes-study, which was an intervention study aiming to develop, implement, and evaluate an evidence-based and potentially cost-effective and scalable intervention program to prevent type 2 diabetes across Europe, primarily focusing on families from vulnerable groups. The Feel4Diabetes-study, which had a cluster-randomized design, was conducted in six European countries,

representing high income (Belgium and Finland), low/middle income countries (Bulgaria and Hungary), and high-income countries under austerity measures (Greece and Spain) [28]. Recruitment was based on a standardized, multi-stage sampling procedure and was conducted in six European countries. Participating countries were categorized into three socioeconomic levels according to the World Bank country classification. In each country, children, as well as their parents, attending the first three grades of primary schools located in the selected vulnerable areas were recruited to the study [28,29]. The baseline survey was conducted in the scholar year 2015–2016. Baseline measurements were conducted between April and June 2016. However, for three countries (Finland, Hungary, and Bulgaria) baseline measurements were extended during August and September 2016) to achieve the sample size. To account for seasonal variations, and to minimize the impact on each individual over time, follow-up measurements were conducted as close to the date of the baseline measurements as possible [28].

From the total Feel4Diabetes-study sample (n = 11,396 families), only mothers and their children with available information on breakfast consumption were considered (n = 9760) in this analysis.

The Feel4Diabetes-study adhered to the Declaration of Helsinki and the conventions of the Council of Europe on human rights and biomedicine and was approved by each local ethical committee. More specifically, in Belgium, by the Medical Ethics Committee of the Ghent University Hospital (ethical approval code: B670201524237; date approval: 21/04/15); in Bulgaria, by the Ethics Committee of the Medical University of Varna (ethical approval code: 52/10-3-201r; date approval: 10/03/16) and the Municipalities of Sofia and Varna, as well as the Ministry of Education and Science local representatives; in Finland, by the hospital district of Southwest Finland ethical committee (ethical approval code: 174/1801/2015; date approval: 13/03/15); in Greece, by the Bioethics Committee of Harokopio University (ethical approval code: 46/3-4-2015; date approval: 03/04/15) and the Greek Ministry of Education; in Hungary, by the National Committee for Scientific Research in Medicine (ethical approval code: 20095/2016/EKU; date approval: 29/03/16); in Spain, by the Clinical Research Ethics Committee and the Department of Consumers' Health of the Government of Aragón (ethical approval code: CP03/2016; date approval: 08/04/15). Participants received an information letter in which they were informed about the purpose of the study. Written and signed informed consent was obtained from the parents/caregivers [28].

2.2. Maternal Education

Maternal education was selected as a marker of the socioeconomic status of the participating families. It was obtained by a self-administered questionnaire completed by mothers. This was asked on a six-point scale ranging from "less than 7 years" to "more than 16 years" of education.

2.3. Anthropometric Measures

Mother's body mass index (BMI) was calculated based on their self-reported weight and height. Children were measured at schools by trained researchers [30]. Bodyweight was measured in light clothing and without shoes using an electronic scale (Type SECA 813; SECA, Hamburg, Deutschland), and body height was measured with a telescopic height-measuring stadiometer (Type SECA 217; SECA, Hamburg, Deutschland). Two readings were obtained out of each measurement and the mean was used for the analysis. A third measurement was also taken if the previous two measurements differed >100 g for weight or >1 cm for height. BMI was calculated from weight and height (kg/m^2), and also specific sex- and age- BMI z-score (zBMI) were calculated according to Cole et al. [31].

2.4. Breakfast Consumption and Food and Beverages Breakfast Consumption

The family's energy balance-related behaviors questionnaire was developed in order to assess habits related to diet and physical activity (total time devoted to physical activity

and screen activities). This questionnaire has previously been validated for its use in European countries [32]. The questionnaire was developed to be filled in by one of the parents or caregivers, who completed it both for him/herself and their child. Parents or caregivers were contacted through their children's school. An information letter regarding the objectives of the study and instructions about how to complete the questionnaires was sent. Questionnaires were delivered to the parents via the school and completed by them at home. Researchers were available to answer any doubt by e-mail or phone.

Parents also responded which one of them fulfilled the questionnaire. Only questionnaires filled in by mothers were used in this study as they represent the great majority (88.5%).

2.4.1. Breakfast Consumption

The frequency of mothers' and children's breakfast consumption was evaluated by the question "On how many days do you/does your child usually eat breakfast (a) on weekdays, and (b) on weekend days?". For weekdays, there were six possible answers ranging from "never/rarely" to "five days/week". For weekend days, there were three possible answers ranging from "never/rarely" to "two days/week". These variables were grouped and categorized into three groups: (a) Breakfast skippers (0–1 day/week), (b) Occasional breakfast consumers (2–5 days/week), and (c) breakfast consumers (6–7 days/week).

2.4.2. Foods and Beverages Breakfast Consumption

The frequency of mothers' and children's foods and beverages breakfast consumption was evaluated by the question, "Having in mind the previous week, how often did you and your child consume the following foods/beverage groups as part of your and his/her breakfast. Breakfast products chosen for the questionnaire were related to the goals of Feel4Diabetes intervention. Eight food and beverage groups were included: fruits, berries and vegetables, fruit juices fresh no sugar, soft drinks and sugar juices, milk or dairy products unsweetened, milk or dairy products sweetened, sweet or salty pastries, low fiber cereal products, and whole-grain cereal products. Each group had four possible answers ranging from "0 days/week" to "7 days/week". These variables were summed up and categorized into three groups for each food and beverage group: (a) never (0 days), (b) sometimes (1–4 days/week), and (c) always (5–7 days/week).

2.5. Statistical Analysis

SPSS Statistics for Windows, Version 21.0, released in 2012 (IBM Corp., Armonk, NY, USA) was used to analyze the data. According to the nature of the studied variables, chi-square test for categorical variables and analysis of variance (ANOVA) for continuous variables were used to compare gender specific sample characteristics. Crosstabs, including chi-square tests for mothers' and children's breakfast consumption, were used to analyze the breakfast routine and the frequency of food and beverage group's breakfast consumption. Analysis of covariance (ANCOVA) was used to analyze the food and beverage groups' consumption of mothers and children in those who occasionally or usually consume breakfast. ANCOVA analysis between food and beverage groups' consumption of mother were adjusted by country, maternal education, and maternal BMI; ANCOVA analysis between food and beverage groups' consumption of children were adjusted by country, maternal education, and child's zBMI. Microsoft Excel version 14.7.0 was used to develop all graphics and figures. All statistical tests were stratified by child's sex, and p-values lower than 0.05 were considered statistically significant.

3. Results

In total, 9760 children (49.05% boys) and their mothers were included in the analysis. Table 1 presents sex-specific sociodemographic characteristics and breakfast routine. In the study sample, boys were older than girls.

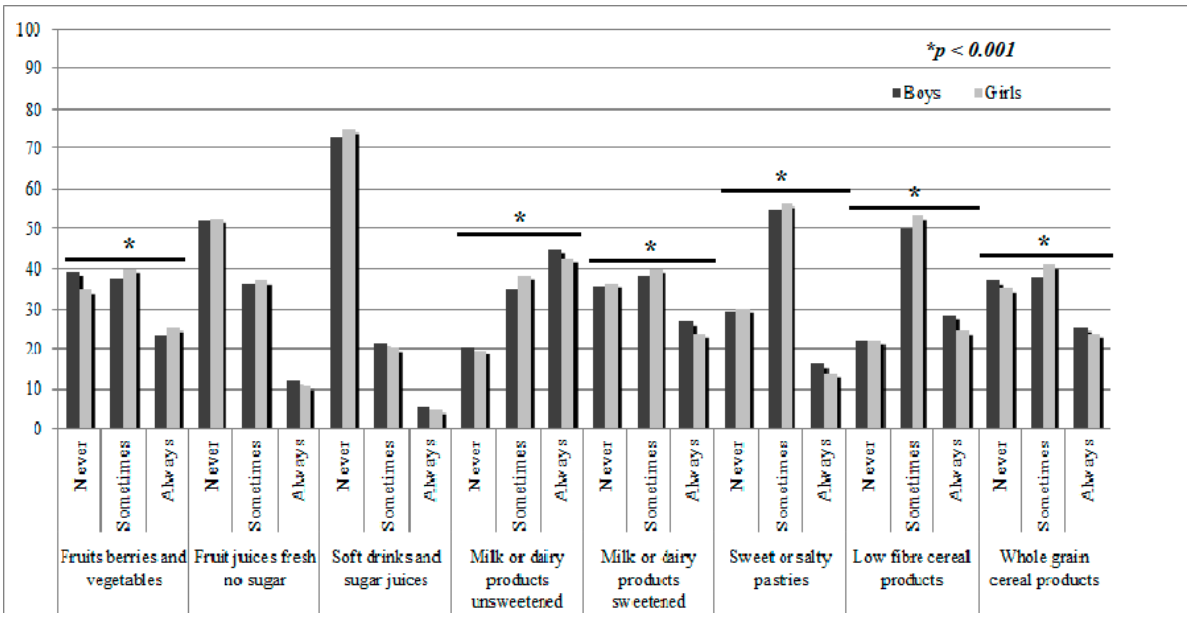
Table 1. Descriptive characteristics of the sample of European children from the Feel4Diabetes study (*n* = 9760).

	Boys (*n* = 4788)	**Girls (*n* = 4972)**	***p* ***
Age (years) mean (CI 95%)	8.22 (8.19; 8.24)	8.18 (8.15; 8.20)	**0.050**
Mothers' Education *n* (%)			
≤12 years	1268 (26.5)	1369 (27.5)	0.126
>12 years	3520 (73.5)	3603 (72.5)	
Country *n* (%)			
Belgium	699 (14.6)	711 (14.3)	0.073
Finland	641 (13.4)	657 (13.2)	
Greece	890 (18.6)	932 (18.7)	
Hungary	720 (15.0)	794 (16.0)	
Bulgaria	1257 (26.3)	1365 (27.5)	
Spain	581 (12.1)	513 (10.3)	
Mothers' Breakfast Consumption *n* (%)			
Breakfast skippers	575 (12.0)	662 (13.3)	0.114
Occasionally breakfast consumers	871 (18.2)	920 (18.5)	
Breakfast consumers	3342 (69.8)	3390 (68.2)	
Children's Breakfast Consumption *n* (%)			
Breakfast skippers	30 (0.6)	39 (0.8)	0.411
Occasionally breakfast consumers	332 (6.9)	369 (7.4)	
Breakfast consumers	4426 (92.4)	4564 (91.8)	

* Significant *p* values are shown in bold font. Abbreviations: 95% CI, 95% confidence intervals. Breakfast consumption categories: Breakfast skippers, children/mothers who usually consume breakfast 0–1 days per week; Occasional breakfast consumers, children/mothers who usually consume breakfast 2–5 days per week; Breakfast consumers, children/mothers who usually consume breakfast 6–7 days per week.

Figure 1 presents the description of food and beverages consumed at breakfast in children (1A) and their mothers (1B) who occasionally or usually consumed breakfast by gender. In children (Figure 1A), there were significant differences between sexes in the consumption of fruits, berries, and vegetables, milk or dairy products unsweetened and sweetened, sweet or salty pastries, and low fiber and whole-grain cereal products. A high proportion of children always consumed milk or dairy products at breakfast (unsweetened: 45.0% of the boys and 42.2% of the girls; sweetened: 26.8% of the boys and 23.8% of the girls). Around one-quarter of the sample consumed cereals at breakfast (low fiber cereals, 28.2% of boys and 24.5% of girls; whole-grain cereal, 25.2% of boys and 23.6% of girls). Regarding the mothers' consumption of food and beverages at breakfast (Figure 1B) in those who occasionally or usually consumed breakfast, significant differences between genders were found in the consumption of fruits, berries, and vegetables, milk or dairy products unsweetened and low fiber and whole-grain cereal products. A high proportion of mothers always consumed milk or dairy products unsweetened at breakfast (45.2% of boys' mothers, 43.0% of girls' mothers). On the other hand, 24.8% of the boys' mothers and 24.4% of the girls' mothers usually consume fruit, berries, and vegetables at breakfast. For the consumption of cereal products, high variability was found. Low fiber cereals were consumed by 20.2% of the boys' mothers and 17.8% of the girls' mothers, however, whole-grain cereals were always consumed by 34.2% and 33.5% of the boys' and girls' mothers, respectively.

(**A**)



(**B**)

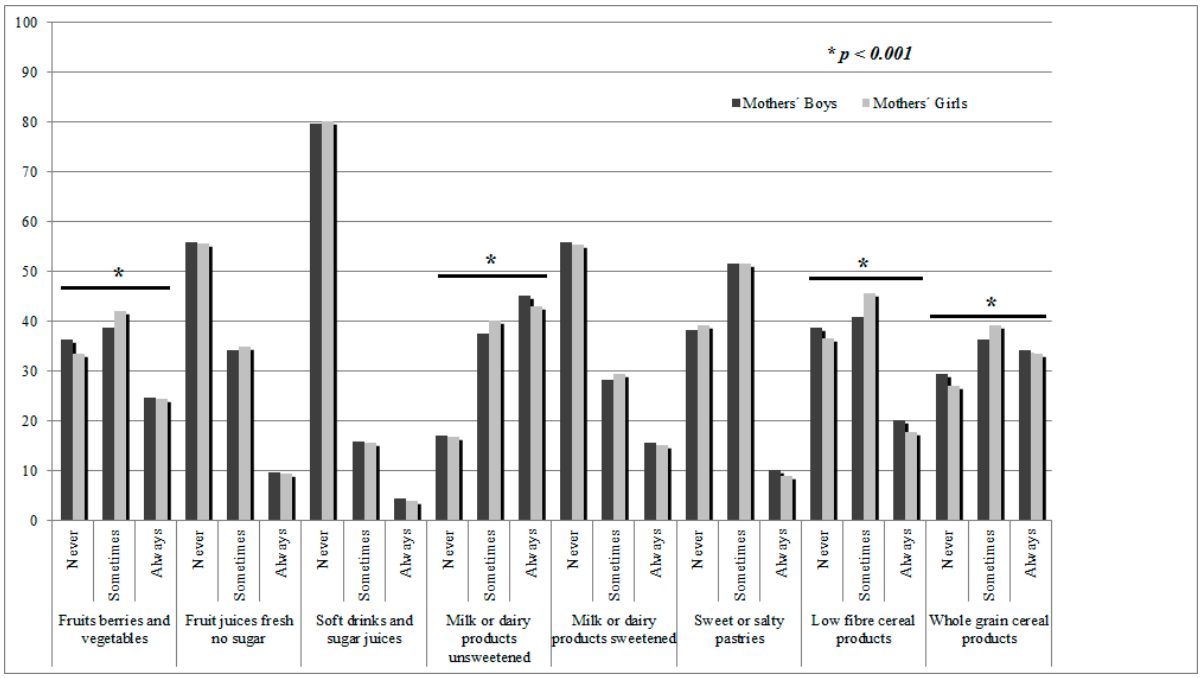


Figure 1. Description of food and beverages consumed at breakfast in children (**A**) and their mothers (**B**) who occasionally or usually consumed breakfast by gender. * *p* values from chi-square indicate statistical significance between genders. Frequency of food and beverage groups' consumption: Never (0 times/week), Sometimes (1–4 times/ week), Always (5–7 times/week).

Tables 2 and 3 present the description of food and beverages consumed at breakfast in children (Table 2) and their mothers (Table 3) who occasionally or usually consumed breakfast by gender. In both, children and their mothers, there were significant differences between occasional breakfast consumers and breakfast consumers in all food and beverages. In children, in both genders, the most consumed foods groups and beverages at breakfast by breakfast consumers were milk or dairy products unsweetened (45.8% of the boys and

42.7% of the girls) and low fiber cereal products (28.8% of the boys and 25.2% of the girls). In boys, 26.4% of the breakfast consumers consumed milk or dairy products sweetened at breakfast. In girls, 25.9% of the breakfast consumers consumed fruits, berries, and vegetables at breakfast. In mothers, the most consumed foods groups and beverages at breakfast by breakfast consumers were milk or dairy products unsweetened (48.8% of the boys' mothers breakfast consumers and 46.4% of the girls' mothers breakfast consumers), low fiber cereal products (41.1% of the boys' mothers breakfast consumers and 35.0% of the girls' mothers breakfast consumers) and whole-grain cereals products (39.3% of the boys' mothers breakfast consumers and 38.6% of the girls' mothers breakfast consumers).

Table 2. Description of food and beverages consumed at breakfast in children who occasionally or usually consumed breakfast.

		Boys Occasional Breakfast Consumers	Boys Breakfast Consumers	*p* *	Girls Occasional Breakfast Consumers	Girls Breakfast Consumers	*p* *
Fruits, berries and vegetables	Never	131 (33.3)	1966 (38.7)	**0.002**	112 (25.3)	1783 (34.4)	**<0.001**
	Sometimes	181 (46.1)	1889 (37.2)		239 (54.0)	2059 (39.7)	
	Always	81 (20.6)	1219 (24.0)		92 (20.8)	1345 (25.9)	
Fruit juices fresh unsweetened	Never	162 (42.0)	2597 (51.3)	**<0.001**	198 (45.6)	2657 (51.4)	**0.017**
	Sometimes	179 (46.4)	1845 (36.4)		191 (44.0)	1917 (37.1)	
	Always	45 (11.7)	621 (12.3)		45 (10.4)	594 (11.5)	
Soft drinks and sugar juices	Never	219 (57.6)	3630 (72.2)	**<0.001**	234 (54.7)	3806 (74.4)	**<0.001**
	Sometimes	126 (33.2)	1104 (21.9)		150 (35.0)	1038 (20.3)	
	Always	35 (9.2)	297 (5.9)		44 (10.3)	274 (5.4)	
Milk or dairy products unsweetened	Never	77 (19.9)	1017 (20.1)	**<0.001**	71 (16.2)	1005 (19.4)	**<0.001**
	Sometimes	175 (45.2)	1728 (34.1)		231 (52.7)	1962 (37.9)	
	Always	135 (34.9)	2319 (45.8)		136 (31.1)	2209 (42.7)	
Milk or dairy products sweetened	Never	106 (27.6)	1793 (36.2)	**<0.001**	138 (32.0)	1839 (36.5)	**0.001**
	Sometimes	192 (50.0)	1850 (37.4)		209 (48.5)	2000 (39.7)	
	Always	86 (22.4)	1304 (26.4)		84 (19.5)	1202 (23.8)	
Sweet or salty pastries	Never	66 (17.1)	1452 (28.9)	**<0.001**	86 (19.7)	1476 (28.9)	**<0.001**
	Sometimes	255 (66.2)	2753 (54.8)		281 (64.4)	2892 (56.6)	
	Always	64 (16.6)	816 (16.3)		69 (15.8)	742 (14.5)	
Low fiber cereal products	Never	86 (22.5)	1122 (22.3)	**0.022**	87 (19.9)	1134 (22.3)	**0.028**
	Sometimes	210 (55.0)	2455 (48.9)		259 (59.1)	2676 (52.6)	
	Always	86 (22.5)	1448 (28.8)		92 (21.0)	1281 (25.2)	
Whole-grain cereal products	Never	172 (45.7)	1934 (38.7)	**<0.001**	183 (43.3)	1842 (36.4)	**<0.001**
	Sometimes	160 (42.6)	1835 (36.7)		193 (45.6)	2073 (40.9)	
	Always	44 (11.7)	1230 (24.6)		47 (11.1)	1151 (22.7)	

* *p* values from chi-square indicate statistical significance between genders. Frequency of food and beverage groups' consumption: Never (0 times/week), Sometimes (1–4 times/ week), Always (5–7 times/week).

Table 3. Description of food and beverages consumed at breakfast in mothers who occasionally or usually consumed breakfast.

		Boys' Mothers Occasional Breakfast Consumers	Boys' Mothers Breakfast Consumers	*p* *	Girls' Mothers Occasional Breakfast Consumers	Girls' Mothers Breakfast Consumers	*p* *
Fruits, berries and vegetables	Never	350 (34.8)	1394 (36.8)	**<0.001**	346 (33.1)	1290 (33.8)	**<0.001**
	Sometimes	482 (48.0)	1403 (37.1)		536 (51.3)	1535 (40.2)	
	Always	173 (17.2)	989 (26.1)		162 (15.5)	991 (26.0)	
Fruit juices fresh unsweetened	Never	527 (53.1)	2089 (55.5)	**0.006**	539 (52.5)	2103 (55.4)	**<0.001**
	Sometimes	386 (38.9)	1286 (34.2)		420 (40.9)	1310 (34.5)	
	Always	79 (8.0)	389 (10.3)		68 (6.6)	383 (10.1)	
Soft drinks and sugar juices	Never	650 (67.3)	3007 (80.6)	**<0.001**	701 (69.7)	3007 (80.5)	**<0.001**
	Sometimes	251 (26.0)	560 (15.0)		226 (22.5)	579 (15.5)	
	Always	65 (6.7)	163 (4.4)		79 (7.9)	151 (4.0)	
Milk or dairy products unsweetened	Never	200 (20.1)	618 (16.3)	**<0.001**	197 (18.9)	651 (17.0)	**<0.001**
	Sometimes	515 (51.8)	1327 (34.9)		536 (29.5)	1400 (36.6)	
	Always	279 (28.1)	1852 (48.8)		307 (29.5)	1777 (46.4)	
Milk or dairy products sweetened	Never	524 (52.9)	2083 (55.8)	**<0.001**	541 (52.7)	2071 (54.7)	**<0.001**
	Sometimes	357 (36.1)	1023 (27.4)		377 (36.7)	1080 (25.8)	
	Always	109 (11.0)	630 (16.9)		108 (10.5)	637 (16.8)	
Sweet or salty pastries	Never	273 (27.2)	1555 (40.9)	**<0.001**	310 (29.7)	1584 (41.3)	**<0.001**
	Sometimes	644 (64.1)	1853 (48.7)		638 (61.2)	1892 (49.3)	
	Always	88 (8.8)	394 (10.4)		95 (9.1)	362 (9.4)	
Low fiber cereal products	Never	345 (34.4)	1453 (38.4)	**0.001**	353 (34.0)	1387 (36.6)	**0.005**
	Sometimes	476 (47.5)	1556 (41.1)		520 (50.0)	1691 (35.0)	
	Always	181 (18.1)	775 (20.5)		166 (16.0)	716 (18.9)	
Whole-grain cereal products	Never	420 (41.7)	1010 (26.5)	**<0.001**	410 (39.6)	944 (24.6)	**<0.001**
	Sometimes	469 (46.5)	1302 (34.2)		512 (49.5)	1407 (36.7)	
	Always	119 (11.8)	1495 (39.3)		113 (10.9)	1479 (38.6)	

* *p* values from chi-square indicate statistical significance between genders. Frequency of food and beverage groups' consumption: Never (0 times/week), Sometimes (1–4 times/ week), Always (5–7 times/week).

Table 4 presents the proportion of mothers and their children's breakfast routine. The highest proportion was for children who usually consumed breakfast in concordance with their mothers (67.95% in boys; 65.65% in girls). At the opposite, only 0.44% of boys and 0.60% of girls of the total sample were in concordance with their mothers as breakfast skippers. Also, 3.45% of boys and 3.48% of girls whose mothers occasionally consumed breakfast were occasional breakfast consumers as well. Other possible combinations were observed, 0.06% of the boys and 0.14% of the girls whose mothers always consumed breakfast were breakfast skippers, and 1.80% of the boys and 2.39% of the girls whose mothers always consumed breakfast were occasional breakfast consumers.

