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Mª Luisa Miguel Berges

Sedentary behaviours and food and beverages' consumption in European preschool children
Comportamientos sedentarios y consumo de alimentos y bebidas en niños europeos en edad preescolar

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SEDENTARY BEHAVIOURS AND FOOD AND BEVERAGES' CONSUMPTION IN EUROPEAN PRESCHOOL CHILDREN
COMPORTAMIENTOS SEDENTARIOS Y CONSUMO DE ALIMENTOS Y BEBIDAS EN NIÑOS EUROPEOS EN EDAD PREESCOLAR

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Departamento de Fisiatría y Enfermería

Facultad de Ciencias de la Salud

UNIVERSIDAD DE ZARAGOZA

MARÍA LUISA MIGUEL BERGES

ZARAGOZA 2019

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Sedentary behaviours and food and beverages' consumption in European preschool children

Comportamientos sedentarios y consumo de alimentos y bebidas en niños Europeos en edad prescolar

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Si quieres salud levántate y *camina* hacia ella.

A mis padres, mi abuelo y hermanos.

A David.

Dr. Luis A. MORENO AZNAR
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Que la Tesis Doctoral titulada "Comportamientos sedentarios y consumo de alimentos y bebidas en niños Europeos en edad prescolar" que presenta Dña. **MARÍA LUISA MIGUEL BERGES** 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 26 de Agosto de 2019

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The doctoral thesis entitled “Sedentary behaviours and food and beverages’ consumption in European preschool children” presented by Ms. **MARÍA LUISA MIGUEL BERGES** has been carried out under my supervision, being an expression of the technical and interpretative capacity of the author in conditions that make her deserving the Doctoral Degree, as long as the members of the jury will have this consideration.

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En Zaragoza, a 20 de agosto de 2019

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La presente Tesis Doctoral es un compendio de trabajos científicos previamente publicados o aceptados para su publicación. Los artículos que constituyen la presente tesis se detallan a continuación:

I. **Miguel-Berges ML**, Reilly JJ, Moreno Aznar LA, Jiménez-Pavón D. Associations Between Pedometer-Determined Physical Activity and Adiposity in Children and Adolescents: Systematic Review. Clin J Sport Med. 2018 Jan;28(1):64-75.

II. **Miguel-Berges ML**, Santaliestra-Pasias AM, Mouratidou T, Androutsos O, de Craemer M, Pinket AS, Birnbaum J, Koletzko B, Iotova V, Usheva N, Kulaga Z, Gozdz M, Manios Y, Moreno LA; ToyBox-study group. Associations between food and beverage consumption and different types of sedentary behaviours in European preschoolers: the ToyBox-study. Eur J Nutr. 2017 Aug;56(5):1939-1951.

III. **Miguel-Berges ML**, Zachari K, Santaliestra-Pasias AM, Mouratidou T, Androutsos O, Iotova V, Galcheva S, De Craemer M, Cardon G, Koletzko B, Kulaga Z, Manios Y, Moreno LA. Clustering of energy balance-related behaviours and parental education in European preschool children: the ToyBox study. Br J Nutr. 2017 Dec;118(12):1089-1096.

IV. **María L. Miguel-Berges**, Alba M. Santaliestra-Pasias, Theodora Mouratidou, Pilar De Miguel-Etayo, Odysseas Androutsos, Marieke De Craemer, Sonya Galcheva, Berthold Koletzko, Zbigniew Kulaga, Yannis Manios, Luis A. Moreno and on behalf of the ToyBox-study group. Combined Longitudinal Effect of Physical Activity and Screen Time on Food and Beverage Consumption in European Preschool Children: The ToyBox-Study. Nutrients 2019, 11, 1048.

V. **María L. Miguel-Berges**, Alba M. Santaliestra-Pasias, Theodora Mouratidou, Odysseas Androutsos, Marieke De Craemer, Sonya Galcheva, Berthold Koletzko, Zbigniew Kulaga, Yannis Manios and Luis A. Moreno on behalf of the ToyBox-study

group. Parental perceptions, attitudes and knowledge on European preschool children's total screen time: The ToyBox-study (accepted).

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1. Proyecto de investigación [Research Project]

La presente tesis incluye cuatro artículos basados en datos obtenidos del siguiente proyecto:

Estudio ToyBox (Enfoque basado en la evidencia multifactorial utilizando modelos de comportamiento para la comprensión y promoción de diversión, la comida sana, el juego y las políticas para la prevención de la obesidad en la infancia). Proyecto financiado por la Unión Europea: European Commission Seventh Framework Programme (FP7-KBBE-2009-3) under grant agreement no245200.