Table 4. Crosstab between mothers' and boys' and girls' breakfast routine.

	Boys' Breakfast Consumers	**Boys' Occasional Breakfast Consumers**	**Boys' Breakfast Skippers**	**Total**	***p* ***
Mothers' breakfast consumers	3253 (67.95)	86 (1.80)	3 (0.06)	3342 (69.81)	**<0.001**
Mothers' occasional breakfast consumers	700 (14.61)	165 (3.45)	6 (0.12)	871 (18.18)	
Mothers' breakfast skippers	473 (9.87)	81 (1.70)	21 (0.44)	575 (12.01)	
Total	4426 (92.43)	332 (6.95)	30 (0.62)	4788 (100)	
	Girls' Breakfast Consumers	**Girls' Occasional Breakfast Consumers**	**Girls' Breakfast Skippers**	**Total**	***p* ***
Mothers' breakfast consumers	3264 (65.65)	119 (2.39)	7 (0.14)	3390 (68.18)	**<0.001**
Mothers' occasional breakfast consumers	745 (14.98)	173 (3.48)	2 (0.04)	920 (18.5)	
Mothers' breakfast skippers	555 (11.18)	77 (1.54)	30 (0.60)	662 (13.32)	
Total	4564 (91.81)	369 (7.41)	39 (0.78)	4972 (100)	

* Significant *p* values are shown in bold font. Breakfast consumers categories: Breakfast skippers, children/mother who usually consume breakfast 0–1 days/week; Occasional breakfast consumers, children/mother who usually consume breakfast 2–5 days/week; Breakfast consumers, children/mother who usually consume breakfast 6–7 days/week.

Mean scores of food and beverage consumption (times/week) at breakfast in children who occasionally or usually consumed breakfast are shown in Table 5. Firstly, the analyses were performed without stratification by sex (table not shown), however, it was observed some differences between sexes and results were presented stratified by sex. In both boys and girls, breakfast consumers had a higher intake of milk or dairy products unsweetened, low fiber cereal and whole-grain cereals products at breakfast than occasionally breakfast consumers ($p < 0.001$). Girls usually consuming breakfast had a higher intake of fruits, berries and vegetables, and a lower intake of soft drinks and sugar juices ($p < 0.001$) at breakfast compared to girls occasionally consuming breakfast.

Table 6 presents the mean scores of food and beverage group's consumption (times/week) at breakfast in mothers who occasionally or usually consumed breakfast. Mothers (either boys and girls) usually consuming breakfast had a higher intake of fruits, berries and vegetables, milk, and dairy unsweetened and sweetened products, low fiber and whole-grain cereal products ($p < 0.001$), and fresh and unsweetened fruit juices ($p < 0.001$) at breakfast compared to mothers occasionally consuming breakfast. These mothers who usually consumed breakfast also had a lower intake of soft drinks and sugar juices compared to mothers who occasionally consumed breakfast ($p < 0.001$).

Table 7 presents the cross-tabulation between the frequency of food and beverage consumption at breakfast between mothers and their children. In both, boys and girls, breakfast food and beverages consumption were in concordance with their mothers' consumption in all food and beverage groups. In both sexes, close to 60% and 50% of children who always consumed fruits, berries, and vegetables, and fresh and unsweetened fruit juices were those whose mothers always consumed the same food and beverages groups ($p < 0.001$). Regarding consumption of soft drinks, more than 90% of children who never consume them were those whose mothers never consume them ($p < 0.001$). The high proportion of children who always consumed milk or dairy products unsweetened or sweetened, and low fiber or whole-grain cereals products were those whose mothers always consume them ($p < 0.001$). The high proportion of children who never consumed sweets or salty pastries were those whose mothers never consume it ($p < 0.001$).

Table 5. Analysis of covariance between food and beverage consumption at breakfast and breakfast routine in children, stratified by gender.

Children's Foods and Beverage Groups Consumption at Breakfast (Times per week)	Boys' Breakfast Routine			Girls' Breakfast Routine		
	Occasionally Breakfast Consumers	Breakfast Consumers		Occasionally Breakfast Consumers	Breakfast Consumers	
	Mean (95% CI)	Mean (95% CI)	*p* *	Mean (95% CI)	Mean (95% CI)	*p* *
Fruits berries and vegetables	2.37 (2.07, 2.66)	2.55 (2.48, 2.62)	0.241	2.38 (2.11, 2.65)	2.70 (2.63, 2.77)	**0.021**
Fruit juices fresh unsweetened	1.80 (1.56, 2.04)	1.77 (1.71, 1.83)	0.826	1.58 (1.36, 1.79)	1.75 (1.70, 1.81)	0.127
Soft drinks and sugar juices	1.26 (1.08, 1.45)	1.15 (1.11, 1.20)	0.245	1.49 (1.33, 1.65)	1.08 (1.04, 1.12)	**<0.001**
Milk or dairy products unsweetened	3.20 (2.88, 3.53)	3.97 (3.89, 4.05)	**<0.001**	3.21 (2.92, 3.50)	3.84 (3.76, 3.92)	**<0.001**
Milk or dairy products sweetened	2.59 (2.28, 2.91)	2.80 (2.72, 2.88)	0.213	2.44 (2.16, 2.71)	2.63 (2.56, 2.70)	0.182
Sweet or salty pastries	2.62 (2.38, 2.85)	2.35 (2.29, 2.40)	**0.031**	2.35 (2.14, 2.55)	2.23 (2.17, 2.28)	0.265
Low fiber cereal products	2.54 (2.25, 2.82)	3.07 (2.99, 3.14)	**<0.001**	2.54 (2.29, 2.79)	2.93 (2.86, 2.99)	**0.004**
Whole-grain cereal products	1.99 (1.71, 2.27)	2.66 (2.60, 2.74)	**<0.001**	2.02 (1.77, 2.28)	2.65 (2.59, 2.73)	**<0.001**

* Statistical significance among different breakfast patterns. Significant *p* values are shown in bold font. Abbreviations: 95% CI, 95% confidence intervals. All analyses were adjusted by the following covariates: BMI z-score, country, and maternal education. Breakfast consumers categories: Occasional breakfast consumers, children who usually consume breakfast 2–5 days per week; Breakfast consumers, children who usually consume breakfast 6–7 days per week.

Table 6. Analysis of covariance between food and beverage consumption at breakfast and breakfast routine in mothers, stratified by gender.

Mothers' Foods and Beverage Groups Consumption at Breakfast (Times per Week)	Boys' Mother Breakfast Routine			Girls' Mother Breakfast Routine		
	Occasional Breakfast Consumers	Breakfast Consumers		Occasional Breakfast Consumers	Breakfast Consumers	
	Mean (95% CI)	Mean (95% CI)	*p* *	Mean (95% CI)	Mean (95% CI)	*p* *
Fruits, berries and vegetables	2.35 (2.19, 2.51)	2.71 (2.63, 2.80)	**<0.001**	2.25 (2.10, 2.40)	2.77 (2.69, 2.84)	**<0.001**
Fruit juices fresh unsweetened	1.49 (1.36, 1.61)	1.63 (1.57, 1.69)	**0.048**	1.39 (1.27, 1.51)	1.63 (1.57, 1.69)	**<0.001**
Soft drinks sugar juices	1.08 (0.99, 1.17)	1.10 (1.02, 1.01)	**0.043**	1.10 (1.02, 1.18)	0.93 (0.89, 0.98)	**<0.001**
Milk or dairy products unsweetened	3.16 (2.99, 3.33)	4.15 (4.07, 4.24)	**<0.001**	3.14 (2.98, 3.31)	4.01 (3.93, 4.09)	**<0.001**
Milk or dairy products sweetened	1.55 (1.40, 1.70)	1.98 (1.91, 2.06)	**<0.001**	1.60 (1.46, 1.74)	1.94 (1.87, 2.01)	**<0.001**
Sweet or salty pastries	1.87 (1.75, 1.98)	1.92 (1.86, 1.97)	0.450	1.83 (1.73, 1.94)	1.84 (1.78, 1.89)	0.987
Low fiber cereal products	2.11 (1.96, 2.26)	2.44 (2.37, 2.52)	**<0.001**	2.08 (1.94, 2.22)	2.38 (2.31, 2.45)	**<0.001**
Whole-grain cereal products	2.15 (1.99, 2.31)	3.44 (3.36, 3.52)	**<0.001**	2.14 (1.99, 2.29)	3.44 (3.37, 3.52)	**<0.001**

* Statistical significance among different breakfast patterns. Significant *p* values are shown in bold font. Abbreviations: 95% CI, 95% confidence intervals. All analyses were adjusted by the following covariates: country, maternal education and mother BMI. Breakfast consumers categories: Occasional breakfast consumers: mothers who usually consume breakfast 2–5 days/week; Breakfast consumers, mothers who usually consume breakfast 6 or 7 days/week.

Table 7. Frequency of foods and beverages consumption at breakfast between mothers and their children.

		Boys' Food and Beverage Consumption				Girls' Food and Beverage Consumption			
		Never	Sometimes	Always		Never	Sometimes	Always	
		n (%)	*n* (%)	*n* (%)	*p* *	*n* (%)	*n* (%)	*n* (%)	*p* *
Fruits, berries, and vegetables									
Mothers' food and beverage consumption	Never	1132 (71.3)	252 (16.7)	89 (9.3)	**<0.001**	1021 (72,1)	274 (16.5)	91 (8.6)	**<0.001**
	Sometimes	312 (19.7)	966 (63.8)	298 (31.3)		295 (20.8)	1091 (65.8)	347 (32.8)	
	Always	143 (9.0)	295 (19.5)	566 (59.4)		100 (7.1)	292 (17.6)	620 (58.6)	
Fruit juices fresh unsweetened									
Mothers' food and beverage consumption	Never	1780 (85.4)	392 (26.8)	82 (16.8)	**<0.001**	1810 (85.1)	392 (25.8)	66 (14.8)	**<0.001**
	Sometimes	252 (12.1)	961 (65.8)	173 (35.5)		257 (12.1)	1032 (68.0)	146 (32.7)	
	Always	53 (2.5)	107 (7.3)	232 (47.6)		60 (2.8)	94 (6.2)	235 (52.6)	
Soft drinks and sugar juices									
Mothers' food and beverage consumption	Never	2726 (93.9)	383 (44.8)	65 (29.3)	**<0.001**	2799 (93.5)	371 (45.1)	58 (29.4)	**<0.001**
	Sometimes	150 (5.2)	422 (49.4)	60 (27.0)		168 (5.6)	412 (50.1)	47 (23.9)	
	Always	27 (0.9)	50 (5.8)	97 (43.7)		26 (0.9)	40 (4.9)	92 (46.7)	
Milk or dairy products unsweetened									
Mothers' food and beverage consumption	Never	355 (44.2)	172 (12.2)	173 (9.5)	**<0.001**	361 (46.6)	208 (13.2)	130 (7.3)	**<0.001**
	Sometimes	219 (27.2)	869 (61.9)	434 (23.8)		225 (29.0)	975 (61.9)	451 (25.5)	
	Always	230 (28.6)	364 (25.9)	1216 (66.7)		189 (24.4)	393 (24.9)	1188 (67.2)	
Milk or dairy products sweetened									
Mothers' food and beverage consumption	Never	1241 (88.1)	634 (42.4)	340 (32.1)	**<0.001**	1288 (88.2)	664 (41.2)	294 (30.4)	**<0.001**
	Sometimes	127 (9.0)	756 (50.6)	240 (22.6)		131 (9.0)	829 (51.5)	223 (23.1)	
	Always	40 (2.8)	104 (7.0)	480 (45.3)		41 (2.8)	117 (7.3)	449 (46.5)	
Sweets or salty pastries									
Mothers' food and beverage consumption	Never	969 (81.9)	467 (21.3)	105 (16.1)	**<0.001**	1037 (83.2)	490 (21.2)	87 (15.5)	**<0.001**
	Sometimes	188 (15.9)	1623 (74.1)	266 (40.7)		191 (15.3)	1701 (73.6)	237 (42.2)	
	Always	26 (2.2)	99 (4.5)	283 (43.3)		18 (1.4)	121 (5.2)	237 (42.2)	
Low fiber cereal products									
Mothers' food and beverage consumption	Never	685 (76.7)	637 (31.7)	240 (21.2)	**<0.001**	680 (75.3)	616 (28.3)	188 (18.8)	**<0.001**
	Sometimes	161 (18.0)	1187 (59.1)	306 (27.1)		187 (20.7)	1357 (62.3)	322 (32.2)	
	Always	47 (5.3)	183 (9.1)	585 (51.7)		36 (4.0)	204 (9.4)	489 (48.9)	
Whole-grain cereal products									
Mothers' food and beverage consumption	Never	954 (63.5)	176 (11.6)	63 (6.2)	**<0.001**	873 (60.5)	184 (10.9)	57 (5.9)	**<0.001**
	Sometimes	306 (20.4)	935 (61.5)	227 (22.3)		354 (24.5)	1088 (64.7)	163 (16.9)	
	Always	242 (16.1)	410 (27.0)	727 (71.5)		217 (15.0)	409 (24.3)	743 (77.2)	

* Significant *p* values are shown in bold font. Frequency of food and beverage groups' consumption: Never: 0 times/week; Sometimes: 1–4 times/week; Always: 5–7 times/week.

4. Discussion

The most important finding of the current study is that children's breakfast routine is associated with mothers' breakfast routine, independently of the children's gender. To the best of our knowledge, this is the first study to examine the associations between the breakfast routine of children and their mothers, analyzing breakfast habits, and also the foods and beverages consumed at breakfast.

Our findings showed that 92.4% of the boys and 91.8% of the girls were breakfast consumers. During childhood, the proportion of breakfast consumption in six countries was similar to our study [33]. Regarding mothers, our results showed that 69.8% of boys' mothers and 68.2% of girls' mothers were breakfast consumers, which is a lower prevalence

than the one observed in the International Breakfast Research Initiative, in which it was observed that between 76–95% of young adults from different countries usually consume breakfast [33].

In our study, we observed that in both sex groups, breakfast routine in terms of frequency of breakfast consumption and foods and beverages consumed at breakfast were in agreement with their mother's breakfast routine. The highest proportion of breakfast skippers were observed in those whose mothers usually skip breakfast, while the highest proportion of breakfast consumers were those whose mothers usually consume breakfast. In agreement with our research, a previous study showed that children's dietary habits, which include breakfast consumption, are associated with their parents' dietary habits [34]. Recent research observed a significant relation between the breakfast consumption frequency of the father or the mother and breakfast frequency of children [35]. Furthermore, strong parental support for breakfast as the main daily meal was significantly associated with children's daily breakfast intake [36]. Another study developed in European children of similar ages that our study suggested that children were more likely to consume breakfast daily because they had high parental modeling [21]. Parents influence children's diets, especially during shared family mealtimes [20]. Furthermore, some authors concluded that food behaviors are developed and reinforced by the family food environment [20,37].

Regarding the foods and beverages consumed at breakfast, in both, boys and girls, breakfast consumers had a higher intake of milk or unsweetened dairy products and cereal products (low fiber and whole-grain) compared to occasionally breakfast consumers. In agreement with our results, different studies showed that ready-to-eat cereals, milk, and bread are the main components in children and adolescents' breakfast in Europe [38–40]. Indeed, a previous systematic review observed that breakfast based on ready-to-eat cereals is the most commonly consumed type of breakfast by children and adolescents, and furthermore, those who usually consume breakfast showed a higher daily intake of milk and dairy products and cereals than breakfast skippers [4]. Regarding mothers, the results showed a higher intake of fruits, berries and vegetables, fresh and unsweetened fruit juices, milk and dairy products (sweetened and unsweetened), and cereal products (low fiber and whole-grain). This conforms to the findings of a previous study that showed a higher variety of foods and beverages consumed at breakfast by adults [41].

Our findings showed that in both genders, breakfast foods and beverages consumption agreed with their mothers' consumption, being the high proportion of children who always consumed fruits, berries, and vegetables those whose mothers always consumed this type of products. A previous longitudinal study showed that mothers' and children's food preferences were significantly associated, and for this reason, those foods and beverages which are disliked by mothers tended not to be offered to children [42]. It was observed that family mealtime routine and parental monitoring during childhood may provide a supportive food environment that promotes children's overall diet quality [43]. This could be possible because it was observed that parents' dietary and physical activity practices shape their children's nutritional and activity patterns [44,45]. Children develop preferences that affect their food selections due to the establishment of eating practices that contribute to lifelong nutritional habits and overall health during childhood. For this reason, parents are responsible for modeling healthy food choices and dietary practices, which shape children's food preferences and eating behaviors [46,47].

Our study is characterized by a number of strengths and limitations. Firstly, it is necessary to take into consideration the cross-sectional design, from which no causal conclusions can be drawn. Second, the term "breakfast consumption" includes a variety of definitions, and nowadays, there is no consensus regarding the definition of breakfast consumption. Third, the questionnaires were self-reported, and it may have been possible that mothers overestimated the child's and their own consumption. Fourth, we only analyzed mothers' information because most of the participating parents are women (88.5% women; 10.6% men), and previous authors concluded that especially the mother's role is of importance to improve children's diet quality [48–50]. Fifth, the frequency of consumption

of selected groups of products may differ depending on the season. For three countries (Finland, Hungary, and Bulgaria) baseline measurements were extended during different months to achieve the sample size. To account for seasonal variations and to minimize the impact on each individual overtime, follow-up measurements were conducted as close to the date of the baseline measurements as possible. Furthermore, the study design is a cluster randomized clinical trial, including an overall European sample, but the specifics country cohorts were not representative of the general population. Also, the aim of the study was not to compare the results between countries; however, the major strength of our study is the large sample of children and its geographical distribution across Europe. Moreover, questionnaires have been designed under standardized procedures for a multi-country population, and these have been tested for their reliability in European countries [32].

5. Conclusions

In the present study, we analyzed the breakfast routine in a large sample of European children and their mothers. The highest proportion of children was breakfast consumers. Furthermore, a high percentage of the mothers also were breakfast consumers. The highest proportion of children who usually consumed breakfast was found in those whose mothers were breakfast consumers. Also, those food and beverage groups consumed by mothers at breakfast were the same that their children consumed at this eating occasion. Our results may suggest a clear transfer of breakfast routine from the mother to their children, although our analyses do not allow causal inferences. Mothers might be an important influence regarding children's breakfast consumption, in terms of behavior and also in terms of quality of breakfast. Furthermore, during childhood, breakfast is an established habit; however, it may be lost during adolescence because, at that age, each individual reaffirms their personality and makes their own decisions about eating habits, choices, and preferences. However, more studies are needed to investigate the impact of parents on children's breakfast routine (frequency and foods and beverages consumed).

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Data Availability Statement: The datasets generated and/or analyzed during the current study are not publicly available, since the data used is confidential based on Feel4Diabetes publications rules, but are available from the corresponding author on reasonable request.

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MANUSCRIPT IV

Breakfast consumption and its relationship with diet quality and adherence to Mediterranean diet in European adolescents: the HELENA study.

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Breakfast consumption and its relationship with diet quality and adherence to Mediterranean diet in European adolescents: the HELENA study.

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Short title: Breakfast consumption and its relationship with diet indices in European adolescents.

List of abbreviations

24h-DRs: 24-hour dietary recalls

95% CI: 95% confidence intervals

ANCOVA: Analysis of covariance

ANOVA: Analysis of variance

BMI: Body mass index

DP: Dietary Pattern

DQI: Diet Quality Index

DQI-A: Diet Quality Index for Adolescents

DQI-A.M: Diet Quality Index for Adolescents (includes the meal index)

DQI-A.P: Diet Quality Index for Adolescents (includes the PA)

DQI-A.MP: Diet Quality Index for Adolescents (includes the PA and meal index)

FBDG: Flemish food-based dietary guidelines

FCP: Food Choices and Preferences

HELENA-CSS: Healthy Lifestyle in Europe by Nutrition in Adolescence Cross Sectional Study

HELENA-DIAT: HELENA-Dietary Assessment Tool

MD: Mediterranean Diet

MDS: Mediterranean Diet Score

PA: Physical activity

PASW: Predictive Analytics Software

YANA-C: Young Adolescents' Nutrition Assessment on Computer

Abstract

Objective: The aim of the current study is to analyze the associations between breakfast consumption and adherence to diet quality index (DQI) and Mediterranean Diet Score (MDS) in European adolescents.

Methods: A multinational cross-sectional study was carried out in 1804 adolescents aged 12.5-17.5 years. The Food Choices and Preferences questionnaire was used to ascertain breakfast consumption (consumers, occasional consumers and skippers), and two non-consecutive 24h dietary recalls were used to estimate the total daily intake and to calculate the subsequent DQI and MDS. Mixed linear regression models were used to examine the relationship between breakfast consumption and DQI-A and MDS. Age, maternal education, BMI, country and total energy intake were included as covariates.

Results: In both sexes, significant differences were observed among the breakfast consumption categories. In both boys and girls, breakfast consumers had significantly higher DQI indices than those adolescents who skipped breakfast regularly ($p<0.001$). Regarding total MDS, in both boys and girls, breakfast consumers had a higher total MDS than breakfast skippers ($p<0.001$), however, no associations were shown between occasional breakfast consumers and DQI indices and MDS.

Conclusion: Breakfast consumption has been linked with better dietary quality scores compared with those children who usually skip breakfast. Promotion of regular breakfast consumption in adolescents could be an effective strategy to improve the overall diet quality.

Keywords: Diet quality; Mediterranean diet; diet; adolescents, breakfast

1. Introduction

Breakfast is considered to be a key component of a healthy diet [1]. Skipping breakfast has been consistently associated with a high risk of obesity, type 2 diabetes and cardiovascular disease [2-4]. The vast majority of the population consumes breakfast regularly, except during adolescence [1]. In previous studies, adolescents who reported regular breakfast consumption had higher diet quality scores and healthier lifestyle patterns in comparison to breakfast skippers [5, 6]. On the other hand, in a couple of previous systematic review and meta-analysis, it has observed that breakfast consumption seems to improve diet quality. Those children and adolescent who consumed it, had a higher daily macro- and micronutrient and healthy food intake[7, 8]. However, there is not enough evidence about the reasons of skip breakfast in adolescence. In this line, a recent published study [9], observed that some reasons included short sleep duration, not feel hungry in the morning, not having anyone to prepare food or not have time to eat, and also, perceptions or fears around weight seems to be important determinant.

The Diet Quality Index for Adolescents (DQI-A) and the Mediterranean Diet Score (MDS) are indicators of overall diet quality [10, 11]. The diet quality index (DQI) is based on the principles of balance and variation, considering that all food groups contribute to a healthy diet [10, 12]. The DQI-A has shown positive associations with high consumption of fruits, vegetables and fiber and negative associations with less nutritious foods such as snacks and candy, sauces and creams and soft drinks [13]. Mediterranean diet (MD) is considered to be a Dietary Pattern (DP) that contributes to better health and quality of life [14] and is characterized by a high consumption of olive oil as culinary fat, and a high consumption of plant-based foods; moderate consumption of seafood, dairy products, poultry and eggs; and low consumption of sweet desserts, and red and processed meats [14, 15]. In adolescents, the MD was associated with a lower risk of overweight [16] and lower waist circumference [17]. Furthermore, the MDS was also negatively associated with different chronic diseases such as cardiovascular disease [15] and mortality in adults [11].

Breakfast is an important component of the MD and skipping it may be unfavourable to the overall diet quality [18, 19]. In a previous research, authors observed that Cypriot children who ate breakfast had higher adherence to the MD [20]. Among Australian children, those consuming breakfast had better dietary intake profiles [21]. The aim of the current study is to analyse the associations between breakfast consumption and adherence to DQI and MDS in European adolescents.

2. Methods

2.1. Study design and sample

The Healthy Lifestyle in Europe by Nutrition in Adolescence Cross Sectional Study (HELENA-CSS) is a multi-centre study on the nutritional and lifestyle status of adolescents [22]. The HELENA-CSS was carried out between October 2006 and December 2007 in ten European cities: Athens, Heraklion (Greece), Dortmund (Germany), Ghent (Belgium), Lille (France), Pecs (Hungary), Rome (Italy), Stockholm (Sweden), Vienna (Austria) and Zaragoza (Spain) [22]. A random cluster sampling (all pupils from a selection of classes from the 10 cities) of 3000 adolescents, stratified for geographical location, age and socioeconomic status, was targeted for the assessment [22]. The total sample size was calculated with a confidence level of 95% with ± 0.3 error in the parameter BMI. Error of 0.3 was chosen as a worst case scenario as precision level described by Cochran WG [23].

The general inclusion criteria for HELENA-CSS were (1) being within the age range of 12.5-17.5 years, (2) not participating simultaneously in another clinical trial, and (3) not having an acute infection for at least one week before inclusion. Due to incomplete data, adolescents from Heraklion and Pecs were excluded from the dietary intake assessments [22]. From a total sample of 3528 adolescents, only adolescents with two 24-hour dietary recalls (24h-DRs), and adolescents having completed at least 75% of the Food Choices and Preferences (FCP) questionnaire were included. For the final analysis, only adolescents with available data of breakfast consumption, DQI and MDS were considered.

The HELENA study was performed following the ethical guidelines of the Declaration of Helsinki 1964, and the ethical committee of each centre approved the study. Written and signed informed consent was achieved from the adolescents and their parents or guardians [24].

2.2. Socioeconomic status

As a marker of socioeconomic status of the participating families, maternal education was selected from all the available socioeconomic-related variables. Maternal education was categorized as lower education, lower secondary education, higher secondary education, and higher education or university degree on the basis of information achieved by a self-administered questionnaire completed by the adolescents.

2.3. Anthropometric measurements

Anthropometric measurements (weight and height) were performed by trained staff in a standardized way [25]. Weight was measured with an electronic scale (Type SECA861, precision = 100g, range 0-150 kg), and height was measured with a telescopic stadiometer (Type SECA 225, precision = 0.1 cm, range = 70-200 cm). Body mass index (BMI) was calculated from height and weight (kg/m^2) [25]. The definition of overweight (including obesity) was based on the international BMI-for-Age classification [26].

2.4. Dietary assessment

Food intake was assessed using the HELENA-Dietary Assessment Tool (HELENA-DIAT) [27]. HELENA-DIAT, a self-administered computerized 24h-DR, was based on the Young Adolescents' Nutrition Assessment on Computer (YANA-C) [28]. Participants completed the HELENA-DIAT twice on non-consecutive days within a time span of two weeks, to achieve information closer to habitual food intake. Trained dietitians assisted the adolescents to complete the 24-h recalls that were later checked for quality [29].

2.5. Diet quality index

A previously validated DQI, originally developed for preschool-aged children to measure their compliance with the Flemish food-based dietary guidelines (FBDG) [30], was adapted for use in adolescents (DQI-A) [31]. The DQI-A consisted of three components: quality, diversity and equilibrium. Furthermore, an updated version of the DQI-A composed of dietary quality, dietary diversity, dietary equilibrium and, additionally, the meal and physical activity index was used [13, 30, 32].

Dietary quality expressed whether the adolescent made the optimal food quality choices within a food group. *Dietary diversity* was expressed as the degree of variation in the diet. *Dietary equilibrium* was calculated from the difference between the adequacy component and the excess component [13]. The DQI-A was calculated taking into consideration the dietary quality, diversity and equilibrium. Also, the DQI-A *Meal index* (DQI-A.M) was calculated from the frequency variables "breakfast", "lunch" and "dinner", representing the number of days per week that these meals were consumed [30]. Finally, the DQI-A *Physical Activity index (DQI-A.PA)* was acquired by the International Physical Activity (PA) Questionnaire for Adolescents and representing if the participants had a low, moderate, high or vigorous PA [32].

Different diet quality indices were calculated with the only difference between them being the inclusion or not of the meal index and PA. DQI-A.M includes the meal index, DQI-A.PA includes the PA index and DQI-A.MP includes the meal and PA indices.

2.6. Mediterranean Diet Sscore

The MDS consists of nine single components, and a scale indicating the degree of adherence to the traditional MD. An adapted version of the traditional MDS developed for adults was calculated and validated for adolescents [33]. In our research, seven positive components (fruits, vegetables, pulses, cereals, fish and seafood, monounsaturated/saturated fats ratio and dairy products) and one negative component (meat) were included. The consumption of alcohol was not considered because of our focus on an adolescent population.

2.7. Breakfast consumption

The FCP questionnaire was developed based on 44 focus groups, which explored attitudes and issues of concern among adolescents regarding food choices, preferences, healthy eating and lifestyle [34]. Adolescents reported their breakfast consumption by responding to the following statement: "I often skip breakfast". There were seven possible answers ranging as (1) Strongly disagree; (2) Moderately disagree; (3) Slightly disagree; (4) Neither agree or disagree; (5) Slightly agree; (6) Moderately agree; (7) Strongly agree. These categories were grouped into three groups: (a) Breakfast consumers (answers "1" or "2"), (b) occasional breakfast consumers (answers "3", "4" or "5"), and (c) breakfast skippers (answers "6" or "7") [35].

2.8. Statistical analysis

The Predictive Analytics Software (PASW) version 21.0 (SPSS Inc., Chicago, IL, USA) was used to analyse the data.

According to the nature of the studied variables, chi-square test for categorical variables, and analysis of variance (ANOVA) for continuous variables were used to compare sex specific sample characteristics.

To compare mean scores of DQI-A and MDS by frequency of breakfast consumption, analysis of covariance (ANCOVA) was used, adjusted by age, maternal education, BMI, country and total energy intake.

Mixed linear regression models were used to examine the relationship between breakfast consumption and the calculated indices (DQI and MDS). Age, maternal education, BMI, country (center) and total energy intake were included as covariates. Values are presented as adjusted β values (estimated unstandardized regression coefficients) and 95% confidence intervals (95% CI). The reference group was selected as those allocated in the breakfast skippers group. All statistical tests were stratified by sex and corresponding p values lower than 0.05 were considered statistically significant.

3. Results

In total, 1804 adolescents (44.62% boys) were included in the analysis. **Table 1** presents sex-specific socio-demographic characteristics on age, maternal education, body composition, total energy intake and country in the study sample. **Supplementary table** presents sex-specific mean daily food intake of the studied sample. There were significant differences between sexes in BMI status, total energy intake, and country. However, no differences were observed between sexes in age and maternal education. According to BMI, 23.2% of the boys and 18.5% of the girls were overweight or obese.

Figure 1 presents the proportion of frequency of breakfast consumption by sex. There were significant differences between sexes according to breakfast consumption. In boys, 59.1% were breakfast consumers, 8.8% occasional breakfast consumers, and 32.0% were breakfast skippers. In girls, 52.3% were breakfast consumers, 5.8% occasional breakfast consumers and 41.9% were breakfast skippers. **Figures 2 and 3** show the mean DQI-A and MDS mean characteristics of the study sample. There were significant differences between sexes in DQI-A, DQI-A.M, DQI-A.PA and DQI-A.MP. However, regarding total MDS, no differences were observed between sexes.

Associations between mean scores of DQI and MDS according to frequency of breakfast consumption are shown in **Table 2.** In both groups, breakfast consumption was significantly associated with higher DQI in all indices (DQI-A, DQI-A.M, DQI-A.PA and DQI-A.MP) ($p < 0.001$). Likewise, in both groups, boys and girls, breakfast consumers were significantly associated with higher total MDS ($p < 0.05$).

Table 3 presents the association between breakfast consumption and DQI-A and MDS. Breakfast skippers were used as the reference group for analysis. Adolescents, both boys and girls, who usually consume breakfast, had a significantly higher DQI-A, DQI-A.M, DQI-A.PA and DQI-A.MP than those adolescents who usually skip breakfast (Table 3, all $P<0.001$). However, no significant associations were showed between occasional breakfast consumers and DQI-A, DQI-A.M, DQI-A.PA and DQI-A.MP.

Regarding total MDS, in both, boys and girls, those adolescents who usually consumed breakfast, had a higher total MDS than breakfast skippers (boys: $\beta= 0.41$, 95%CI: 0.19; 0.63; girls: $\beta= 0.47$, 95%CI: 0.29;

0.65) ($p<0.001$). However, no associations were shown between occasional breakfast consumers and total MDS.

4. Discussion

To the best of our knowledge, this is the first study to examine breakfast consumption and its relationship with different dimensions of the overall diet quality. The most important finding of the current study was that, independently of the type of score used, those adolescents who usually consumed breakfast had better scores in the dietary indices compared to those who habitually skipped it. Still, a relationship could not be established for those who consumed breakfast occasionally.

The proportion of adolescent breakfast consumers was 59.1% in boys and 52.3% in girls. In accordance with our findings, in another study conducted in six countries, breakfast consumption was high during childhood, but it was lower in adolescents [1]. However, the proportion was higher than in our study, as around 78-89% of the adolescents were breakfast consumers. Results from this study also showed that girls consumed breakfast less frequently than boys [1]. These results are consistent with previous studies where authors observed that breakfast skipping was more common among girls [36, 37]. Previous research suggested that overweight girls were more likely to skip breakfast as a means to reduce energy intake [36]. This could be due to in girls, skipping breakfast could be influenced by dieting and body shape ideals [38].
In spite of including PA index, no differences were observed in relation to the consumption of breakfast. This could be due to food consumption and PA are independent behaviours, and although adolescents could skip breakfast, they compensate throughout the day for food intake, so no differences were observed in the general diet quality [39].

Our findings showed that in both boys and girls, those adolescents who consumed breakfast regularly showed higher DQI-A compared to those adolescents who usually skipped breakfast. A previous study concluded that breakfast consumption provides an opportunity to improve overall nutrient intake [4]. In this sense, Mielgo-Ayuso et al. showed that breakfast consumption was also associated with higher intake and higher blood concentration of some vitamins [35]. Previous authors showed positive associations between breakfast consumption and fruits and vegetables intake [5, 6, 40], and negative associations between breakfast consumption and soft drinks in adolescents [5, 6, 40]. In adolescents from a low-income urban setting,

significant associations between breakfast consumption and higher Healthy Eating Index (HEI) scores were also observed [36]. The HEI, DQI, Healthy Diet Indicator (HDI) and MDS are the four original diet quality scores that have been most extensively validated [41]. The observed findings may be explained by the fact that skipping breakfast has been associated with poor nutritional habits, being a strong indicator of a healthy diet [40].

All the DQI modalities included in our study provide similar results. Diet quality indices are valuable tools to evaluate a global assessment of the dietary quality of a person or population. However, a healthy diet also involves consuming a certain number of meals per day and PA is a lifestyle indicator strongly linked with dietary consumption. Regardless of being important lifestyles indicators associated with health, in our study, they do not provide additional information to the classic DQI.

Regarding MDS, breakfast consumers had a higher MDS compared with breakfast skippers, showing the same direction as the association with the DQIs. In agreement with our results, a previous study in Lebanese adolescents, showed that breakfast consumption was associated with a higher adherence to MD [42]. Furthermore, in another study conducted in children, breakfast consumers had a higher adherence to MD as compared with breakfast skippers [20]. A high MD adherence was associated with healthier habits, such as healthier nutrient and food consumption, and with a lower risk of overweight and obesity in both children and adolescents [14, 16, 20].

Our study has some limitations, as for instance, results cannot be interpreted in terms of cause-effect relationship because of the cross-sectional design of the study and is not a representative sample by country. Furthermore, diet evaluation has a big difficulty because it is necessary trained staff, time to filled it by the adolescents or their families and also economic and social resources to manage the dietary databases of the project. The use of the statement “I often skip breakfast” to estimate the breakfast consumption frequency of the adolescents is influenced by what adolescents consider as having breakfast. The term “breakfast consumption” includes a variety of definitions and nowadays, there is no consensus regarding the definition of breakfast consumption. Furthermore, the FCP questionnaire is a self-reported questionnaire; however, the questionnaire has been tested and validated [43].

The principal strength of our study is the large sample and its geographical distribution across Europe. The standardized and harmonized methodology and the use of reliable and validated questionnaires are also important strengths. Furthermore, dietary intake was assessed using two 24-h dietary recalls, and this

method is widely accepted to be used in epidemiological studies to describe the usual diet. However, obtain dietary information requires qualified professionals for the collection, treatment, and subsequent analysis, to ensure that it is detailed and accurate.

5. Conclusions

In the present study we assessed the associations between breakfast consumption and DQIs and MDS in a large sample of European adolescents. Regular breakfast consumption was found to be associated with a higher DQI-A and with higher MDS in European adolescents, which means that the breakfast routine has been linked with better dietary quality scores compared with those children who usually skip breakfast. Consuming breakfast regularly seems to be a good indicator of healthy habits. Longitudinal and intervention studies in children and adolescents are needed to investigate the impact of breakfast consumption on different energy balance-related behaviours and health. Promotion of regular breakfast consumption in adolescents could be an effective strategy to improve the overall diet quality.

Declarations

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Conflicts of interest/Competing interests

The authors declare that they have no competing interests.

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Ethics approval: The HELENA study was performed following the ethical guidelines of the Declaration of Helsinki 1964, and the ethical committee of each centre approved the study.

Data availability: The data generated or analysed during this study can be found within the published article.

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Figure 1. Proportion of breakfast consumers, occasional breakfast consumers and breakfast skippers of the study sample by sex.

*p values from chi-square indicate statistical significance among sex specific sample characteristics.

Figure 2. Mean diet quality indices of the study sample by sex.

Abbreviations: DQI-A, Diet Quality Index for Adolescents; DQI-A.M: Diet Quality Index for Adolescents (includes the meal index); DQI-A.PA: Diet Quality Index for Adolescents (includes the PA); DQI-A.MPA: Diet Quality Index for Adolescents (includes the PA and meal index).
*p values from ANOVA indicate statistical significance among sex specific sample characteristics.

Figure 3. Mean Mediterranean Diet Score of the study sample by sex.

Abbreviations: MDS, Mediterranean Diet Score.
*p values from ANOVA indicate statistical significance among sex specific sample characteristics

Table 1. Descriptive characteristics of the studied sample of European adolescents from the HELENA study (n= 1804)

	Boys (n=805)	**Girls (n=999)**	***P***
Age (years), mean (CI 95%)	14.85 (14.76, 14.93)	14.80 (14.72, 14,87)	0.429
AGE CATEGORY n (%)			0.754
<12.5 – 13.99	226 (28.1)	301 (30.1)	
14 – 14.99	212 (26.3)	256 (25.6)	
15 – 15.99	202 (25.1)	235 (23.5)	
16 - >17.5	165 (20.5)	207 (20.7)	
MATERNAL EDUCATION n (%)			0.198
Lower education	52 (6.5)	57 (6.0)	
Lower secondary education	208 (25.8)	241 (24.1)	
Higher secondary education	236 (29.3)	340 (34.0)	
Higher education or university degree	309 (38.4)	361 (36.1)	
WEIGHT STATUS CATEGORY n (%)			**0.014**
Low and normal BMI	618 (76.8)	814 (81.5)	
Overweight and obesity BMI	187 (23.2)	185 (18.5)	
Total energy intake (Kcal/day), mean (CI 95%)	2518.99 (2458.53, 2579.46)	2169.77 (2133.14, 2206.39)	**<0.001**
COUNTRY n (%)			**<0.001**
Greece	116 (14.4)	139 (13.9)	
Germany	150 (18.6)	104 (10.4)	
Belgium	116 (4.4)	135 (13.5)	
France	75 (9.3)	106 (10.6)	
Italy	75 (9.3)	144 (14.4)	
Sweden	71 (8.8)	133 (13.3)	
Austria	134 (16.6)	161 (16.1)	
Spain	68 (8.4)	77 (7.7)	

Abbreviations: HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence; 95%CI, 95% confidence intervals; BMI, body mass index

*Significant differences are shown in bold font.

Table 2. Diet quality index and Mediterranean Diet Score mean values according to breakfast consumption in European adolescents.

BOYS										
	Final DQI-A MEAN (95% CI)	***P***	**Final DQI-A.M MEAN (95% CI)**	***p***	**Final DQI-A.PA MEAN (95% CI)**	***p***	**Final DQI-A.MPA MEAN (95% CI)**	***p***	**Total MDS MEAN (95% CI)**	***p***
Breakfast consumers	51.76 (50.27, 53.25) [b]		62.58 (61.36, 63.79)[b]		62.36 (61.16, 63.55)[b]		68.89 (67.85, 69.93)[b]		4.20 (4.07, 4.32)[b]	
Occasional breakfast consumers	50.20 (46.37, 54.03) [c]		60.69 (57.56, 63.83)[c]		60.90 (57.81, 63.98)[c]		67.15 (64.47, 69.83)[c]		4.04 (3.71, 4.36)	
Breakfast skippers	44.72 (42.67, 46.77) [b,c]	**<0.001**	55.48 (53.80, 57.16)[b,c]	**<0.001**	56.26 (54.60, 57,91)[b,c]	**<0.001**	62.56 (61.12, 63.99)[b,c]	**<0.001**	3.80 (3.63, 3.98)[b]	**0.002**
GIRLS										
	Final DQI-A MEAN (95% CI)	***p***	**Final DQI-A.M MEAN (95% CI)**	***p***	**Final DQI-A.PA MEAN (95% CI)**	***p***	**Final DQI-A.MPA MEAN (95% CI)**	***p***	**Total MDS MEAN (95% CI)**	***p***
Breakfast consumers	56.69 (55.44, 57.95)[b]		66.66 (65.63, 67.68)[b]		65.50 (64.47, 66.53)[b]		71.71 (70.83, 72.59)[b]		4.14 (4.02, 4.26)[b]	
Occasional breakfast consumers	56.09 (52.37, 59.80)		64.97 (61.94, 68.00)[c]		65.99 (62.95, 69.03)		71.11 (68.51, 73.72)[c]		4.07 (3.72, 4.42)	
Breakfast skippers	51.97 (50.56, 53.39)[b]	**<0.001**	60.96 (59.79, 62.09)[b,c]	**<0.001**	62.31 (61.15, 63.46)[b]	**<0.001**	67.41 (66.42, 68.40)[b,c]	**<0.001**	3.78 (3.65, 3.92)[b]	**0.001**

Abbreviations: 95%CI, 95% confidence intervals; DQI-A, Diet Quality Index for Adolescents; DQI-AM: Diet Quality Index for Adolescents (includes the meal index); DQI-AP: Diet Quality Index for Adolescents (includes the PA); DQI-AMP: Diet Quality Index for Adolescents (includes the PA and meal index); MDS, Mediterranean Diet Score

All analyses were adjusted by the following covariates: age, maternal education, BMI, center and total energy intake. P values from ANCOVA indicate statistical significance among different breakfast patterns; significant *p* values are shown in bold font.

[a] Significant differences between breakfast consumers and occasional consumers ($p<0.05$); [b] Significant differences between breakfast consumers and breakfast skippers ($p<0.05$); [c] Significant differences between occasional breakfast consumers and breakfast skippers ($p<0.05$).

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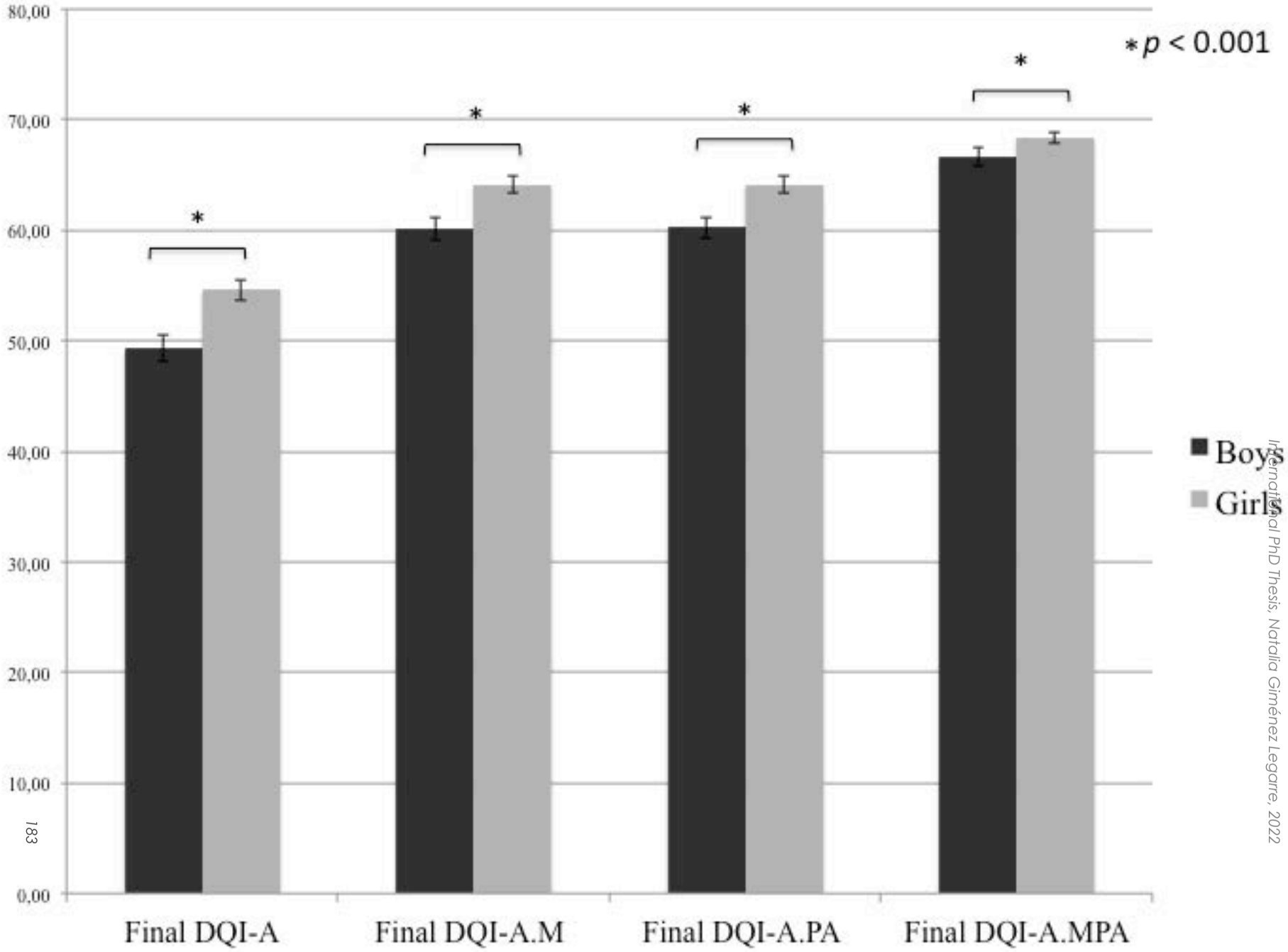
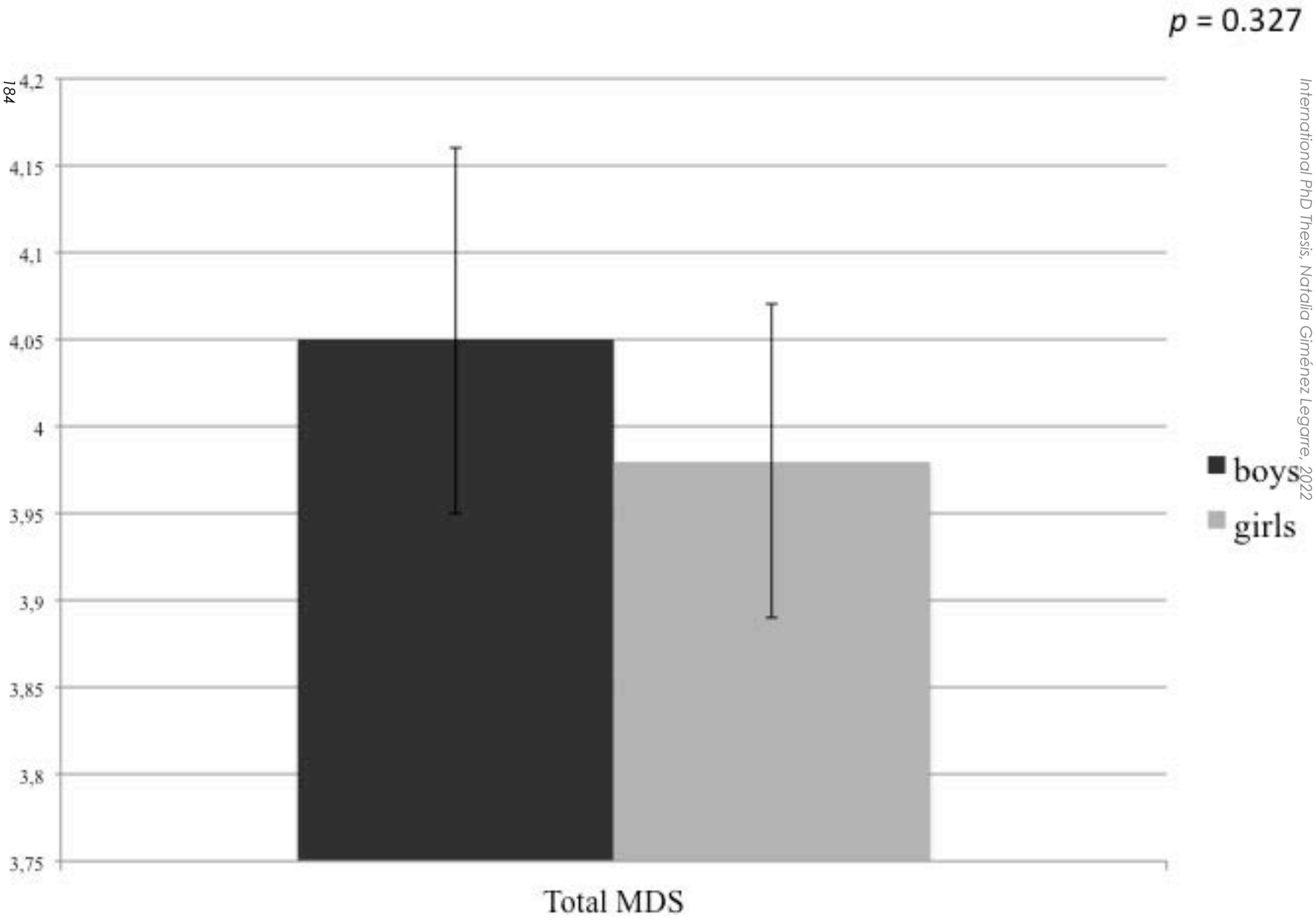
Table 3. Results of the linear mixed effects model assessing the association between breakfast consumption and diet quality indices and Mediterranean Diet Score