Página web: www.toybox-study.eu

Coordinador: Yannis Manios. Harokopio University

Investigador principal en España: Luis Moreno Aznar

Así mismo, durante los cinco años en que se ha desarrollado esta tesis, María L Miguel-Berges ha participado en el trabajo de campo de los siguientes proyectos: Ifamly Project (Investigating the determinants of food choice, lifestyle and health in European children, adolescents and their parents) (No. 266044), estudio Feel4Diabetes (No. 643708), estudio Belinda (Better life by Nutrition During Adulthood) (No. CB15/00/043), estudio Calina (No. PI13/00105), estudio Saycare (South American Youth/Child Cardiovascular and Environmental), estudio Pubmep (Riesgo metabólico en niños obesos: alteraciones epigenéticas e implicaciones fisiopatológicas y diagnósticas) (No. PI16/01205) y el proyecto DietaPyr2 (Innovaciones aplicadas a la cadena productiva pirenaica de vacuno para valorizar una carne identificable por el consumidor) (No. EFA 144/16).

2. Listado de abreviaturas [List of abbreviatons*]

- AAP Academia Americana de Pediatría
- AF Actividad física
- ANOVA Análisis de varianza
- ANCOVA Análisis de covarianza
- BMI Body Mass Index
- CEICA Comité Ético de Investigación Clínica de Aragón
- CI Confidence intervals
- DVD Digital Versatil Disk
- EBRB Energy balance-related behaviours
- ENSE Encuesta Nacional de Salud de España
- FFQ Food frequency questionnaire
- F&V fruits and vegetables
- IMC Índice de Masa Corporal
- METs Equivalente metabólico
- PA Physical activity
- PASW Predictive Analytics Software
- PCQ Primary caregivers´ questionnaire
- SE standard error
- SES Estatus socioeconómico
- T0 Inicio del estudio
- T1 Seguimiento del estudio
- TP Tiempo de pantalla
- TOYBOX Enfoque basado en la evidencia multifactorial utilizando modelos de comportamiento para la comprensión y promoción de diversión, la comida sana, el juego y las políticas para la prevención de la obesidad en la infancia
- TV Televisión

3. Resumen

La edad preescolar es un período importante para adoptar comportamientos de estilo de vida saludable, incluidos los hábitos de alimentación y la actividad física. Se sabe que el rebote temprano de la adiposidad está fuertemente asociado con el aumento del índice de masa corporal y la obesidad en la adolescencia. Los niños que tienen sobrepeso a la edad de 5 años son de 4 a 5 veces más propensos a tener obesidad en la adolescencia en comparación con los otros niños y que la mayoría de los adolescentes que tienen obesidad la tendrán en la edad adulta. Puesto que más del 95% de los niños en edad preescolar en Europa asisten a algún tipo de educación fuera del hogar (por ejemplo, jardín de infancia) éstos son ideales para implementar intervenciones dirigidas a mejorar la salud de los mismos. Numerosos estudios científicos evidencian que la inactividad física y el sedentarismo se han convertido en una epidemia de grandes dimensiones en la sociedad española, con un gran impacto negativo en la salud de la población. Independientemente de la actividad física realizada, el comportamiento sedentario (como el uso de pantallas) implica por sí mismo un factor de riesgo para ciertas enfermedades crónicas como diabetes tipo 2, enfermedad cardiovascular y obesidad. Existe una relación directa entre el número de horas que los niños pasan delante de pantallas y una mayor prevalencia de obesidad. Obesidad, que en niños y adolescentes españoles ha ido en aumento en las últimas décadas hasta estabilizarse en los últimos años en valores de 26% de niños y el 24% de las niñas con sobrepeso u obesidad. Entre los factores asociados a la obesidad están la ingesta de bebidas azucaradas y las dietas altamente energéticas y deficientes en frutas y verduras, el escaso número de horas de sueño y el excesivo sedentarismo. El tiempo total de pantalla se define como la visualización o uso de cualquier aparato con pantalla, incluyendo TV, DVD, video juegos, tablet, smartphone y ordenadores. Según las guías australianas y basándose en la Academia Americana de Pediatría, los niños menores de dos años no deberían pasar tiempo frente a una pantalla y para los niños de 2 a 5 años, el tiempo máximo

frente a cualquier pantalla se ha establecido en una hora. Estas recomendaciones se basan en seguir diferentes pautas establecidas por la Academia Americana de Pediatría: (1) limitar el tiempo total de pantallas; (2) retirar los televisores de las habitaciones de los niños; (3) animar a que los niños menores de 6 años sean partícipes de actividades que promuevan el desarrollo del cerebro adecuadamente como hablar, jugar, cantar y leer; (4) controlar los programas que los niños ven y siempre que se pueda verlos junto con los niños.