	Boys			Girls		
	β	**95% CI**	***p* value**	**β**	**95% CI**	***p* value**
Final DQI-A						
Breakfast consumers	5.33	2.90; 7.76	**<0.001**	4.72	2.90; 6.53	**<0.001**
Occasional breakfast consumers	1.10	-3.06; 5.28	0.603	2.30	-1.50; 6.10	0.236
Breakfast skippers	Ref.			Ref.		
Final DQI-AM						
Breakfast consumers	5.84	3.84; 7.83	**<0.001**	5.87	4.39; 7.36	**<0.001**
Occasional breakfast consumers	1.75	-1.66; 5.18	0.314	2.96	-0.14; 6.06	0.062
Breakfast skippers	Ref.			Ref.		
Final DQI-AP						
Breakfast consumers	4.88	2.90; 6.87	**<0.001**	3.17	1.66; 4.67	**<0.001**
Occasional breakfast consumers	1.16	-2.24; 4.58	0.503	2.03	-1.12; 5.19	0.207
Breakfast skippers	Ref.			Ref.		
Final DQI-AMP index						
Breakfast consumers	5.38	3.65; 7.10	**<0.001**	4.40	3.10; 5.70	**<0.001**
Occasional breakfast consumers	1.67	-1.29; 4.64	0.269	2.62	-0.09; 5.33	0.059
Breakfast skippers	Ref.			Ref.		
Total MDS						
Breakfast consumers	0.41	0.19; 0.63	**<0.001**	0.47	0.29; 0.65	**<0.001**
Occasional breakfast consumers	0.08	-0.29; 0.46	0.663	0.30	-0.07; 0.68	0.113
Breakfast skippers	Ref.			Ref.		

Models were adjusted by the following covariates: age, maternal education, BMI, center, and total energy intake. Abbreviations: 95%CI, 95% confidence intervals; DQI, diet quality index; PA, physical activity; MDS, Mediterranean Diet Score; Ref., reference group (breakfast skippers). *Significant differences are shown in bold font.

1




p = 0.327
4,2
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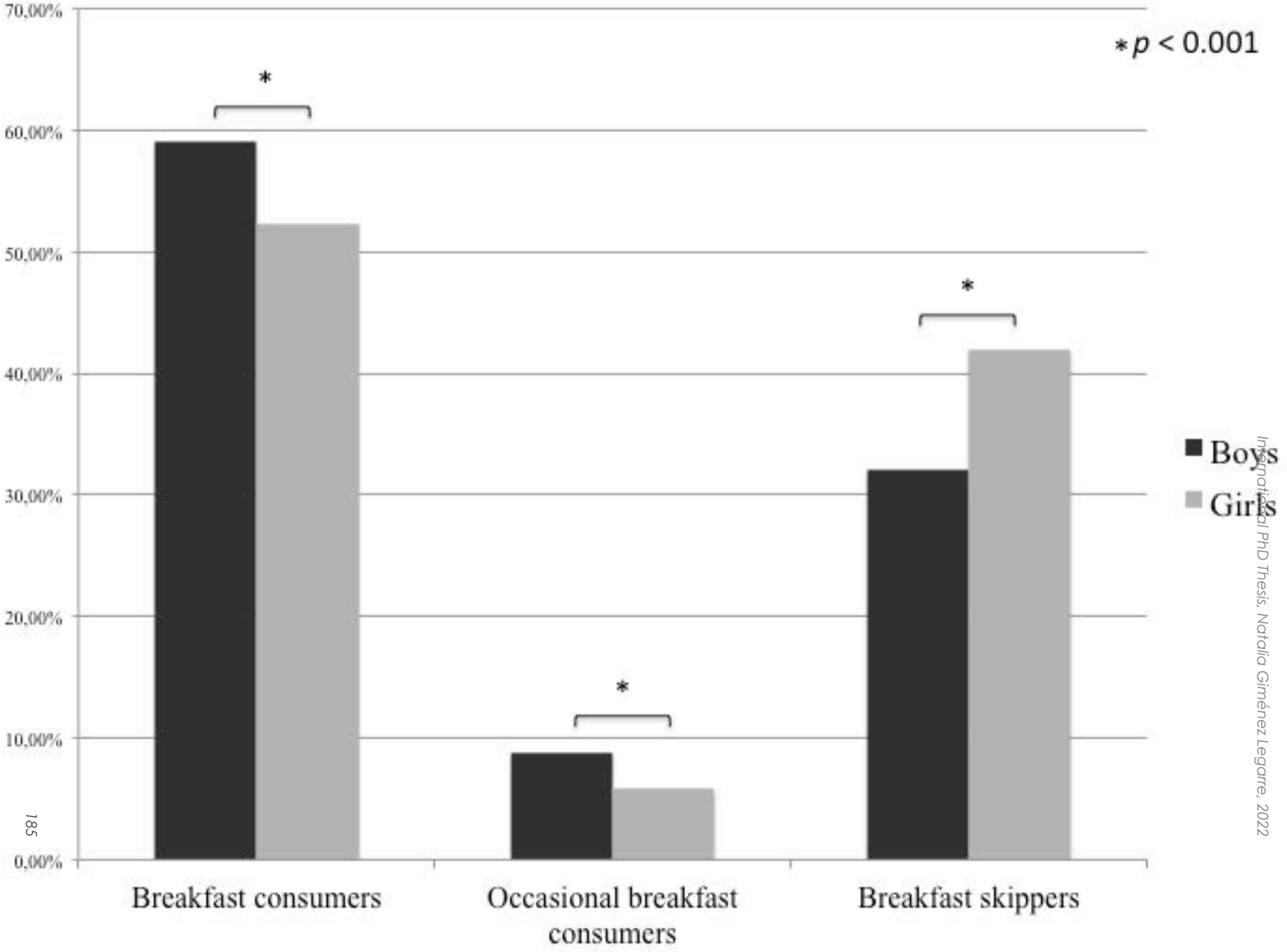
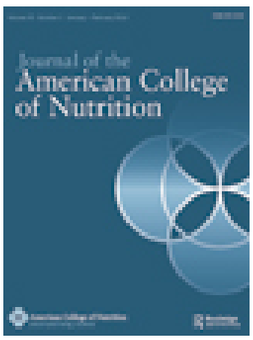
Total MDS



MANUSCRIPT V

Dietary Patterns and Their Relationship With the Perceptions of Healthy Eating in European Adolescents: The HELENA Study.



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Dietary Patterns and Their Relationship With the Perceptions of Healthy Eating in European Adolescents: The HELENA Study

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ABSTRACT

Objective: The aim of this study was to identify dietary patterns (DPs) in European adolescents and to examine the association between perceptions of healthy eating and the obtained DPs.

Method: A multinational cross-sectional study was carried out in adolescents aged 12.5 to 17.5 years and 2,027 (44.9% males) were considered for analysis. A self-reported questionnaire with information on food choices and preferences, including perceptions of healthy eating, and two 24-hour dietary recalls were used. Principal component analysis was used to obtain sex-specific DPs, and linear analyses of covariance were used to compare DPs according to perceptions of healthy eating.

Results: Three and four DPs for boys and girls were obtained. In boys and girls, there were significant associations between some perceptions about healthy food and the Breakfast-DP ($p < 0.05$). In boys, Breakfast-DP and Healthy Beverage-DP were associated with the perception of the own diet as healthy ($p < 0.05$). Healthy Beverage-DP was associated with those disliking fruits and vegetables ($p < 0.05$). Girls considering the own diet as healthy were associated with Mediterranean-DP, Breakfast-DP, and Unhealthy Beverage and Meat-DP ($p < 0.05$). The perception of snacking as a necessary part of a healthy diet was associated with Breakfast-DP in both genders ($p < 0.05$).

Conclusions: In European adolescents, perceptions of healthy eating were mainly associated with a DP characterized by foods consumed at breakfast. Future studies should further explore these findings in order to implement health promotion programs to improve healthy eating habits in adolescents.

Abbreviations: 24H-DR: 24-hour dietary recall; BMI: body mass index; DPs: dietary patterns; FAS: Family Affluence Scale; FCP: Food Choices and Preferences; F&V: fruits and vegetables; HELENA-CSS: Healthy Lifestyle in Europe by Nutrition in Adolescence Cross Sectional Study; PA: physical activity; SES: socioeconomic status

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KEYWORDS
Dietary patterns; food preferences; food choices; perceptions; adolescents

Introduction

Overweight and obesity in high-, middle-, and low-income countries is a public health issue around the world (1, 2). According to the World Health Organization, the worldwide prevalence of obesity has nearly doubled since 1980 (3). Worldwide, in 2016, 50 million girls and 74 million boys were obese (4). The rising trends of developed overweight or obesity in children have plateaued in many high-income countries (4). Obesity is a multifactorial disorder originating from genetic and environmental factors and their

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interactions (5). Children with high body mass index (BMI) usually present an excess of total body fat, cardiometabolic risk factors, together with a propensity to experience type 2 diabetes, hypertension, and cardiovascular diseases later in life (6). Childhood obesity also represents an additional cost for both societal and health services (6).

Obesity is determined by a chronic energy imbalance involving both excessive dietary intake and low physical activity (PA) levels (7). Dietary patterns (DPs) are measures of the total usual intake of food and beverages combination in individuals and groups (8). It is generally accepted that DPs and other behaviors, as for instance PA, established during childhood, tracked into adolescence and continue into adulthood, and all these behaviors have implications for the development of chronic diseases (9). Consumption of some food groups has been associated with the development of risk factors for obesity and others diseases. For instance, a high consumption of sugar-sweetened beverages has been associated with obesity and future cardiometabolic risk (10). In a previous cross-sectional study which included a sample of 2801 American children, high fruit juice intake was also associated with an increased adiposity gain (11). On the other hand, a high level of intake of fruits and vegetables (F&V) and dairy products was related with a lower risk of obesity in American and European children (11–13).

Diet, PA and sedentary behaviors are acknowledged as major behavioral determinants of energy-balance, behaviors and obesity (14). The analysis of DPs may better predict the risk of diseases than the analysis of isolated nutrients or foods, once the joint effect of various nutrients involved in a DP would be better identified (15). Published studies showed that an unhealthy DP was associated with an overall unhealthy lifestyle (16). Also, it was suggested that there is an association between adolescents' perceptions of their dietary practices and their actual dietary behaviors (17). In previous studies authors observed that those adolescents with the best knowledge about healthy eating will not determine the best food's choices (18, 19).

For all these reasons, the hypothesis of the current study is that those adolescents perceiving their eating habits as healthy also have the healthiest DPs. For this reason, the aims of our study are the following: (1) to identify DPs in European adolescents and (2) to analyze the associations between several perceptions of healthy eating and the obtained DPs.

Methods

Study design sample

The Healthy Lifestyle in Europe by Nutrition in Adolescence Cross Sectional Study (HELENA-CSS) is a multi-center study that aimed to describe the lifestyle and nutritional status of adolescents (20). The HELENA-CSS was carried out between October 2006 and December 2007 in 10 European cities: Athens, Heraklion, Dortmund, Ghent, Lille, Pecs, Rome, Stockholm, Vienna, and Zaragoza (20, 21). Due to logistical reasons, adolescents from Heraklion and Pecs were excluded for the dietary intake assessments (20, 21). A random cluster sampling (all pupils from a selection of classes from all European schools) of 3000 adolescents, stratified for geographical location, age, and socioeconomic status, was carried out (21). The total sample size was calculated with a confidence level of 95% with ± 0.3 error in the parameter BMI. An error of 0.3 was chosen as a worst case scenario as precision level described by Cochran WG (22).

The general inclusion criteria for HELENA-CSS were (1) being within the age range of 12.5 to 17.5 years, (2) not participating simultaneously in another clinical trial, and (3) being free of any acute infection lasting less than 1 week before inclusion. From a sample of 3528 adolescents, only adolescents with two 24-hour dietary recalls (24H-DRs) and having completed at least 75% of the Food Choices and Preferences (FCP) questionnaire were included.

The HELENA study was performed following the ethical guidelines of the Declaration of Helsinki of 1964 and was approved by each local institutional review board. Written and signed informed consent was obtained from the adolescents and their parents or guardians (23).

Socioeconomic status (SES)

Collected demographic data included information on gender, age, and SES by means of a standardized self-reported questionnaire. A modified version of the Family Affluence Scale (FAS) developed by Currie et al. (24) was used as a proxy indicator of SES. The adolescents completed a questionnaire asking about car ownership, home computers and Internet access. The FAS was slightly modified by replacing the item on frequency of family holidays by Internet availability at home. Adolescents were scored from 0 (very low SES) to 8 (very high SES) and were merged into three groups: a score of 0 to 2 was grouped as low, 3 to 5 as medium, and 6 to 8 as high SES.

Physical examination

Physical measurement (weight and height) were performed by trained staff in a standardized way (25). Weight was measured with an electronic scale (Type SECA861, precision = 100 g, range 0–150 kg), and height was measured with a telescopic stadiometer (Type SECA 225, precision = 0.1 cm, range = 70–200 cm) (26). BMI was calculated from height and weight (kg/m^2). The definition of obesity (including overweight) was based on the international BMI (27). Age- and sex-specific BMI z scores were calculated according to Cole et al. (27).

Dietary assessment

Dietary intake data were obtained using two self-administered 24H-DRs by means of a software developed for the project (28), and it was completed during school time and assisted by dieticians/researchers, who instructed the participants on how to fill it. This method has been used and recommended to assess dietary intake in European children and adolescents. (29)

The program was improved and culturally adapted by adding national dishes to reach a European standard (30). The dietary data collection is organized in six meal occasions, and the participants can select from about 400 predefined food items and are free to add nonlisted foods manually. Special techniques are used to allow a detailed description and quantification of foods, e.g. pictures of portion sizes. Amounts eaten are reported as grams or milliliters or by common household measures.

Participants completed the 24H-DR twice on nonconsecutive days within a time span of 2 weeks. The Multiple Source Method (31) was used to calculate usual energy (kcal/d), nutrients, and foods intake, considering the effect of day-to-day within-person variability and random error in the recalls. The 43 food groups included were aggregated into 30 food groups according to their nutritional values.

Healthy eating preferences

The healthy eating preferences module is part of the self-administered FCP questionnaire, which investigates agreement/disagreement with a series of attitude statements regarding food choices and behaviors, healthy eating, and preferences.

The selected sentences that were answered by the participants were as follows: (1) I think that my diet is healthy; (2) Snacking is a necessary part of a healthy diet; (3) I enjoy eating F&V; (4) Food I eat at home is healthy; (5) I often skip breakfast; (6) Most snack foods that I eat are healthy; and (7) What I eat now will have a big impact on my future health. The predefined response categories were (1) strongly disagree; (2) moderately disagree; (3) slightly disagree; (4) neither agree nor disagree; (5) slightly agree; (6) moderately agree; (7) strongly agree. These categories were grouped into three groups: (1) strongly, moderately, and slightly disagree; (2) neither agree nor disagree; and (3) slightly, moderately, and strongly agree.

Statistical analysis

The Predictive Analytics Software version 20.0 (SPSS Inc.) was used to analyze the data. All analyses were gender-specific because of observed significant differences in FCP and dietary consumption. According to the nature of the studied variables, chi-square test for categorical variables and analysis of variance for continuous variables were used to compare gender-specific sample characteristics.

Principal component analysis (PCA) with varimax rotation was used to obtain DPs in our sample. It is a technique often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of variables by defining sets highly interrelated (32). Each obtained DP represents a linear combination of all food groups, which are weighted by their factor loading (those with an absolute value of > 0.3 were considered important contributors to each DP). The following criteria were used when deciding the number of components to be retained: eigenvalue > 1, the scree plot (a graphical presentation of eigenvalues), and the interpretability of each component (33, 34).

To compare the DPs (dependent variable) and healthy eating perceptions, analysis of covariance was used, stratified by gender and adjusted for age, SES, BMI, and energy intake. In addition, a Bonferroni *post-hoc* test was conducted to make pairwise comparisons. A two-sided significance level of 0.05 was considered to be statically significant.

Results

In total, 2027 adolescents (44.9% boys) were included in the analysis. Table 1 presents gender-specific sociodemographic characteristics on age, SES, BMI, food intake, and the questions related with healthy eating perceptions.

Table 2 presents the results of the PCA, including three DPs for boys and four DPs for girls. Only the food groups loading $|> 0.30|$ in each DP are presented. The obtained DPs in boys were namely Mediterranean-DP, Breakfast-DP, and Healthy Beverages-DP. The cumulative variance explained is 27.25%, corresponding with 10.95%, 8.94%, and 7.35% for each DP, respectively. In girls, the obtained DP was namely Mediterranean-DP, Breakfast-DP, Unhealthy Beverage and Meat-DP, and Healthy Snack Foods-DP. The cumulative variance explained is 34.67%, corresponding with 9.92%, 9.17%, 8.80%, and 6.71% for each DP, respectively.

Associations between healthy eating perceptions and DPs are shown separately by gender in Table 3 (boys) and Table 4 (girls). In boys, the perception of their own diet as healthy was associated with the Breakfast-DP ($p = 0.003$) and Healthy Beverage-DP ($p < 0.001$). On the other hand, the perception of snacking as a necessary part of a healthy diet was associated with the Breakfast-DP ($p < 0.001$). Those adolescents who thought that their snacks were healthy were associated with Breakfast-DP ($p < 0.001$). Furthermore, those enjoying eating F&V had the same DP ($p = 0.001$). In contrast, those adolescents who agreed that the food they eat at home is healthy were associated with Breakfast-DP ($p = 0.036$) and Healthy Beverage-DP ($p = 0.001$). Moreover, those boys who usually had breakfast presented the same DP ($p < 0.001$). In addition, those boys who thought that their food consumption would have a big impact on their future health had a high adherence with Mediterranean-DP ($p = 0.001$).

In girls (Table 4), the perception of their own diet as healthy had a high adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). However, those girls who disagreed with the same statement were associated with Unhealthy Beverage and Meat-DP ($p = 0.010$). Girls who agreed that snacking was part of a healthy diet presented high adherence with Breakfast-DP ($p < 0.001$). Besides, those adolescents who considered that snack consumption was healthy had a high adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). On the other hand, girls who do not enjoy eating F&V had a high adherence with Mediterranean-DP ($p = 0.005$). At opposite, those who enjoyed eating F&V had a high

Table 1. Descriptive characteristics of the sample of European adolescents from the HELENA study (n = 2027).

	Boys (n = 910)	Girls (n = 1117)	*p*
Age (years), mean (95% CI)	14.87 (14.79, 14.95)	14.80 (14.72, 14,87)	0.172
AGE CATEGORY, n (%)			0.712
<12.5–13.99	254 (27.9)	334 (29.9)	
14–14.99	237 (26.0)	291 (26.1)	
15–15.99	218 (24.0)	264 (23.6)	
16–>17.5	201 (22.1)	228 (20.4)	
SES, n (%)			0.019
Low	75 (8.3)	135 (12.1)	
Medium	509 (56.1)	599 (53.7)	
High	323 (35.6)	382 (34.2)	
BMI	21.3 (21.0, 21.5)	21.2 (21.0, 21.4)	0.736
WEIGHT STATUS CATEGORY, n (%)			0.008
Lower and optimal BMI	694 (76.3)	906 (81.1)	
Overweight and obese BMI	216 (23.7)	211 (18.9)	
FOOD AND BEVERAGES INTAKE (g or ml) mean (95% CI)			
Bread and rolls (g/d)	117 (113.4, 121.6)	93 (90.1, 95.9)	<0.001
Cereals (g/d)	139.4 (134.1, 144.7)	104.8 (101.1, 108.4)	<0.001
Sweet bakery products (g/d)	58.0 (55.3, 60.9)	51.0 (48.9, 53,1)	<0.001
Savory snacks (g/d)	10.30 (9.1, 11.5)	6.2 (5.5, 6.9)	<0.001
Sugar, honey, jam, syrup, and other sugar products (g/d)	12.1 (10.8, 13.4)	9.9(9.0, 10.8)	0.008
Confectionery non-chocolate (g/d)	7.3 (6.3, 8.3)	7.8 (7.1, 8.6)	0.359
Chocolate (g/d)	29.9 (27.6, 32.2)	21.4 (20.0, 22.8)	<0.001
Vegetable oils (g/d)	7.5 (6.7, 8.2)	6.00 (5.5, 6.5)	<0.001
Butter and animal fats (g/d)	6.9 (6.1, 7.8)	5.3 (4.8, 5.9)	0.002
Margarine, lipids of mixed origins (g/d)	4.2 (3.5, 4.8)	2.6 (2.3, 3.0)	<0.001
Sauces (g/d)	37.3 (35.4, 39.1)	29.6 (28.3, 30.9)	<0.001
Nuts, seeds, olives, and avocado (g/d)	3.1 (2.4, 3.9)	4.1 (3.3, 4.9)	0.071
Pulses (g/d)	9.8 (7.8, 11.7)	8.6 (7.1, 10.2)	0.373
Vegetables excluding potatoes (g/d)	92.1 (88.0, 96,08)	92.2 (88.9, 95.5)	0.957
Starch roots, potatoes (g/d)	65.3 (62.2, 68.3)	59.0 (56.8, 61.3)	0.001
Fruits (g/d)	124.0 (117.3, 130.7)	128.7 (123.3, 134.1)	0.283
Soups, bouillon (g/d)	37.3 (33.2, 41.4)	37.8 (34.4, 4.3)	0.846
Water (ml/d)	753.9 (718.17, 789.7)	742.3 (713.3, 771.3)	0.616
Coffee, tea (ml/d)	44.4 (37.8, 51.0)	52.5 (46.0, 58.9)	0.089
Fruit and vegetable juice (ml/d)	162.4 (151.8, 172.9)	140.3 (132.4, 148.1)	0.001
Carbonated/soft/isotonic drinks (ml/d)	374.8 (351.4, 398.2)	213.8 (200.5, 227.1)	<0.001
Alcoholic beverages (ml/d)	29.8 (21.6, 38.1)	5.2 (2.3, 8.2)	<0.001
Meat (g/d)	161.6 (156.2, 167.0)	128.5 (124.7, 132.2)	<0.001
Fish products (g/d)	20.6 (19.5, 22.1)	19.6 (18.4, 20.9)	0.309
Eggs (g/d)	13.5 (12.4, 14.6)	10.8 (10.0, 11.6)	<0.001
White milk and buttermilk (g/d)	189.9 (177.3, 202.6)	131.7 (123.5, 139.9)	<0.001
Dairy products (g/d)	83.7 (76.1, 91.3)	71.5 (66.1, 76.8)	0.008
Cheese (g/d)	32.4(30.7, 33.9)	26.8(25.7, 27.8)	<0.001
Other milk products (g/d)	12.8 (11.1, 14.6)	15.6 (14.1, 17.2)	0.017
Meat substitutes and vegetarian products (g/d)	1.1 (0.4, 1.8)	2.3 (1.6, 2.9)	0.019
HEALTHY EATING PERCEPTIONS, n (%)			
I think that my diet is healthy			0.658
Strongly, moderately, and slightly disagree	148 (16.3)	180 (16.2)	
Neither agree nor disagree	182 (20.1)	242 (21.7)	
Slightly, moderately, and strongly agree	576 (63.6)	691 (62.1)	
Snacking is a necessary part of a healthy diet			0.304
Strongly, moderately, and slightly disagree	335 (37.3)	380 (34.4)	
Neither agree nor disagree	173 (19.3)	210 (19.0)	
Slightly, moderately, and strongly agree	389 (43.4)	515 (46.6)	
I enjoy eating fruit and vegetables			<0.001
Strongly, moderately, and slightly disagree	150 (16.6)	115 (10.3)	
Neither agree nor disagree	130 (14.4)	109 (9.8)	
Slightly, moderately, and strongly agree	624 (69.0)	890 (79.9)	
Food I eat at home is healthy			0.013
Strongly, moderately, and slightly disagree	63 (7.0)	109 (9.8)	
Neither agree nor disagree	139 (15.4)	200 (18.0)	
Slightly, moderately, and strongly agree	701 (77.6)	803 (72.2)	
I often skip breakfast			<0.001
Strongly, moderately, and slightly disagree	531 (58.5)	589 (52.8)	
Neither agree nor disagree	79 (8.7)	68 (6.1)	
Slightly, moderately, and strongly agree	297 (32.7)	458 (41.1)	
Most snacks foods that I eat are healthy			0.005
Strongly, moderately, and slightly disagree	392 (43.6)	437 (39.5)	
Neither agree nor disagree	235 (26.1)	258 (23.3)	
Slightly, moderately, and strongly agree	273 (30.3)	412 (37.2)	
What I eat now will have a big impact on my future health			<0.001
Strongly, moderately, and slightly disagree	168 (18.6)	122 (11.0)	
Neither agree nor disagree	159 (17.6)	167 (15.1)	
Slightly, moderately, and strongly agree	574 (63.7)	819 (73.9)	

(*continued*)

Table 1. Continued.

	Boys (n = 910)	Girls (n = 1117)	*p*
I like the food my parents prepare at home			0.619
Strongly, moderately, and slightly disagree	47 (5.2)	49 (4.4)	
Neither agree nor disagree	64 (7.1)	74 (6.7)	
Slightly, moderately, and strongly agree	786 (87.6)	987 (88.9)	

HELENA = Healthy Lifestyle in Europe by Nutrition in Adolescence; BMI = body mass index; SES = socioeconomic status; CI = confidence interval.

Table 2. Gender-specific factor loadings of identified dietary patterns (DPs).

	Boys			Girls			
	Mediterranean-DP	Breakfast-DP	Healthy Beverages-DP	Mediterranean-DP	Breakfast-DP	Unhealthy Beverages and Meat-DP	Healthy Snack Foods-DP
Bread and rolls		0.632		0.320	0.579		
Cereals (flour, pasta, rice and other cereals)	0.551			0.655			
Sweet bakery products: cakes, pies, and biscuits	0.311						−0.336
Savory snacks							
Sugar products (sugar, honey, jam, syrup, and other sugar products)		0.481			0.565		
Confectionery non-chocolate							
Chocolate							
Vegetable oils	0.814			0.657		−0.404	
Butter and animal fats		0.624			0.487		
Margarine and lipids of mixed origins		0.446					
Sauces (excluding dessert sauces)						0.519	
Nuts, seeds, olives, and avocado							
Pulses (excluding fresh peas, sweet corn, and broad bean)	0.341					−0.343	
Vegetables excluding potatoes	0.569			0.447			
Starch roots, potatoes	−0.301						
Fruits					0.316		0.641
Soups, bouillon			0.359				
Water	0.403		0.359			−0.572	
Coffee, tea		0.359			0.602		
Fruit and vegetable juices						0.344	
Carbonated/soft/isotonic drinks including nonalcoholic wine, nonalcoholic beer			−0.659			0.516	
Alcoholic beverage							
Meat				0.366		0.393	
Fish products							
Eggs							
White milk and buttermilk			0.578				0.640
Dairy products (yogurt and fromage blanc and milk and yogurt beverages)							
Cheese	0.495	0.368		0.596			
Other milk products (dessert and puddings, milk-based and creams)							
Meat substitutes and vegetarian products							
Variance explained (%)	10.95	8.94	7.35	9.92	9.17	8.80	6.71
Cumulative variance explained (%)			27.25				34.67

adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). Furthermore, those girls who think that food they eat at home is healthy had a high adherence with Breakfast-DP ($p < 0.001$) and Healthy Snack Foods-DP ($p < 0.001$). At opposite, those adolescents who disagreed with this statement were associated with Unhealthy Beverage and Meat-DP ($p = 0.031$). Girls who did not skip breakfast had a high adherence with Healthy Snack Foods-DP ($p < 0.001$). In addition, those girls who thought that their food consumption would have a big impact on their future health had a high adherence with Healthy Snack Foods-DP ($p = 0.011$).

Discussion

The current study evaluated the association between healthy eating perceptions and DPs in European adolescents. Three DPs were identified in boys and four in girls. To our knowledge, this is the first study analyzing the relationship between different adolescents' diet-related perceptions and their adherence to the identified DPs. The most important finding was the association between reported agreement to perceiving their diet as healthy and Breakfast-DP in both genders.

The DPs identified in the current study differ from those identified in a previous HELENA paper (32) because the

Table 3. Mean scores of dietary patterns according to healthy eating perceptions in boys.

	Mediterranean-DP MEAN (95% CI)	*p*	Breakfast-DP MEAN (95% CI)	*p*	Healthy Beverage-DP MEAN (95% CI)	*p*
I think that my diet is healthy						
1: Disagreement	−0.005 (−0.153, 0.143)		−0.186 (−0.324, −0.048)[b]		−0.419 (−0.580, −0.259)[a,b]	
2: Neither agree nor disagree	−0.109 (−0.241, 0.022)		−0.081 (−0.203, 0.042)[c]		0.031 (−0.111, 0.174)[a]	
3: Agreement	0.037 (−0.037, 0.111)	0.163	0.061 (−0.008, 0.130)[b,c]	**0.003**	0.097 (0.017, 0.177)[b]	**<0.001**
Snacking is a necessary part of a healthy diet						
1:Disagreement	0.011 (−0.085, 0.108)		−0.103 (−0.194, −0.011)[b]		0.002 (−0.105, 0.109)	
2: Neither agree nor disagree	0.080 (−0.054, 0.214)		−0.153 (−0.279, −0.026)		−0.064 (−0.213, 0.084)	
3: Agreement	−0.068 (−0.158, 0.021)	0.173	0.161 (0.077, 0.246)[b]	**<0.001**	0.024 (−0.075, 0.124)	0.625
Most snack foods that I eat are healthy						
1: Disagreement	0.005 (−0.084, 0.094)		−0.086 (−0.170, −0.001)[b]		−0.010 (−0.108, 0.088)	
2: Neither agree nor disagree	0.022 (−0.093, 0.137)		−0.067 (−0.176, 0.042)[c]		−0.013 (−0.139, 0.114)	
3: Agreement	−0.028 (−0.135, 0.079)	0.813	0.188 (0.086, 0.289) [b,c]	**<0.001**	0.011 (−0.107, 0.129)	0.955
I enjoy eating fruit and vegetables						
1: Disagreement	−0.019 (−0.164, 0.127)		−0.187 (−0.323, −0.052)[b]		−0.133 (−0.292, 0.026)	
2: Neither agree nor disagree	0.034 (−0.122, 0.190)		−0.137 (−0.282, 0.008)[c]		0.132 (−0.037, 0.302)	
3: Agreement	−0.002 (−0.073, 0.069)	0.882	0.066 (0.000, 0.133)[b,c]	**0.001**	−0.005 (−0.083, 0.072)	0.082
Food I eat at home is healthy						
1: Disagreement	0.003 (−0.222, 0.229)		−0.172 (−0.386, 0.042)		−0.367 (−0.614, −0.120)[b]	
2: Neither agree nor disagree	−0.059 (−0.210, 0.092)		−0.117 (−0.260, 0.026)		−0.134 (−0.300, 0.031)	
3: Agreement	0.013 (−0.054, 0.080)	0.696	0.042 (−0.022, 0.106)	**0.036**	0.060 (−0.014, 0.133)[b]	**0.001**
I often skip breakfast						
1: Disagreement	0.020 (−0.058, 0.098)		0.046 (−0.028, 0.120)		0.170 (0.085, 0.254)[a,b]	
2: Neither agree nor disagree	0.136 (−0.064, 0.336)		−0.140 (−0.330, 0.051)		−0.175 (−0.392, 0.042)[a]	
3: Agreement	−0.064 (−0.170, 0.041)	0.182	−0.045 (−0.145, 0.055)	0.119	−0.262 (−0.376, −0.148)[b]	**<0.001**
What I eat now will have a big impact on my future health						
1: Disagreement	−0.125 (−0.260, 0.011)[b]		0.039 (−0.092, 0.169)		−0.116 (−0.266, 0.033)	
2: Neither agree nor disagree	−0.157 (−0.296, −0.018)[c]		−0.055 (−0.189, 0.078)		−0.064 (−0.217, 0.090)	
3: Agreement	0.092 (0.018, 0.165)[b,c]	**0.001**	0.008 (−0.063, 0.078)	0.596	0.043 (−0.038, 0.124)	0.133
I like the food my parents prepare at home						
1: Disagreement	0.113 (−0.145, 0.372)		−0.184 (−0.431, 0.063)		−0.237 (−0.521, 0.046)	
2: Neither agree nor disagree	0.059 (−0.163, 0.280)		−0.092 (−0.303, 0.119)		0.095 (−0.147, 0.338)	
3: Agreement	−0.001 (−0.064, 0.062)	0.632	0.022 (−0.038, 0.082)	0.187	0.002 (−0.067, 0.071)	0.195

Note. CI = confidence interval; Agreement = strongly, moderately, and slightly agree; Disagreement = strongly, moderately, and slightly disagree; DP = dietary pattern; B-DP, Boy-Dietary Pattern; Bold letter show significant differences between three categories ($p < 0.05$).
[a]Significant differences between disagreement and neither agree nor disagree ($p < 0.05$);
[b]significant differences between disagreement and agreement ($p < 0.05$);
[c]significant differences between neither agree nor disagree and agreement ($p < 0.05$).

objective was different. To our knowledge, there is no similar study identifying DPs in adolescents from different European countries. There are several studies limited to some specific European countries or regions (35–37).

As in other studies that were conducted in Greece, Italy, or Spain, (38) a healthy pattern was found in girls. In another study conducted in Spanish young populations, different patterns were observed: snack DP, healthy DP, protein-rich DP, meat-rich DP, and ludicrous DP (35). On the other hand, a study in Portuguese adolescents showed that unhealthier behaviors like sedentary activities were associated with DP characterized by higher consumption of sweets, fast foods, and soft drinks (36).

Assessing the relationship between healthy eating perceptions and DPs, in boys those considering their diet as healthy showed positive associations with Breakfast-DP and Healthy Beverage-DP. Girls considering their diet as healthy also showed positive associations with Breakfast-DP and Healthy Snack Foods-DP. The most consistent finding was the association between perceiving their diet as healthy and Breakfast-DP in boys and girls, which characterized by the consumption of foods regularly consumed at breakfast. We also observed in both sexes that perceptions of snacking as part of a healthy diet was associated by the consumption of foods regularly consumed at breakfast; this is consistent with the results of a literature review showing that interventions should ensure that foods and beverages consumed by youth at snack occasions contribute to meeting dietary recommendations (39). These findings are important due to the fact that breakfast has been considered as an important meal of the day, and several authors observed that is considered as part of healthy diet (40, 41). Also, a high proportion of young people have the tendency to skip breakfast (42), and it has been related with greater body fatness, overweight and abdominal obesity (43) make essential to focus on this habit. For these reasons, the promotion of breakfast consumption could be an essential key factor in future health policies or strategies to improve lifestyle behaviors, especially in adolescence.

In boys and girls, those who thought their snacks' consumption were healthy were positively related with the breakfast DP characterized by the consumption of breakfast foods in boys and girls. Several authors showed that the frequency of snacking has increased in all age groups, including adolescents (44). Also, dietary intake of frequent snack consumers was characterized by low nutritional quality (i.e., high energy content) across the day (44).

Concerning the question about enjoying eating F&V, we found a significant association with Mediterranean-DP, characterized by the consumption of foods typically consumed in the Mediterranean diet. In a similar study, it was observed that the proportion of individuals having usual low

Table 4. Associations between food choices and preferences and mean scores of dietary patterns in girls.

	Mediterranean-DP MEAN (95% CI)	*p*	Breakfast-DP MEAN (95% CI)	*p*	Unhealthy Beverage and Meat-DP MEAN (95% CI)	*p*	Healthy Snacks Foods-DP MEAN (95% CI)	*p*
I think that my diet is healthy								
1:Disagreement	0.023 (−0.103, 0.148)		−0.125 (−0.261, 0.010) *b*		0.171 (0.031, 0.311) *b*		−0.430 (−0.575, −0.285) *a, b*	
2: Neither agree nor disagree	−0.030 (−0.136, 0.076)		−0.233 (−0.349, −0.118) *c*		0.058 (−0.061, 0.177)		−0.057 (−0.181, 0.066) *a, c*	
3: Agreement	0.003 (−0.060, 0.066)	0.803	0.113 (0.044, 0.181) *b, c*	**< 0.001**	−0.061 (−0.132, 0.010) *b*	**0.010**	0.132 (0.058, 0.205) *b, c*	**< 0.001**
Snacking is a necessary part of a healthy diet								
1: Disagreement	−0.069 (−0.154, 0.017)		−0.157 (−0.249, −0.064) *b*		−0,043 (−0.139, 0.052)		−0.091 (−0.192, 0.010)	
2: Neither agree nor disagree	0.016 (−0.099, 0.130)		−0.091 (−0.215, 0.034) *c*		0,087 (−0.040, 0.215)		0.005 (−0.130, 0.140)	
3: Agreement	0.050 (−0.024, 0.123)	0.116	0.158 (0.079, 0.237) *b,c*	**< 0.001**	0,003 (−0.079, 0.084)	0.275	0.062 (−0.025, 0.148)	0.078
Most snack foods that I eat are healthy								
1: Disagreement	−0.008 (−0.087, 0.071)		−0.215 (−0.299, −0.130) *b*		0.023 (−0.066, 0.111)		−0.171 (−0.263, −0.079) *b*	
2: Neither agree nor disagree	−0.005 (−0.108, 0.098)		−0.080 (−0.190, 0.030) *c*		−0.017 (−0.132, 0.098)		−0.024 (−0.144, 0.096) *c*	
3: Agreement	0.010 (−0.071, 0.092)	0.946	0.286 (0.199, 0.373) *b, c*	**< 0.001**	−0.006 (−0.097, 0.085)	0.844	0.196 (0.101, 0.291) *b, c*	**< 0.001**
I enjoy eating fruit and vegetables								
1: Disagreement	0.241 (0.086, 0.396) *b*		−0.428 (−0.595, −0.261) *b*		−0.037 (−0.212, 0.138)		−0.347 (−0.529, −0.165) *b*	
2: Neither agree nor disagree	0.007 (−0.151, 0.164)		−0.368 (−0.538, −0.198) *c*		−0.035 (−0.213, 0.143)		−0.205 (−0.391, −0.020)	
3: Agreement	−0.035 (−0.090, 0.020) *b*	**0.005**	0.099 (0.039, 0.159) *b, c*	**< 0.001**	0.009 (−0.053, 0.072)	0.817	0.069 (0.004, 0.134) *b*	**< 0.001**
Food I eat at home is healthy								
1: Disagreement	−0.145 (−0.305, 0.016)		−0.124 (−0.299, 0.051)		0.190 (0.011, 0.369) *b*		−0.364 (−0.550, −0.177)	
2: Neither agree nor disagree	−0.037 (−0.154, 0.080)		−0.216 (−0.343, −0.088)		0.058 (−0.073, 0.189)		−0.229 (−0.365, 0.093)	
3: Agreement	0.025 (−0.034, 0.083)	0.125	0.066 (0.002, 0.130)	**< 0.001**	−0.047 (−0.112, 0.019) *b*	**0.031**	0.103 (0.035, 0.171)	**< 0.001**
I often skip breakfast								
1: Disagreement	0.006 (−0.063, 0.075)		0.029 (−0.047, 0.104)		−0.033 (−0.110, 0.044) *b*		0.199 (0.120, 0.278) *b*	
2: Neither agree nor disagree	−0.041 (−0.242, 0.160)		−0.103 (−0.323, 0.117)		0.127 (−0.097, 0.352)		0.097 (−0.134, 0.327) *c*	
3: Agreement	0.001 (−0.077, 0.079)	0.909	−0.028 (−0.113, 0.058)	0.414	0.026 (−0.062, 0.113) *b*	0.322	−0.274 (−0.363, −0.184) *b, c*	**< 0.001**
What I eat now will have a big impact on my future health								
1: Disagreement	−0.048 (−0.199, 0.103)		−0.012 (−0.177, 0.153)		−0.006 (−0.175, 0.163)		−0.173 (−0.350, 0.004)	
2: Neither agree nor disagree	−0.023 (−0.151, 0.105)		−0.124 (−0.264, 0.016)		0.069 (−0.074, 0.213)		−0.132 (−0.282, 0.018)	
3: Agreement	0.020 (−0.038, 0.077)	0.636	0.021 (−0.042, 0.084)	0.132	−0.018 (−0.083, 0.047)	0.552	0.053 (−0.014, 0.121)	**0.011**
I like the food my parents prepare at home								
1: Disagreement 2: Neither agree	−0.241 (−0.477, −0.005)		0.041 (−0.218, 0.301)		−0.251 (−0.516, 0.014)		−0.084 (−0.363, 0.196)	
nor disagree 3: Agreement	−0.082 (−0.275, 0.110)		−0.208 (−0.419, 0.004)		−0.032 (−0.249, 0.184)		−0.133 (−0.360, 0.095)	
	0.021 (−0.032, 0.073)	0.072	0.012 (−0.046, 0.070)	0.137	0.011 (−0.048, 0.070)	0.162	0.010 (−0.052, 0.072)	0.423

DP = dietary pattern; CI = confidence interval.

Bold letter show significant differences between three categories ($p < 0.05$)

consumption of F&V was significantly higher among those reporting a dislike for that food group (37). Our results could be due to the emphasis of parents supporting the consumption of these foods with high nutritional value. In a previous literature review, it was observed that adolescents' eating habits and food choices may be influenced by their parents, and they play an important role in the formation of eating habits and preferences of children and adolescents (45); therefore, interventions aiming to increase F&V intake among children should also target the parents (46), and also it is important to involve adolescents in food preparation in order to improve diet quality through family interactions (47).

We have also observed, in both genders, a positive association between the same question and the DP, which included foods typically consumed at breakfast. In agreement with our study, in Italian adolescents, a positive association between breakfast consumption and consumption of F&V was observed (48).

Adolescents' perception that the food they eat at home is healthy was positively associated with the Breakfast-DP in both genders. Also in girls, the same perception was associated with the DP characterized by the consumption of unhealthy beverages and meat. In Australian girls, unavailability of healthy foods at home and parents not supporting healthy eating were positively associated with consumption of salty snacks (49).

Also, taking into consideration the Unhealthy Beverage and Meat-DP obtained, it was characterized with the highest proportion of low SES in girls, and by high adherence to sugar-sweetened beverage and F&V juices, and could be behind of the obtained associations. In this direction, in a previous longitudinal study, authors suggested that there is a positive association between SES and diet quality in adolescence (50).

Adolescents who used to often skip breakfast had lower adherence to the Healthy Beverage-DP and Healthy Snack Foods-DP, characterized by the consumption of healthy beverages in boys and healthy snack foods in girls. According to several authors, the habit of skipping breakfast may facilitate weight gain and overweight or obesity risk (41). This relationship could be explained by the fact that those adolescents skipping breakfast or consuming low energy at breakfast consume a high percentage of energy at other meal occasions, especially at dinner (51). In addition, several authors have observed that skipping breakfast was associated with high snacking consumption and an increased intake of low nutritional foods (52). In this sense, all these findings support the idea to support the breakfast consumption as a tool to improve the overall diet quality and nutrient adequacy.

Finally, adolescents considering that what they eat now will have a big impact on their future health had higher adherence to the Mediterranean-DP. In a previous study, it was suggested that parental perceptions regarding healthy eating are an important target for public health interventions because of the possible association between parental perception and child weight (53). On the other hand, eating influences in adolescents like individual, social, environmental, community setting, or societal influences may explain the adolescents' eating behaviors and food intake (54). In a previous HELENA paper, it was observed that obese adolescents were not able to assess their diet quality regarding to their normal-weight peers (55).

Strengths and limitations

Our study has some limitations, including the lack of possibility to compare the results between countries. Furthermore, the food consumption and the adolescents' perception are based on self-reported questionnaires; however, the questionnaires have been tested and validated (28).

The principal strength of our study is the large sample and their geographical distribution across Europe. The standardized and harmonized methodology and the use of reliable and validated questionnaires are also an important strength. Moreover, the use of PCA to create DPs is also a strength. Besides, the use of DPs takes into account interactions among foods, which is not possible using the single food approach.

Conclusions

In the present study, we have analyzed the relationships between different DPs and healthy eating perceptions in a large group of European adolescents. Dietary habits are one of the key elements in the development of healthy lifestyles, especially from childhood. This is relevant because lifestyles acquired in these life stages are key factors in the development of diseases such as overweight and obesity.

In conclusion, we observed significant associations between different DPs and perceptions of healthy eating. Analyzing relationships between perceptions of healthy eating and food and beverage consumption should contribute to developing effective strategies to increase awareness of healthy lifestyles among young Europeans, and this in turn could influence food intake as well as other lifestyles. Investing in improving adolescents' knowledge can be a strategy to promote healthy habits and healthy lifestyles.

Conflict of interest

The authors declare no conflicts of interest.

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Author's contribution

J.D., C.G., M.G.G, S.H., A.K., M.K., C.L., Y.M., D.M., M.S., K.W. and L.M. conceived and designed study. N.G.L., A.M.S.P., and L.A. conducted the interpretation of data. N.G.L., A.M.S.P., L.B., J.D., A.O., C.G., M.G.G., S.H., A.K., M.K., C.L., Y.M., D.M., M.S., K.W., I.H., and L.M. critically reviewed the manuscript. N.G.L., A.M.S.P., and L.M wrote the paper, and I.H. and L.B. participated in data interpretation. All the authors read and approved the final version of the manuscript.

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Appendix

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DISCUSIÓN

DISCUSSION

La palabra desayuno, tal y como se indica en el diccionario de la Real Academia de la Lengua Española (RAE), está compuesta por el prefijo "des-" (negación o inversión del significado de la palabra a la que va antepuesto) y el verbo "ayunar" (abstenerse total o parcialmente de comer o beber), por lo que literalmente, su significado es "deshacer el ayuno". Y por ello, el acto de desayunar se define como la primera comida del día que rompe el estado de ayuno después del período más largo de sueño.

La frase "desayuna como un rey, almuerza como un príncipe y cena como un mendigo" (Adelle Davis, 1904-1974) es un concepto ampliamente extendido a lo largo de los años, siendo considerado tradicionalmente como la comida más importante del día (1).

FRECUENCIA DE DESAYUNO

Nuestros datos sobre el porcentaje de frecuencia de consumo de desayuno concuerdan con los obtenidos en el estudio IBRI, realizado en seis diferentes países. En este estudio, se observa que la tendencia al consumo habitual de desayuno es alta durante la infancia, disminuye en gran proporción durante la adolescencia y empieza a aumentar nuevamente en la adultez (3).

Los datos obtenidos en esta investigación siguen el mismo patrón, ya que hemos observado que existe un alto consumo de desayuno en la población infantil, ya que el 92.4% de los niños y el 91.8% de las niñas desayunaban de forma habitual. En cambio, en el estudio realizado en adolescentes, hemos observado que únicamente el 59.1% de los chicos y el 52.3% de las chicas desayunaban de forma habitual. Finalmente, en adultos, hemos observado que la frecuencia de desayuno de las madres de los niños evaluados fue de un 69%. Comparando nuestros resultados con los del último informe del estudio ALADINO, realizado en España, se observó que el 80.6% de los escolares desayunan todos los días (121), cifras que concuerdan con EEUU, en el que se ha observado un 82% de consumidores habituales de desayuno en población infantil (28).

DESAYUNO DURANTE LA INFANCIA Y ADOLESCENCIA

Establecer prácticas alimentarias durante la infancia y la adolescencia contribuyen a la creación de hábitos nutricionales, proporcionando además un entorno de apoyo que promueve la calidad general de la dieta. (122-124). Además, la evidencia científica sugiere que estos comportamientos alimentarios pueden persistir de forma significativa hasta la edad adulta (125-127), por lo que promover hábitos saludables permitirá extrapolarlos y mantenerlos hasta la vida adulta

Muchos de los estudios publicados se han centrado en el desayuno durante la adolescencia (128-131), existiendo menos investigaciones en los niños más pequeños (132).

La adolescencia es una época de transición y de rápido crecimiento en la que los hábitos alimenticios están fuertemente influenciados por sus familias y amigos. Uno de los hábitos alimenticios no saludable característico de ese período es el saltarse el desayuno (39). En niños, la rutina de desayuno ha sido asociada con la rutina de desayuno de sus madres, independientemente del género de los niños. Se ha observado que ambos, niños y niñas, estuvieron en concordancia con sus madres, tanto en términos de frecuencia de desayuno como en el tipo de alimentos y bebidas consumidos en el mismo, siendo una elevada proporción los niños que consumían frecuentemente frutas y/o verduras aquellos cuyas madres los consumían también. Esto puede ser debido a que, frecuentemente, aquellos alimentos y bebidas que no son del agrado de las madres, tiende a no ser ofrecidos a los niños (133). Se ha observado que los hábitos de los niños se asocian fuertemente con los hábitos de sus padres ya que existe un gran modelado parental, especialmente en la edad infantil (42, 134, 135). Además, se ha observado que los padres influyen en la alimentación de sus hijos, especialmente cuando se comparten las comidas familiares, desarrollando y reforzando el entorno alimentario familiar (41, 136), siendo además un factor muy importante a la hora de modelar las elecciones del consumo de alimentos saludables (124).

La adolescencia es una época en la que la necesidad fisiológica de una alimentación de alta calidad nutricional es particularmente importante, principalmente por el rápido crecimiento que se produce en esta fase del desarrollo (44). En cambio, la adolescencia es también un período de mayor autonomía, que se caracteriza a menudo por conductas alimentarias exploratorias, a menudo poco saludables y erróneas, como saltarse las comidas, aumento del consumo de snacks y comidas preparadas para consumir (43, 137); siendo común saltarse las comidas durante esta etapa de la vida, especialmente el desayuno (138). En nuestro estudio hemos observado que, en adolescentes, existen diferencias significativas en el consumo de desayuno por parte de los chicos y de las chicas. Esto se encuentra en concordancia con lo obtenido por diversos autores en investigaciones previas (39, 139, 140). Esto podría ser debido a que durante la adolescencia, en las chicas, existe una mayor preocupación por su apariencia y están más influenciadas por la dieta y los ideales de belleza (141). Las razones más comunes reportadas sobre la omisión del desayuno incluyen aquellas relacionadas con la falta de tiempo, sensación de hambre por la mañana y el control de peso (142, 143).

COMPOSICIÓN DEL DESAYUNO

En el artículo realizado donde se analizaba las asociaciones entre la rutina de desayuno de los niños y las de su madre, se presentó una descripción de los alimentos consumidos por aquellos que consumían el desayuno de forma habitual (siempre o casi siempre). Se observó que una alta proporción de niños consumía siempre leche o productos lácteos en el desayuno. Además, se mostró que una cuarta parte de la muestra total consumía cereales en el desayuno, tanto integrales como bajos en fibra. En el estudio ALADINO, realizado en España, se ha observado que, de los escolares que desayunaban habitualmente, más del 80% desayunaban leche, más del 50% consumían galletas y pan o tostadas, un 45% consumía cereales de desayuno y un 20% fruta fresca (121). En cuanto a las madres, al igual que en los niños, una alta proporción consumía leche o productos lácteos a la hora del desayuno. Además, cerca del 25% de las madres consumían frutas y verduras durante el desayuno. Respecto al consumo de cereales, se observó una alta variabilidad, ya que alrededor del 20% consumían cereales bajos en fibra y, en cambio, cerca del 35% de las madres consumían cereales integrales. Por otro lado, aproximadamente un 10% de las madres consumían zumos no azucarados, y dulces o pastas y únicamente un 4% consumían zumos de frutas azucarados o refrescos.

De acuerdo con estos resultados, en las revisiones sistemáticas realizadas en la presente tesis doctoral, se ha observado que existen diferencias entre la composición del desayuno según la diversidad cultural. En la mayoría de los estudios europeos y norteamericanos, se evaluó el consumo de RTEC, leche y pan como componentes principales de sus desayunos (144-147), mientras que en otros países se consumían otros alimentos locales tradicionales. Por ejemplo, en los niños mexicanos, las tortillas y los frijoles fueron los alimentos más consumidos durante el desayuno (34). En cambio, en Japón, un desayuno típico se basa en el consumo de arroz o pan acompañado de otros alimentos, como frutas y verduras, productos lácteos, legumbres, huevos y té (148).

DESAYUNO A BASE DE CEREALES LISTOS PARA CONSUMIR

Los cereales listos para consumir son uno de los alimentos más consumidos por los niños a la hora del desayuno en los países occidentalizados (149). Estos cereales pueden definirse como un alimento a base de cereales que se procesa hasta el punto en el que se pueden comer sin ningún tipo de preparación, aunque habitualmente se agrega leche o productos lácteos (150). Los cereales listos para consumir son ricos en hidratos de carbono y contienen también fibra,

proteínas, vitaminas y minerales, lo que permite cubrir los requerimientos nutricionales recomendados de algunos nutrientes. Gran parte de este efecto es posible que se deba a la fortificación a la que son sometidos muchos de estos cereales (151). A lo largo de los años los tipos y/o opciones de cereales de desayuno han aumentado para satisfacer una demanda creciente, comercializándose a menudo, como una fuente rica de nutrientes (152).

En la revisión sistemática y metaanálisis incluida en la presente tesis doctoral, se observó que la mayoría de los artículos evaluados comparaban el consumo de desayuno a base de cereales con saltarse el desayuno. Se observó que aquellos niños y adolescentes que consumían un desayuno a base de cereales tuvieron una mayor ingesta diaria de energía que aquellos que no desayunaban. Además, también se observó que tenían una mayor ingesta diaria de hidratos de carbono, fibra y proteínas que aquellos que no desayunaban de forma habitual. La mayor ingesta de hidratos de carbono y de fibra es razonable, ya que los cereales tienen un alto contenido en hidratos de carbono y, habitualmente, también tienen un elevado contenido en fibra (153). Además, en un estudio anterior se observó que con el consumo de cereales se cubría el 10% de la ingesta de fibra total diaria (154), siendo el desayuno una gran ocasión para realizar una comida rica en hidratos de carbono (3, 155). Esto puede ser debido, al igual que lo anteriormente mencionado, porque al no consumir el desayuno, puede aumentar la sensación de hambre a lo largo de la mañana, y como resultado, incrementar el consumo de snacks con elevada densidad energética (156). Además, aunque con excepciones, los cereales suelen tener un bajo contenido en grasa (153). Por otro lado, en relación al consumo de alimentos y bebidas, se observó que aquellos niños y adolescentes que habitualmente consumían cereales durante el desayuno mostraron unos hábitos más saludables a lo largo del día, ya que mostraron un elevado consumo de cereales integrales, leche y productos lácteos y frutas. Además, se asoció negativamente con el consumo de alimentos menos saludables como azúcar y dulces, carnes, refrescos azucarados y otro tipo de bebidas.

Respecto a la ingesta diaria de micronutrientes, en el metaanálisis incluido en la presente tesis doctoral, se observó que, aquellos niños y adolescentes que consumían un desayuno a base de cereales tenían una mayor ingesta diaria total de diversas vitaminas como es el caso de la tiamina, riboflavina, vitamina A y vitamina C, que aquellos niños y adolescentes que no consumían el desayuno. Además, en nuestra revisión sistemática se observó que diferentes estudios habían observado una mayor ingesta diaria total de niacina, piridoxina, biotina, folato y cobalamina en aquellos que consumían cereales en el desayuno. Por otro lado, en relación con la ingesta de minerales, en nuestro metaanálisis observamos que aquellos que desayunaban cereales tenían una mayor ingesta diaria total de calcio, hierro, magnesio, sodio, potasio que

aquellos que se saltaban el desayuno. Además, en nuestra revisión sistemática se observó una mayor ingesta diaria total de sodio, magnesio, zinc, potasio, fósforo, yodo y cobre en aquellos que desayunaban cereales en comparación con los que no consumían el desayuno. Como se ha mencionado antes, la leche y los productos lácteos son uno de los grupos de alimentos consumidos con mayor frecuencia durante el desayuno (157, 158), y estos proporcionan una gran cantidad de vitaminas y minerales como calcio, vitamina D, magnesio o fósforo (159-161). Además, en estudios anteriores se ha observado que los niños y adultos que consumían cereales en el desayuno incrementaban su ingesta diaria total de vitaminas y minerales, aunque es importante mencionar que, aproximadamente el 92% de todos los cereales listos para consumir están fortificados con micronutrientes esenciales (69, 162).

Diferentes autores han documentado que el consumo de cereales contribuye a una alimentación más saludable; en cambio, los autores de una revisión sistemática previa recomiendan que se debería diferenciar entre los diferentes tipos de cereales, siendo importante recomendar aquellos cereales con los mejores perfiles nutricionales y funcionales (163). Los cereales pueden contener altos niveles de sal y azúcar, los cuales, si se consumen en exceso, son identificados como factores de riesgo de numerosas enfermedades crónicas (164, 165). Además, la alta ingesta de azúcares añadidos está asociado con un mayor riesgo de sufrir caries dentales (166), así como con el aumento del peso corporal (167) y del riesgo de desarrollar diversas enfermedades crónicas como diabetes tipo 2 (168) y enfermedades cardiovasculares (169). En varios estudios realizados en España se ha observado un elevado consumo de azúcares añadidos en niños y adolescentes, encontrándose los cereales de desayuno una de las fuentes alimentarias principales de azúcares añadidos a la ingesta diaria (170-172) .

Aunque este tipo de cereales de desayuno han sido diseñados para que estén convenientemente listos para comer y sean fáciles de preparar, existe una amplia variedad de productos dentro de esta categoría, desde productos a base de avena, de un solo ingrediente, que pueden requerir cocción o la adición de otros ingredientes (por ejemplo, leche para preparar un desayuno estilo “porridge”), hasta galletas, que ofrecen un alimento denso en energía, estable a la hora de ser almacenado y fácil de llevar, ya que no requiere preparación (152). Como ya se ha observado en investigaciones anteriores, la forma en la que se consumen cada uno de los tipos de estos alimentos es diferente, y por tanto, estas diferencias también se extienden al perfil nutricional de cada uno de ellos (173).

Actualmente existe una opinión contradictoria sobre el consumo de desayuno, respecto si es saludable desayunar o no. En parte, este debate viene se justifica porque tradicionalmente, se ha asociado el consumo de este tipo de cereales a

la hora del desayuno. Este alto consumo ha sido promovido por las grandes campañas publicitarias de promoción de desayuno junto con el consumo de este tipo de cereales. En una investigación reciente, se observó que los cereales estaban dentro de las cinco principales categorías anunciadas con más frecuencia, siendo la mayoría versiones poco saludables, las cuales excedían los criterios del modelo de perfil de nutrientes recomendado por la Organización Mundial de la Salud (OMS) para Europa en relación a las grasas, azúcar, sodio y/o energía (174). Se ha observado que la exposición al marketing sobre diferentes tipos de alimentos no saludables normaliza el consumo de ese tipo de alimentos, influyendo en las actitudes, expectativas y comportamiento a la hora de la compra y de su consumo a lo largo de la vida, especialmente en los niños (175). Por ejemplo, en Europa, los niños en su día a día, están expuestos a un alto nivel de marketing de alimentos no saludables en una variedad de entornos (escuelas, deporte, supermercados) y a través de una variedad de medios (televisión, dispositivos digitales, internet) (174). En España, la Agencia Española de Seguridad Alimentaria y Nutrición (AECOSAN) junto con los operadores de televisión elaboraron en 2005 el código PAOS, el cual fue revisado y ampliado en 2012. El código PAOS se trata de un código de autorregulación que permite reducir la presión de venta y contenido de anuncios de alimentos y bebidas dirigidos a menores, así como mejorar la calidad y el contenido de estos (176). Sin embargo, en muchas ocasiones este código se ve incumplido por parte de las grandes industrias y por tanto, se ha puesto en duda la efectividad del mismo (177).

DESAYUNO Y CALIDAD DE LA DIETA

En la dos revisiones sistemáticas y metaanálisis realizados en la presente tesis doctoral, se ha observado que, tanto en niños como en adolescentes, aquellos que desayunan de forma habitual, tenían una mayor ingesta de nutrientes de forma global en la alimentación, así como un consumo de alimentos más saludables. Además, hemos observado que, en adolescentes el consumo de desayuno ha sido asociado con un DQI-A y un MDS más altos, en comparación con aquellos que se saltan el desayuno.

En relación a la ingesta diaria de macronutrientes, se ha observado que aquellos niños y adolescentes que consumen desayuno de forma habitual mostraron una mayor ingesta diaria de energía, hidratos de carbono, fibra y proteínas en comparación con aquellos que no lo consumían. Así mismo, aquellos que desayunaban tuvieron una menor ingesta diaria de grasas y ácidos grasos saturados. En nuestra revisión sistemática no encontramos ninguna evidencia que respalde la hipótesis de que saltarse el desayuno conduce a un aumento de la ingesta diaria de energía debido a la sobrealimentación compensatoria diaria,

como anteriormente se había hipotetizado por parte de otros autores (178). A pesar de que diversos estudios observaron que aquellos niños y adolescentes que desayunaban tenían una mayor ingesta diaria de energía, es difícil hacer interpretaciones con la ingesta de energía como valor único y sin información adicional, ya que la ingesta diaria de energía depende principalmente de la masa corporal y de la actividad física, que son los principales determinantes del gasto energético (3). En relación a la alta ingesta de hidratos de carbono y de fibra en aquellos niños y adolescentes que desayunan de forma habitual, es razonable, principalmente porque uno de los alimentos consumidos con mayor frecuencia a la hora del desayuno son los cereales, convirtiéndose el desayuno en una ocasión para realizar una comida rica tanto en hidratos de carbono como en fibra (3). En cuanto a la mayor ingesta de proteínas en aquellos niños y adolescentes que desayunaban de forma habitual, puede ser debido a que los lácteos y los productos lácteos como el queso o el yogur son uno de los alimentos consumidos con más frecuencia a la hora del desayuno tanto en Europa como en otros países como EEUU y Canadá, alimentos que presentan un elevado contenido en proteínas (69, 179). Saltarse el desayuno parece promover la sensación de hambre a lo largo de la mañana y debido a eso, incrementarse el consumo de snacks o alimentos de picoteo, los cuales normalmente tienen una baja calidad nutricional, ya que poseen un elevado contenido de grasas y azúcares añadidos (40, 180) y son consumidos habitualmente por niños y adolescentes.

Además, hemos observado que el hábito de desayunar está vinculado a un mayor consumo diario de vitaminas y minerales. En la mayoría de los artículos evaluados, se observó que aquellos niños y adolescentes que desayunaban de forma habitual tenían una mayor ingesta de las vitaminas del grupo B, y vitaminas A y C. En cambio, en nuestro metaanálisis, no se observaron diferencias significativas en la ingesta diaria de tiamina entre aquellos que desayunaban y aquellos que no. En cuanto a la ingesta de minerales, aquellos niños y adolescentes que desayunaban habitualmente tuvieron una mayor ingesta diaria de calcio, hierro, magnesio, sodio y potasio, zinc y yodo respecto a aquellos niños y adolescentes que no consumían el desayuno.

El consumo habitual de desayuno ha sido asociado en estudios anteriores con una mayor ingesta de micronutrientes (24, 32). En este sentido, se ha observado en estudios previos que aquellos niños y adolescentes que desayunan suelen consumir alimentos más saludables, y presentan una mayor probabilidad de consumir las cinco porciones de frutas y verduras diarias recomendadas, siendo estos alimentos una fuente importante de diversas vitaminas (32, 181). Además, uno de los grupos de alimentos más consumidos a la hora del desayuno son los lácteos y sus derivados, que aportan una gran cantidad de vitaminas y minerales, como el calcio, vitamina D, magnesio o fósforo (159, 161).

Por otro lado, en relación al consumo diario de alimentos y bebidas, se ha observado que aquellos niños y adolescentes que consumían desayuno tenían un mayor consumo diario de alimentos y bebidas más saludables, en comparación con aquellos que se saltaban el desayuno, observándose un mayor consumo diario de frutas y verduras, legumbres, pescado, pan y cereales, leche y productos lácteos aquellos que consumían el desayuno habitualmente. Además, se observó que aquellos que no desayunaban tenían un mayor consumo de refrescos y bebidas azucaradas, carnes y comida rápida. Previamente, un estudio sugirió que la adopción de hábitos saludables a la hora de realizar comidas podía ayudar a los adolescentes a mejorar su calidad de la dieta (29). En este sentido, la revisión sistemática incluida en esta tesis doctoral se ha encontrado evidencia para apoyar la hipótesis de que el consumo de desayuno puede ayudar a seguir hábitos más saludables.

EL DESAYUNO COMO INDICADOR DE UNA DIETA SALUDABLE

En la presente tesis doctoral se ha observado que, en adolescentes, tanto en chicos como en chicas, aquellos que desayunaban mostraban un mayor índice de calidad de la dieta (DQI-A) global en comparación con aquellos que generalmente omitían el desayuno. Además, todas las modalidades de DQI proporcionaron resultados similares. Estos resultados, por tanto, apoyan que el desayuno parece ser un buen indicador de llevar una alimentación saludable, siguiendo en la línea adicional en la que no consumir el desayuno se ha asociado con malos hábitos nutricionales (39). Los índices de calidad de la dieta son herramientas valiosas para realizar una evaluación global de la calidad de la dieta de una persona y/o población. En cambio, una alimentación saludable también implica realizar diversas comidas al día, así como la práctica de actividad física. Por todo ello, valorar tanto la alimentación como los factores adicionales permite tener una visión más amplia sobre los indicadores de estilo de vida relacionados. Además, también se observó que aquellos adolescentes que consumían el desayuno habitualmente presentaban un mayor MDS en comparación con aquellos que no lo consumían. En concordancia con nuestros resultados, diversos autores observaron que, tanto en niños como en adolescentes, el desayuno se asociaba con una mayor adherencia a la dieta mediterránea (182, 183). En ese sentido, una elevada adherencia a la dieta mediterránea ha sido asociada con unos hábitos más saludables y con un menor riesgo de sobrepeso y obesidad durante la infancia y la adolescencia (182, 184, 185).

El consumo de desayuno ha sido identificado como un fuerte indicador de una alimentación saludable, así como una influencia positiva en las elecciones alimentarias tanto en niños como en adolescentes (29, 39). En concordancia con

estos resultados, hemos observado que aquellos adolescentes que tenían un patrón dietético caracterizado por el consumo de alimentos consumidos habitualmente en el desayuno (PD-Desayuno), percibían su alimentación como saludable. Del mismo modo, en ambos géneros, este patrón también está asociado con la percepción de que la alimentación de su casa es saludable. Además, aquellos adolescentes que tenían un patrón dietético de desayuno manifestaron que disfrutaban comiendo frutas y verduras y que la mayoría de snacks que comían eran saludables.

Esto podría explicarse ya que algunos adolescentes que no desayunan o consumen poca energía en el desayuno consumen un alto porcentaje de energía en otras comidas, especialmente en la cena (186). Además, se ha observado que la omisión del desayuno ha sido asociado con un alto consumo de snacks y con una mayor ingesta de alimentos de bajo valor nutricional (181). Por esta razón, la promoción del consumo de desayuno podría ser un factor clave en las futuras políticas de salud y en las estrategias para mejorar los comportamientos de estilos de vida, especialmente durante la adolescencia.

FUTURAS LÍNEAS DE INVESTIGACIÓN

Durante los últimos años ha existido un creciente interés por estudiar el efecto del desayuno en los diferentes grupos poblaciones, especialmente durante la edad escolar. Se ha demostrado que la omisión del desayuno está significativamente asociada con un estilo de vida menos saludable y con un mayor riesgo de sufrir enfermedades crónicas no transmisibles como la obesidad, diabetes tipo 2 y enfermedades cardiovasculares (1-3, 5).

Existen multitud de estudios que estudian el consumo/omisión del desayuno relacionado con múltiples factores, pero en cambio, existen muy pocos estudios sobre los diferentes tipos de desayuno (a excepción de los desayunos a base de cereales). Un estudio reciente sugiere enseñar estrategias a los padres para ayudar a los niños a aprender a preparar su propio desayuno, ya que podría mejorar la ingesta del mismo, así como adquirir habilidades culinarias durante el periodo de crecimiento (132), puesto que esto ha sido positivamente asociado con la calidad de la dieta en la edad adulta (187).

Esta tesis doctoral se ha centrado en observar el efecto del hábito de desayuno en la alimentación global (composición y calidad) de los niños y adolescentes. Es importante y necesario conocer de forma precisa la composición del desayuno para poder así explicar las asociaciones encontradas. Existen múltiples estudios sobre lo que implica omitir el desayuno, en cambio, pocos sobre el papel preventivo del mismo o sobre lo que implica consumir un tipo de desayuno u otro. Por tanto, es necesario seguir trabajando, y hacer hincapié en

la composición del desayuno y observar su influencia en la dieta global y su posible papel preventivo a la hora de sufrir diversas enfermedades o patologías, así como su influencia en la función cognitiva y el rendimiento escolar.

Además, son necesarios más estudios que evalúen los diferentes patrones de desayuno existentes en la población infantil y adolescente, para poder desarrollar políticas y mensajes que ayuden a impulsar el consumo de desayuno, haciendo hincapié en las diferentes posibilidades de desayuno que existen, pudiendo añadir otros tipos de alimentos que habitualmente no son caracterizados como "alimentos típicos del desayuno" como por ejemplo, legumbres y/o verduras y hortalizas.

APORTACIONES PRINCIPALES DE LA TESIS DOCTORAL

ARTÍCULO I: Existe una asociación entre el consumo de desayuno y la ingesta diaria total de macronutrientes, así como el consumo de alimentos y bebidas. Los niños y adolescentes que desayunan de forma habitual tienen una ingesta de nutrientes, así como un consumo de alimentos más saludable. Por esta razón, el desayuno parece tener un efecto positivo en la ingesta diaria de energía y macronutrientes, así como parece ayudar a llevar una alimentación más saludable. El hábito de desayunar permite conseguir un mejor equilibrio de la alimentación global y está asociado con un mejor perfil nutricional de los alimentos incluidos.

ARTÍCULO II: Se ha observado que existe una asociación entre el consumo de desayuno y una mayor ingesta diaria de vitaminas y minerales tanto en niños como en adolescentes. Es por ello que el consumo habitual de desayuno contribuye al cumplimiento de las recomendaciones diarias sobre la ingesta de vitaminas y minerales.

ARTÍCULO III: Se ha observado que la mayor proporción de niños que desayunaban habitualmente eran aquellos cuyas madres habitualmente consumían el desayuno. Asimismo, existía una elevada concordancia entre los grupos de alimentos y bebidas consumidos por las madres en el desayuno y los de sus hijos. Este estudio sugiere la existencia de una clara transferencia de la rutina del desayuno de la madre a sus hijos. Las madres pueden ser una influencia importante en el consumo de desayuno de los niños, en términos de comportamiento y también en términos de calidad del desayuno. Además, durante la infancia, el desayuno es un hábito establecido; sin embargo, puede perderse durante la adolescencia porque, a esa edad, cada individuo reafirma su personalidad y toma sus propias decisiones sobre hábitos, elecciones y preferencias alimentarias. Debido a que las madres son modelos clave a seguir a la hora de la comida, y tradicionalmente, son las encargadas de los alimentos del hogar familiar, las intervenciones nutricionales centradas en niños y adolescentes pueden ser más eficaces si son dirigidas también a las madres y se contemplan como eje clave del patrón dietético familiar.

ARTÍCULO IV: El consumo regular de desayuno se asoció con un DQI-A y un MDS más altos en adolescentes europeos, lo que significa que la rutina del

desayuno se ha relacionado con mejores puntuaciones de calidad dietética en comparación con los adolescentes que generalmente se saltan el desayuno. Por esta razón, consumir desayuno de forma habitual parece ser un buen indicador de hábitos saludables, ayudando a mejorar la calidad de la dieta en general, así como mantener un patrón de dieta mediterránea.

ARTÍCULO V: Se encontraron asociaciones significativas entre percepciones de alimentación saludable y diferentes patrones dietéticos (PD), especialmente el PD-Desayuno. Se ha observado que aquellos adolescentes que tenían un patrón dietético caracterizado por el consumo de alimentos consumidos habitualmente en el desayuno percibían su dieta como saludable. El análisis de las relaciones entre las percepciones de una alimentación saludable y el consumo de alimentos y bebidas debería contribuir al desarrollo de estrategias eficaces para aumentar la concienciación sobre estilos de vida saludables entre los jóvenes europeos y esto, a su vez, podría influir en la ingesta de alimentos y en otros comportamientos relacionados con los estilos de vida. Invertir en mejorar los conocimientos de los adolescentes puede ser una estrategia para promover hábitos y estilos de vida saludables, no obstante, es uno de los aspectos previos para lograr pasar a la acción y darles herramientas para ser agentes del cambio.

MAIN THESIS CONTRIBUTIONS

ARTICLE I: There is an association between breakfast consumption and total daily intake of macronutrients, as well as foods and beverages consumption. Children and adolescents who consume breakfast regularly have a healthier intake of nutrients, as well as a healthier food consumption. For this reason, breakfast seems to have a positive effect on daily energy and macronutrients intake, as well as supporting to lead to a healthier diet. The inclusion of breakfast makes it possible to include a better balance of the overall diet and it is associated with a better nutritional profile of the foods included.

ARTICLE II: It has been observed that there is an association between breakfast consumption and a higher daily intake of vitamins and minerals in both, children and adolescents. For this reason, the habitual consumption of breakfast contributes to the fulfilment of the daily recommendations on the intake of vitamins and minerals.

ARTICLE III: It has been observed that the highest proportion of children who habitually consumed breakfast was observed in those whose mothers habitually consumed breakfast. Likewise, there was a high concordance between the groups of foods and beverages consumed by the mothers at breakfast and those of their children. Therefore, our study suggests the existence of a clear transfer of the breakfast routine from the mother to their children. Mothers can be an important influence on children's breakfast consumption, in terms of behaviour and also, in terms of breakfast quality. Also, during childhood, breakfast is an established habit; however, it can be lost during adolescence because, at that age, each individual reaffirms his personality and makes his own decisions about food habits, choices and preferences. Given that mothers are key role models at mealtimes, and traditionally, they are the ones in charge of feeding the family home, nutritional interventions focused on children and adolescents can be more effective if they are also directed at mothers and they are considered as a key axis of the family dietary pattern.

ARTICLE IV: Regular breakfast consumption was associated with higher DQI-A and MDS in European adolescents, meaning that the breakfast routine has been linked to better dietary quality scores compared to adolescents who generally skip breakfast. For this reason, consuming breakfast on a regular basis seems to be a good indicator of healthy habits, helping to improve the quality of the diet in general, as well as maintaining a Mediterranean dietary pattern.

ARTICLE V: Significant associations were found between perceptions of healthy eating and different dietary patterns (DP), especially Breakfast-DP. It has been observed that those adolescents who had a dietary pattern characterized by the consumption of foods usually consumed at breakfast perceived their diet as healthy. Analysis of the relationships between perceptions of healthy eating and food and drink consumption should contribute to the development of effective strategies to raise awareness of healthy lifestyles among young Europeans and this, in turn, could influence the food intake and other behaviours related to lifestyles. Investing in improving the knowledge of adolescents can be a strategy to promote healthy habits and lifestyles; however, it is one of the previous aspects to be able to take action and give them tools to be agents of change.

CONCLUSIONES

Artículo I: En niños y adolescentes, los que desayunaban presentaban una mayor ingesta diaria de energía, hidratos de carbono, fibra y proteínas y una menor ingesta de grasa en comparación con los que se saltaban el desayuno. Además, los que desayunaban mostraban una mayor ingesta diaria de frutas y verduras, leche y productos lácteos y cereales en comparación con los que se saltaban el desayuno. El desayuno basado en cereales listos para consumir es el tipo de desayuno más consumido por niños y adolescentes. Para mejorar la calidad de los macronutrientes y el consumo de alimentos en niños y adolescentes, se debe promover el hábito de desayunar, haciendo especial hincapié en la calidad del mismo.

Artículo II: El consumo de desayuno está asociado con una mayor ingesta de vitaminas y minerales. Observándose mayores ingestas diarias de riboflavina, vitamina A, vitamina C, calcio, hierro, magnesio, sodio y potasio en los consumidores de desayuno en comparación con los que se saltan el desayuno. Tanto para el artículo I como para el artículo II, el alimento consumido con mayor frecuencia en el desayuno fue el desayuno basado en cereales listos para consumir. El consumo de estos cereales en el desayuno podría tener efectos beneficiosos en la ingesta diaria de vitaminas y minerales. Sin embargo, se debe considerar cada tipo de cereal de forma individualizada, siendo importante conocer el perfil nutricional de los cereales consumidos, ya que suelen tener un alto contenido en azúcares añadidos que deben evitarse.

Artículo III: La mayor proporción de niños y de sus madres consumen el desayuno habitualmente. La mayor proporción de niños que desayunaban habitualmente se encontró en aquellos cuyas madres consumían el desayuno con la misma frecuencia. Además, las madres y sus hijos estuvieron en concordancia a la hora de consumir los diferentes grupos de alimentos y bebidas, siendo los niños que habitualmente consumían frutas, leche y derivados lácteos y no consumían zumos azucarados aquellos cuyas madres tenían el mismo hábito. Nuestros resultados pueden sugerir una clara transferencia de la rutina del desayuno de la madre a sus hijos, aunque nuestros análisis no permiten establecer inferencias causales. Las madres pueden ser una influencia importante en el consumo de desayuno de los niños, tanto en relación con el hábito de desayunar como en relación con la calidad del mismo.

Artículo IV: El consumo regular de desayuno se asoció con mayores índices de calidad de la dieta y de dieta mediterránea en adolescentes europeos. La rutina del desayuno se ha relacionado con mejores puntuaciones de calidad dietética en comparación con los adolescentes que generalmente se saltan el desayuno.

Artículo V: Se han observado asociaciones significativas entre diferentes patrones dietéticos y las percepciones sobre alimentación saludable. Observándose asociaciones significativas entre el patrón dietético caracterizado por el consumo de alimentos típicos de desayuno, con aquellos adolescentes que creían que su dieta era saludable, disfrutaban comiendo frutas y verduras y percibían lo que comían en casa como saludable.

CONCLUSIONS

Article I: In children and adolescents, those who consumed breakfast had a higher daily intake of energy, carbohydrates, fibre and protein and a lower intake of fat compared to those who skipped breakfast. In addition, breakfast consumers showed a higher daily intake of fruits and vegetables, milk and dairy products, and cereals compared to breakfast skippers. Breakfast based on ready-to-eat cereals is the type of breakfast most consumed by children and adolescents; To improve the quality of macronutrients and food consumption in children and adolescents, the habit of eating breakfast should be promoted, with special emphasis on its quality.

Article II: Breakfast consumption is associated with a higher intake of vitamins and minerals. We observed a higher daily intake of riboflavin, vitamin A, vitamin C, calcium, iron, magnesium, sodium and potassium in breakfast consumers compared to those who skip breakfast. For both article I and article II, the most frequent food consumed at breakfast was ready-to-eat cereals. The consumption of these cereals at breakfast could have beneficial effects on the daily intake of vitamins and minerals. However, each type of cereal should be considered individually, and it is important to know the nutritional profile of the cereals consumed, since they usually have a high content of added sugars, and these components should be avoided.

Article III: A high proportion of children and their mothers consume breakfast regularly. The highest proportion of children who regularly consumed breakfast was found in those whose mothers consumed breakfast with the same frequency. In addition, mothers and their children were in concordance in the consumption of different food groups and beverages, being the children who habitually consumed fruits, milk and dairy products and did not consume sugary juices those whose mothers had the same habit. Our results may suggest a clear transfer of the mother's breakfast routine to their children, although our analyses do not allow for causal inferences. Mothers can be an important influence on children's breakfast consumption, both in relation to breakfast habit and in relation to its quality.

Article IV: Regular breakfast consumption was associated with higher indices of diet quality and Mediterranean diet in European adolescents. Breakfast routine has been linked to better dietary quality scores compared to adolescents who typically skip breakfast.

Article V: Significant associations have been observed between different dietary patterns and perceptions about healthy eating, especially with the

dietary pattern characterized by the consumption of typical breakfast foods.

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APÉNDICE – APPENDIX

Factor de impacto de las revistas y ranking en "ISI Web o Knowledge – Journal Citation Reports (JCR)" dentro de sus áreas temáticas correspondientes.

Impact factor and ranking of each Journal in "ISI Web o Knowledge – Journal Citation Reports (JCR)" within their subject categories.

Artículos publicados o aceptados - Published or accepted manuscripts

	Journal Revista	Impact Factor Factor de Impacto	Quartile Cuartil
Manuscript I Artículo I	Nutrients	5.719	Q1
	Ranking in 2020 ISI JCR: 25/106 (Nutrition and Dietetics)		
Manuscript II Artículo II	Nutrients	5.719	Q1
	Ranking in 2020 ISI JCR: 25/106 (Nutrition and Dietetics)		
Manuscript III Artículo III	Nutrients	6.706	Q1
	Ranking in 2021 ISI JCR: 21/109 (Nutrition and Dietetics)		
Manuscript V Artículo IV	European Journal of Clinical Nutrition	4.884	Q2
	Ranking in 2021 ISI JCR: 39/109 (Nutrition and Dietetics)		
Manuscript VI Artículo V	Journal of the American College of Nutrition	2.297	Q3
	Ranking in 2019 ISI JCR: 61/106 (Nutrition and Dietetics)		

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"El desayuno lo es todo. El comienzo, lo primero. Es el bocado del compromiso con un nuevo día, para una vida continua". A. A. Gill.

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Hace un tiempo leí que el trabajo en equipo es el secreto que hace que gente común consiga resultados poco comunes. Este es el secreto del grupo GENUD. Un grupo de gente muy diferente que hace los lunes en la oficina sean menos lunes. Donde siempre hay un hueco para reír, donde a pesar de ser personas tan diferentes, te sientes apoyada, comprendida y donde siempre hay tiempo para un café "quitapenas" o para unas bravas de celebración. Como dice una canción muy famosa… "*Por todo lo que recibí, estar aquí vale la pena, gracias a ti seguí remando contra la marea. Con todo lo que recibí, ahora sé que no estoy solo, ahora te tengo a ti, amigo mío, mi tesoro*".

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CUESTIONARIOS

QUESTIONNAIRES

A continuación, se presentan los cuestionarios utilizados en los diferentes estudios en los cuales se ha basado la presente Tesis Doctoral.

CUESTIONARIO HÁBITOS DE VIDA.
ESTUDIO Feel4Diabetes

10. Sobre cuántos días tú y tu hijo/a desayunáis habitualmente.

Durante los días entre semana, "desayuno" es cualquier cosa que comas o bebas las 2 horas siguientes a levantarse. Esto puede hacerse en casa, de camino al trabajo o en el trabajo.

Durante los fines de semana, "desayuno" es cualquier cosa que comas o bebas antes de las 11 a.m.

TÚ$_a$

¿Cuántos días sueles <u>tú</u> desayunar?

DÍAS ENTRE SEMANA$_1$

❑$_1$ nunca/casi nunca
❑$_2$ 1 día
❑$_3$ 2 días
❑$_4$ 3 días
❑$_5$ 4 días
❑$_6$ 5 días

DÍAS EN FIN DE SEMANA$_2$

❑$_1$ nunca/casi nunca
❑$_2$ 1 día
❑$_3$ 2 días

TU HIJO/A$_b$

¿Cuántos días suele <u>tu hijo/a</u> desayunar?

DÍAS ENTRE SEMANA$_1$

❑$_1$ nunca/casi nunca
❑$_2$ 1 día
❑$_3$ 2 días
❑$_4$ 3 días
❑$_5$ 4 días
❑$_6$ 5 días

DÍAS EN FIN DE SEMANA$_2$

❑$_1$ nunca/casi nunca
❑$_2$ 1 día
❑$_3$ 2 días

11. Pensando en la semana previa, ¿con qué frecuencia tú y tu hijo/a consumís los siguientes alimentos o grupos de alimentos como parte de tu y su DESAYUNO?

TÚ$_a$

		Frecuencia (veces/<u>última semana</u>)				
Grupos de alimentos		**0**	**1-2**	**3-4**	**5-6**	**7**
1	**Frutas, frutos y verduras**	❑$_1$	❑$_2$	❑$_3$	❑$_4$	❑$_5$
2	**Zumos naturales exprimidos o envasados sin azúcar**	❑$_1$	❑$_2$	❑$_3$	❑$_4$	❑$_5$
3	**Refrescos y zumos con azúcar**	❑$_1$	❑$_2$	❑$_3$	❑$_4$	❑$_5$
4	**Leche o productos lácteos, sin azúcar (E.j; queso, yogur natural)**	❑$_1$	❑$_2$	❑$_3$	❑$_4$	❑$_5$
5	**Leche o productos lácteos, con azúcar (E.j; yogur, *pudding,* leche con cacao)**	❑$_1$	❑$_2$	❑$_3$	❑$_4$	❑$_5$

6	**Dulces o pastelitos salados (E.j; tortitas, galletas, bizcocho o pastel, croissant, paste del queso)**	❑1	❑2	❑3	❑4	❑5
7	**Cereales y productos derivados del cereal no integrales (E.j; pan blanco o biscotes, cereales de desayuno azucarados)**	❑1	❑2	❑3	❑4	❑5
8	**Cereales y productos derivados del cereal integrals (E.j; pan integral, muesli, cereales de desayuno no azucarados)**	❑1	❑2	❑3	❑4	❑5

TU HIJO$_b$

		Frecuencia (veces/<u>última semana</u>)				
Food groups		**0**	**1-2**	**3-4**	**5-6**	**7**
1	**Frutas, frutos y verduras**	❑1	❑2	❑3	❑4	❑5
2	**Zumos naturales exprimidos o envasados sin azúcar**	❑1	❑2	❑3	❑4	❑5
3	**Refrescos y zumos con azúcar**	❑1	❑2	❑3	❑4	❑5
4	**Leche o productos lácteos, sin azúcar (E.j; queso, yogur natural)**	❑1	❑2	❑3	❑4	❑5
5	**Leche o productos lácteos, con azúcar (E.j; yogur, *pudding,* leche con cacao)**	❑1	❑2	❑3	❑4	❑5
6	**Dulces o pastelitos salados (E.j; tortitas, galletas, bizcocho o pastel, croissant, paste del queso)**	❑1	❑2	❑3	❑4	❑5
7	**Cereales y productos derivados del cereal no integrales (E.j; pan blanco o biscotes, cereales de desayuno azucarados)**	❑1	❑2	❑3	❑4	❑5
8	**Cereales y productos derivados del cereal integrales (E.j; pan integral, muesli, cereales de desayuno no azucarados)**	❑1	❑2	❑3	❑4	❑5

CUESTIONARIO ELECCIÓN DE ALIMENTOS Y PREFERENCIAS.
Estudio HELENA

1246194007

Healthy Lifestyle in Europe by Nutrition in Adolescence — HELENA

Sixth Framework Programme 2002 - 2006

Cuestionario de elección de alimentos y preferencias

Mediante este cuestionario nos gustaría conocer tus preferencias y elecciones de alimentos. ¡Tus opiniones son muy importantes para nosotros! Este cuestionario te da la oportunidad de contarnos qué piensas acerca de cuestiones que rodean a la elección de alimentos y los factores que influyen en dichas elecciones.

Hay 3 secciones dentro del cuestionario. En total, no debería costar más de 15 minutos completarlo. Por favor, tómate tu tiempo y lee todas las preguntas cuidadosamente. Deberías responder a las preguntas usando las escalas o categorías facilitadas.

Sección 1 - Tus opiniones acerca de la elección de alimentos, preferencias, dieta y salud

Q1.1 Usando la escala que te facilitamos, por favor, califica tu nivel de acuerdo con cada una de las siguientes afirmaciones.

	completamente en desacuerdo	bastante en desacuerdo	ligeramente en desacuerdo	ni de acuerdo, ni en desacuerdo	ligeramente de acuerdo	bastante de acuerdo	completamente de acuerdo
pienso que mi dieta es saludable	O	O	O	O	O	O	O
el sabor de la comida es muy importante para mí	O	O	O	O	O	O	O
picar entre horas es parte necesaria de una dieta sana	O	O	O	O	O	O	O
disfruto comiendo fruta y verdura	O	O	O	O	O	O	O
tiendo a comer todo lo que mis amigos estén comiendo	O	O	O	O	O	O	O
la comida que tomo en casa es saludable	O	O	O	O	O	O	O
elijo mis propios *snacks*	O	O	O	O	O	O	O
me gusta la comida que tomo cuando estoy fuera con mis amigos	O	O	O	O	O	O	O
el sabor de la comida es más importante para mí que su beneficio para la salud	O	O	O	O	O	O	O
a menudo elijo alimentos que veo anunciados en los medios de comunicación (TV, revistas, etc)	O	O	O	O	O	O	O
un alimento rico en grasas sabe mejor que su versión baja en grasas	O	O	O	O	O	O	O
la comida que tomo en el colegio (en el comedor) es saludable	O	O	O	O	O	O	O
a menudo me salto el desayuno	O	O	O	O	O	O	O
los alimentos sanos no me llenan	O	O	O	O	O	O	O
la mayoría de los *snacks* que tomo son sanos	O	O	O	O	O	O	O
me siento bien informado acerca de qué son los alimentos sanos	O	O	O	O	O	O	O
la mayoría de los alimentos sanos no saben muy bien	O	O	O	O	O	O	O
tengo poca elección sobre lo que como en casa	O	O	O	O	O	O	O

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	completamente en desacuerdo	bastante en desacuerdo	ligeramente en desacuerdo	ni de acuerdo, ni en desacuerdo	ligeramente de acuerdo	bastante de acuerdo	completamente de acuerdo
me preocupo por lo que como porque no quiero ganar peso	○	○	○	○	○	○	○
los productos bajos en azúcar saben mejor que la versión "tradicional"	○	○	○	○	○	○	○
me gusta la comida que mis padres preparan en casa	○	○	○	○	○	○	○
si existe la opción de escoger la versión baja en grasas de un alimento, la escogo	○	○	○	○	○	○	○
lo que coma ahora tendrá un gran impacto en mi futura salud	○	○	○	○	○	○	○
la comida que tomo cuando estoy fuera con mis amigos es saludable	○	○	○	○	○	○	○
me gusta la comida que preparan en el comedor de la escuela	○	○	○	○	○	○	○
si existe la opción de escoger la versión integral de un alimento, la eligo	○	○	○	○	○	○	○
la información acerca de la comida saludable es difícil de poner en práctica	○	○	○	○	○	○	○

SOBRE EL AUTOR

Natalia Giménez Legarre nació el 4 de octubre de 1991 en Sos del Rey Católico (Zaragoza). En 2014 terminó la Diplomatura de Nutrición Humana y Dietética en la Facultad de Ciencias de la Salud y del Deporte de Huesca (Universidad de Zaragoza). Ese mismo año realizó un Máster Propio en Fitoterapia en la Universidad de Zaragoza. En el año 2015 realizó el Máster Interuniversitario Oficial en Condicionantes Genéticos, Nutricionales y Ambientales del Crecimiento y el Desarrollo en la Facultad de Medicina de la Universidad de Zaragoza. Finalmente, en el año 2016, Natalia terminó la Adaptación al Grado en Nutrición Humana y Dietética.

En el mismo año, Natalia inició el Doctorado en Ciencias de la Salud y del Deporte. Obtuvo una beca predoctoral por parte de la Fundación Cuenca Villoro (Zaragoza). Desde ese año, y hasta ahora, Natalia forma parte del grupo de investigación GENUD (Growth, Exercise, NUtrition and Development).

Como investigadora predoctoral del grupo GENUD, Natalia ha colaborado en diferentes proyectos de investigación, tanto nacionales como internacionales, como el estudio europeo Feel4Diabetes, estudio CORALS o el estudio MEDKIDS. Además, durante estos años, ha colaborado como docente en la asignatura Metodología de la Investigación, del Grado de Enfermería de la Universidad de Zaragoza.

Actualmente se encuentra desarrollando las labores de coordinación del proyecto europeo DigiCare4You.

PUBLICACIONES:

Apergi K, Karatzi K, Reppas K, Karaglani E, Usheva N, Giménez-Legarre N, Moreno LA, Dimova R, Antal E, Jemina K, Cardon G, Iotova V, Manios Y, Makrilakis K. Association of breakfast consumption frequency with fasting glucose and insulin sensitivity/b cells function (HOMA-IR) in adults from high-risk families for type 2 diabetes in Europe: the Feel4Diabetes Study. Eur J Clin Nutr. 2022 May 25. doi:10.1038/s41430-022-01160-z.

González-Gil EM, Giménez-Legarre N, Cardon G, Mavrogianni C, Kivelä J, Iotova V, Tankova T, Imre R, Liatis S, Makrilakis K, Schwarz P, Timpel P, Dupont E, Couck P, Manios Y, Moreno LA. Parental insulin resistance is associated with unhealthy lifestyle behaviours independently of body mass index in children: The Feel4Diabetes study. Eur J Pediatr. 2022 Jun;181(6):2513-2522. doi: 10.1007/s00431-022-04449-0.

Cacau LT, De Miguel-Etayo P, Santaliestra-Pasías AM, Giménez-Legarre N, Marchioni DM, Molina-Hidalgo C, Censi L, González-Gross M, Grammatikaki E, Breidenassel C, De Ruyter T, Kersting M, Gottrand F, Androutsos O, Gómez-Martinez S, Kafatos A, Widhalm K, Stehle P, Molnár D, Manios Y, De Henauw S, Moreno LA (2021) Breakfast Dietary Pattern Is Inversely Associated with Overweight/Obesity in European Adolescents: The HELENA Study. Children (Basel) 2021 Nov 12;8(11):1044. doi: 10.3390/children8111044.

Giménez-Legarre N, Santaliestra-Pasías AM, Cardon G, Imre R, Iotova V, Kivelä J, Liatis S, Makrilakis K, Mavrogianni C, Milenkovic T, Nánási A, Tankova T, Timpel P, Willems R, Manios Y, Moreno LA, On Behalf Of The Feel Diabetes-Study Group. Cross-Sectional Associations Between Mothers and Children's Breakfast Routine-The Feel4Diabetes-Study. Nutrients. 2021 Feb 24; 13(3):720. (https://doi.org/10.3390/nu13030720).

Willems R, Tsoutsoulopoulou K, Brondeel R, Cardon G, Makrilakis K, Liatis S, Lindström J, Kivelä J, González-Gil EM, Giménez-Legarre N, Usheva N, Iotova V, Tankova T, Antal E, Rurik I, Timpel P, Schwarz PEH, Manios Y, Annemans L (2021) Cost-effectiveness analysis of a school- and community-based intervention to promote a healthy lifestyle and prevent type 2 diabetes in vulnerable families across Europe: the Feel4Diabetes-study. Prev Med. 2021 Dec;153:106722. doi: 10.1016/j.ypmed.2021.106722.

Giménez-Legarre N, Flores-Barrantes P, Miguel-Berges ML, Moreno LA, Santaliestra-Pasías AM. Breakfast characteristics and its association with energy, macronutrients and food intake un children and adolescents: A systematic review and meta-analysis. Nutrients. 2020 Aug 15;12(8):2460. (https://doi.org/10.3390/nu12082460)

Giménez-Legarre N, Miguel-Berges ML, Flores-Barrantes P, Santaliestra-Pasías AM, Moreno LA. Breakfast characteristics and its association with micronutrients intake in children and adolescents: A systematic review and meta-analysis. Nutrients. 2020 Oct 20;12(10):3201 (https://doi.org/10.3390/nu12103201).

Giménez-Legarre N, Santaliestra-Pasías AM, Beghin L, Dallongeville J, de la O A, Gilbert C, González-Gross M, De Henauw S, Kafatos A, Kersting M, Leclerq C, Manios Y, Molnar D, Sjöström M, Widhalm K, Huybrechts I, Moreno LA; HELENA Study Group. Dietary Patterns and its relationship with the perception of healthy eating in European adolescents: the HELENA study. J Am Coll Nutr. 2019 Nov-Dec; 38(8): 703-713. (https://doi.org/10.1080/07315724.2019.1598900).

CURSOS Y SEMINARIOS

Mayo 2021. Cronobiología y Nutrición. Colegio Profesional de Dietistas y Nutricionistas de Aragón. 3 horas.

Enero-Septiembre 2020. Curso para aprender a escribir y publicar un artículo científico. Universidad de Zaragoza. 170 horas.

Enero-Septiembre 2020. Curso de revisiones sistemáticas y meta-análisis: bases para su realización e interpretación. Universidad de Zaragoza. 120 horas.

Junio 2020. I Workshop sobre nutrición y trastornos digestivos. Academia Española de Nutrición y Dietética.

Junio 2020. Encuentro con el experto. “Actualización en alergias alimentarias”. Academia Española de Nutrición y Dietética.

Junio 2020. I Workshop de Alimentación Infantil. Academia Española de Nutrición y Dietética.

Abril-Mayo 2020. Aspectos éticos y normativos en la investigación con seres humanos y animales. Escuela de doctorado. Universidad de Zaragoza.

Abril 2020. Meta-análisis en ciencias de la salud. Escuela de doctorado. Universidad de Zaragoza.

Febrero 2020. Knowledge 2 Connect lunch seminar "How to peer review a scientific manuscript for a biomedical journal". Ghent University.

Noviembre 2019. Foro-Debate “Papel del desayuno y la calidad del mismo en la salud de los niños y adolescentes”. Instituto Danone. Madrid.

Marzo 2019. Ciberseguridad y protección de datos en el ámbito de la investigación biomédica. Fundación Instituto de Investigación Sanitaria de Aragón (IIS Aragón).

Febrero 2019. IX Jornada de Divulgación Científica “La Ciencia Marca Tendencia”. Unidad de Cultura Científica de la Universidad de Zaragoza.

Enero-Febrero 2019. ¿Cómo divulgo los resultados de mi investigación?. Universidad de Zaragoza.

Enero 2019. Tratamiento de datos con la hoja de cálculo Excel. Universidad de Zaragoza.

Noviembre 2018. Jornada: Conducta alimentaria, medicamentos, productos de parafarmacia y riesgos en la red. Facultad de Medicina. Universidad de Zaragoza y Gobierno de Aragón.

Noviembre 2018. Meta-análisis en Ciencias de la Salud. Universidad de Zaragoza.

Noviembre 2018. Abordaje dietético en el paciente oncológico. Colegio Profesional de Dietistas Nutricionistas de Aragón. Zaragoza.

Julio 2017. XVII Escuela de Nutrición "Francisco Grande Covián". Estilos de vida saludables. Universidad Internacional Menéndez Pelayo. Santander (España)

Mayo 2017. Recursos y fuentes de información académica y científica: Uso, gestión y evaluación. Ciencias de la Salud. Universidad de Zaragoza.

Marzo 2015. Estrategias en la práctica deportiva: Claves nutricionales en deporte de intensidad y resistencia. Colegio Profesional de Dietistas-Nutricionistas de Aragón.

ASISTENCIA Y PRESENTACIÓN TRABAJOS A CONGRESOS

23-26 Noviembre 2021. IV Congreso de Alimentación, Nutrición y Dietética. Nutrición personalizada y dietética de precisión. Academia Española de Nutrición y Dietética. Online. Presentación comunicación oral.

23-27 noviembre 2020. III Congreso de Alimentación, Nutrición y Dietética. Combinar la nutrición comunitaria y personalizada: nuevos retos". Online.

12-13 Noviembre 2020. VII Reunión de Jóvenes Investigadores. Sociedad Española de Nutrición. Online. Presentación comunicación oral.

15-19 Octubre 2019. 13th European Nutrition Conference. Malnutrition in an Obese World European Perspectives. Federation of European Nutrition Societies. Dublin (Irlanda). Presentación poster.

3-5 Julio 2019. VIII Congreso Iberoamericano de Nutrición. Academia Española de Nutrición y Dietética. Pamplona (España). Presentación comunicación oral.

20-22 Junio 2019. XXVIII Reunión de la Sociedad Española de Nutrición. Sociedad Española de Nutrición. Soria (España)

20 Junio 2019. VI Reunión de Jóvenes Investigadores. Sociedad Española de Nutrición. Online. Soria (España). Presentación comunicación oral.

23-25 Mayo 2019. II Congreso Internacional en Ciencias de la Salud y del Deporte. Actividad física segura y saludable en la montaña. Trabajo interdisciplinar en salud. Facultad de Ciencias de la Salud y del Deporte de Huesca. Universidad de Zaragoza. Huesca (España). Presentación comunicación oral.

26 Noviembre 2018. II Encuentro Grupos Investigación IA2. Nuevos retos de colaboración y líneas estratégicas. Instituto Agroalimentario de Investigación Mixto Agroalimentario de Aragón. Zaragoza (España). Presentación de poster.

2-3 Julio 2018. V Jornadas Doctorales del Campus Iberus. Campus Iberus. Jaca (Huesca) (España). Presentación de poster.

27-29 Junio 2018., XVII Congreso de la Sociedad Española de Nutrición (SEÑ) y X Jornada de l´Asociació Catalana de Ciències de l´Alimentació (ACCA). Barcelona (España). Presentación de poster.

26 Junio 2018. V Reunión de Jóvenes Investigadores. Sociedad Española de Nutrición (SEÑ). Barcelona (España).

10-11 Noviembre 2017. I Congreso de Alimentación, Nutrición y Dietética. El dietista-nutricionista: Pro-motor de Salud Pública. Academia Española de Nutrición y Dietética. Zaragoza (España).

30 Marzo – 1 Abril. I Congreso Internacional en Ciencias de la Salud y del Deporte. Actividad Física Segura y Saludable en la Montaña. Trabajo Interdisciplinar en Salud. Facultad de Ciencias de Salud y del Deporte. Universidad de Zaragoza. Huesca (España).

ESTANCIAS INTERNACIONALES

Enero-Marzo 2020. Estancia en “Departmen of Public Health & Primary Care”. Ghent University. Gante (Bélgica).

Enero-Marzo 2018. Estancia en “Department of Nutrition & Dietetics. School of Health Science & Education”. Harokopio University. Atenas (Grecia).

BECAS Y PREMIOS

2016-2020. Beca predoctoral Fundación Cuenca Villoro.

Mayo 2019. Accésit en modalidad de comunicación oral. II Congreso Internacional en Ciencias de la Salud y del Deporte. Actividad física segura y saludable en la montaña. Trabajo interdisciplinar en salud. Facultad de Ciencias de la Salud y del Deporte de Huesca. Universidad de Zaragoza. Huesca (España).

ANEXOS

LISTA INVESTIGADORES ESTUDIO FEEL4DIABETES

Feel4Diabetes-study Group:

Coordinator: Yannis Manios

Steering Committee: Yannis Manios, Greet Cardon, Jaana Lindström, Peter Schwarz, Konstantinos Makrilakis, Lieven Annemans, Winne Ko

1. Harokopio University (Greece): Yannis Manios, Kalliopi Karatzi, Odysseas Androutsos, George Moschonis, Spyridon Kanellakis, Christina Mavrogianni, Konstantina Tsoutsoulopoulou, Christina Katsarou, Eva Karaglani, Irini Qira, Efstathios Skoufas, Konstantina Maragkopoulou, Antigone Tsiafitsa, Irini Sotiropoulou, Michalis Tsolakos, Effie Argyri, Mary Nikolaou, Eleni-Anna Vampouli, Christina Filippou, Kyriaki Apergi, Amalia Filippou, Gatsiou Katerina, Efstratios Dimitriadis.

2. Finnish Institute for Health and Welfare (Finland): Jaana Lindström, Tiina Laatikainen, Katja Wikström, Jemina Kivelä, Päivi Valve, Esko Levälahti, Eeva Virtanen, Tiina Pennanen, Seija Olli, Karoliina Nelimarkka.

3. Ghent University (Belgium) Department of Movement and Sports Sciences: Greet Cardon, Vicky Van Stappen, Nele Huys; Department of Public Health and Primary Care: Lieven Annemans, Ruben Willems; Department of Endocrinology and Metabolic Diseases: Samyah Shadid.

4. Technische Universität Dresden (Germany): Peter Schwarz, Patrick Timpel

5. University of Athens (Greece): Konstantinos Makrilakis, Stavros Liatis, George Dafoulas, Christina-Paulina Lambrinou, Angeliki Giannopoulou

6. International Diabetes Federation European Region (Belgium): Winne Ko, Ernest Karuranga.

7. Universidad De Zaragoza (Spain): Luis Moreno, Fernando Civeira, Gloria Bueno, Pilar De Miguel-Etayo, Esther Mª Gonzalez-Gil, María L. Miguel-Berges, Natalia Giménez-Legarre; Paloma Flores-Barrantes, Aleli M. Ayala-Marín, Miguel Seral-Cortés, Lucia Baila-Rueda, Ana Cenarro, Estíbaliz Jarauta, Rocío Mateo-Gallego.

8. Medical University of Varna (Bulgaria): Violeta Iotova, Tsvetalina Tankova, Natalia Usheva, Kaloyan Tsochev, Nevena Chakarova, Sonya Galcheva, Rumyana Dimova,

Yana Bocheva, Zhaneta Radkova, Vanya Marinova, Yuliya Bazdarska, Tanya Stefanova.

9. University of Debrecen (Hungary): Imre Rurik, Timea Ungvari, Zoltán Jancsó, Anna Nánási, László Kolozsvári, Csilla Semánova, Éva Bíró, Emese Antal, Sándorné Radó.

10. Extensive Life Oy (Finland): Remberto Martinez, Marcos Tong

LISTA INVESTIGADORES ESTUDIO HELENA

HELENA Study Group

Co-ordinator: Luis A. Moreno.

Core Group members: Luis A. Moreno, Fréderic Gottrand, Stefaan De Henauw, Marcela González-Gross, Chantal Gilbert.

Steering Committee: Anthony Kafatos (President), Luis A. Moreno, Christian Libersa, Stefaan De Henauw, Sara Castelló, Fréderic Gottrand, Mathilde Kersting, Michael Sjöstrom, Dénes Molnár, Marcela González-Gross, Jean Dallongeville, Chantal Gilbert, Gunnar Hall, Lea Maes, Luca Scalfi.

Project Manager: Pilar Meléndez.

1. Universidad de Zaragoza (Spain)

   Luis A. Moreno, José A. Casajús, Jesús Fleta, Gerardo Rodríguez, Concepción Tomás, María I. Mesana, Germán Vicente-Rodríguez, Adoración Villarroya, Carlos M. Gil, Ignacio Ara, Juan Fernández Alvira, Gloria Bueno, Olga Bueno, Juan F. León, Jesús Mª Garagorri, Idoia Labayen, Iris Iglesia, Silvia Bel, Luis A. Gracia Marco, Theodora Mouratidou, Alba Santaliestra-Pasías, Iris Iglesia, Esther González-Gil, Pilar De Miguel-Etayo, Cristina Julián, Mary Miguel-Berges, Isabel Iguacel, Azahara Rupérez.

2. Consejo Superior de Investigaciones Científicas (Spain)

   Ascensión Marcos, Julia Wärnberg, Esther Nova, Sonia Gómez, Ligia Esperanza Díaz, Javier Romeo, Ana Veses, Belén Zapatera, Tamara Pozo, David Martínez.

3. Université de Lille 2 (France)

   Laurent Beghin, Christian Libersa, Frédéric Gottrand, Catalina Iliescu, Juliana Von Berlepsch.

4. Research Institute of Child Nutrition Dortmund, Rheinische Friedrich-Wilhelms-Universität Bonn (Germany)

   Mathilde Kersting, Wolfgang Sichert-Hellert, Ellen Koeppen.

5. Pécsi Tudományegyetem (University of Pécs) (Hungary)

   Dénes Molnar, Eva Erhardt, Katalin Csernus, Katalin Török, Szilvia Bokor, Mrs. Angster, Enikö Nagy, Orsolya Kovács, Judit Répasi.

6. University of Crete School of Medicine (Greece)

   Anthony Kafatos, Caroline Codrington, María Plada, Angeliki Papadaki, Katerina Sarri, Anna Viskadourou, Christos Hatzis, Michael Kiriakakis, George Tsibinos, Constantine Vardavas, Manolis Sbokos, Eva Protoyeraki, Maria Fasoulaki.

7. Institut für Ernährungs- und Lebensmittelwissenschaften – Ernährungphysiologie. Rheinische Friedrich Wilhelms Universität (Germany)

   Peter Stehle, Klaus Pietrzik, Marcela González-Gross, Christina Breidenassel, Andre Spinneker, Jasmin Al-Tahan, Miriam Segoviano, Anke Berchtold, Christine Bierschbach, Erika Blatzheim, Adelheid Schuch, Petra Pickert.

8. University of Granada (Spain)

   Manuel J. Castillo, Ángel Gutiérrez, Francisco B Ortega, Jonatan R Ruiz, Enrique G Artero, Vanesa España, David Jiménez-Pavón, Palma Chillón, Cristóbal Sánchez-Muñoz, Magdalena Cuenca

9. Istituto Nazionalen di Ricerca per gli Alimenti e la Nutrizione (Italy)

   Davide Arcella, Elena Azzini, Emma Barrison, Noemi Bevilacqua, Pasquale Buonocore, Giovina Catasta, Laura Censi, Donatella Ciarapica, Paola D'Acapito, Marika Ferrari, Myriam Galfo, Cinzia Le Donne, Catherine Leclercq, Giuseppe Maiani, Beatrice Mauro, Lorenza Mistura, Antonella Pasquali, Raffaela Piccinelli, Angela Polito, Romana Roccaldo, Raffaella Spada, Stefania Sette, Maria Zaccaria.

10. University of Napoli "Federico II" Dept of Food Science (Italy)

    Luca Scalfi, Paola Vitaglione, Concetta Montagnese.

11. Ghent University (Belgium)

    Ilse De Bourdeaudhuij, Stefaan De Henauw, Tineke De Vriendt, Lea Maes, Christophe Matthys, Carine Vereecken, Mieke de Maeyer, Charlene Ottevaere, Inge Huybrechts.

12. Medical University of Vienna (Austria)

    Kurt Widhalm, Katharina Phillipp, Sabine Dietrich, Birgit Kubelka Marion Boriss-Riedl.

13. Harokopio University (Greece)

    Yannis Manios, Eva Grammatikaki, Zoi Bouloubasi, Tina Louisa Cook, Sofia Eleutheriou, Orsalia Consta, George Moschonis, Ioanna Katsaroli, George Kraniou, Stalo Papoutsou, Despoina Keke, Ioanna Petraki, Elena Bellou, Sofia Tanagra, Kostalenia Kallianoti, Dionysia Argyropoulou, Stamatoula Tsikrika, Christos Karaiskos.

14. Institut Pasteur de Lille (France)

    Jean Dallongeville, Aline Meirhaeghe.

15. Karolinska Institutet (Sweden)

Michael Sjöstrom, Jonatan R Ruiz, Francisco B. Ortega, María Hagströmer, Anita Hurtig Wennlöf, Lena Hallström, Emma Patterson, Lydia Kwak, Julia Wärnberg, Nico Rizzo.

16. Asociación de Investigación de la Industria Agroalimentaria (Spain)

Jackie Sánchez-Molero, Sara Castelló, Elena Picó, Maite Navarro, Blanca Viadel, José Enrique Carreres, Gema Merino, Rosa Sanjuán, María Lorente, María José Sánchez.

17. Campden BRI (United Kingdom)

Chantal Gilbert, Sarah Thomas, Elaine Allchurch, Peter Burgess.

18. SIK - Institutet foer Livsmedel och Bioteknik (Sweden)

Gunnar Hall, Annika Astrom, Anna Sverkén, Agneta Broberg.

19. Meurice Recherche & Development asbl (Belgium)

Annick Masson, Claire Lehoux, Pascal Brabant, Philippe Pate, Laurence Fontaine.

20. Campden & Chorleywood Food Development Institute (Hungary)

Andras Sebok, Tunde Kuti, Adrienn Hegyi.

21. Productos Aditivos SA (Spain)

Cristina Maldonado, Ana Llorente.

22. Cárnicas Serrano SL (Spain)

Emilio García.

23. Cederroth International AB (Sweden)

Holger von Fircks, Marianne Lilja Hallberg, Maria Messerer

24. Lantmännen Food R&D (Sweden)

Mats Larsson, Helena Fredriksson, Viola Adamsson, Ingmar Börjesson.

25. European Food Information Council (Belgium)

Laura Fernández, Laura Smillie, Josephine Wills.

26. Universidad Politécnica de Madrid (Spain)

Marcela González-Gross, Raquel Pedrero-Chamizo, Agustín Meléndez, Jara Valtueña, David Jiménez-Pavón, Ulrike Albers, Pedro J. Benito, Juan José Gómez Lorente, David Cañada, Alejandro Urzanqui, Rosa María Torres, Paloma Navarro.