Existen pocos estudios que examinen la relación que existe entre el uso de diferentes tipos de pantalla y el consumo de alimentos en niños en edad prescolar. Sin embargo, esta relación ha sido ampliamente estudiada en niños en edad escolar y adolescentes observándose un mayor consumo de bebidas azucaradas y un menor consumo de frutas y verduras en aquellos niños y adolescentes que pasaban más tiempo frente a pantallas. Por ello, los objetivos generales de la presente tesis fueron estudiar la asociación entre los comportamientos sedentarios y el consumo de alimentos y bebidas en niños europeos en edad prescolar. Así como explorar cómo influye la educación de los padres en el estilo de vida de los niños además de la influencia de las percepciones, el conocimiento y las reglas de los padres sobre el tiempo de pantalla dedicado por lo niños.

Los datos utilizados fueron obtenidos en el estudio ToyBox, un estudio prospectivo y multicéntrico cuyo objetivo es la prevención de la obesidad focalizándose en cuatro comportamientos clave relacionados con el equilibrio energético como el consumo de agua, consumo de snacks, sedentarismo y consumo de frutas y verduras, en niños e involucrando a las familias. La muestra fue de un total de 7.056 niños de entre 3.5 y 5.5 años, de seis países europeos (Alemania, Bélgica, Bulgaria, España, Grecia y Polonia), reclutados de mayo a junio de 2012 a través de las escuelas infantiles.

En esta muestra de niños europeos en edad prescolar, los comportamientos sedentarios se asociaron con el consumo de alimentos ricos en energía y refrescos. Nuestros resultados respaldan la evidencia de limitar la exposición de los niños a

actividades basadas en pantallas ya que se ha observado una asociación positiva con el consumo de alimentos de elevada densidad energética. Se dividió la muestra según diferentes grupos de comportamientos, teniendo en cuenta los hábitos de los niños. El grupo más saludable caracterizado por el alto consumo de agua, frutas y verduras y práctica de actividad física fue más frecuente entre los niños con al menos un padre con educación media o superior. Se identificó que los niños con niveles más bajos de educación materna, paterna y ambas tenían menor probabilidad de ser asignados al grupo de "estilo de vida saludable" y mayor probabilidad de ser asignados al grupo de "estilo de vida poco saludable". Por lo tanto, el nivel educativo de los padres es uno de los factores clave que deben considerarse al desarrollar intervenciones de prevención de la obesidad infantil. Se observó que el 50,4% de la muestra no cumplió con las recomendaciones diarias de actividad física ni de tiempo de pantalla, ni al inicio ni al final del estudio. Los niños en edad preescolar que cumplieron con ambas recomendaciones consumieron menos bebidas gaseosas, zumos azucarados, dulces, postres y snacks, y consumieron más agua, frutas y verduras, productos lácteos, pasta y arroz que los que no cumplieron las recomendaciones. También se observó que aquellos niños cuyos padres tenían reglas que limitaran su tiempo sedentario tenían menos probabilidades de pasar una gran cantidad de tiempo de pantalla, mientras que los niños con padres permisivos se asociaban con altos niveles de visualización de pantalla. Mejorar las prácticas de crianza de los hijos puede ser un enfoque prometedor para disminuir el tiempo de pantalla de los niños pequeños.

En resumen, dado que el comportamiento sedentario juega un papel clave en la salud de los niños, los datos obtenidos de la presente Tesis Doctoral ponen de manifiesto la importancia de establecer intervenciones de salud pública desarrollando estrategias de prevención que se focalicen en los estilos de vida de los niños y de las familias.

3. Abstract

Preschool age, a period which comprising from 4 to 6 years, is an important period to form and adopt healthy lifestyle behaviours including dietary habits and physical activity (PA). This is important given the increase body mass index (BMI), overweight and obesity later in life. In fact, overweight preschool children are 4 to 5 times more likely to be obese adolescents and in later life in adulthood. Childhood obesity has been associated, in the short term, with psychological problems and low school performance and with an increased risk of many comorbidities in the future, such as diabetes mellitus type 2, dyslipidemia, hypertension and coronary heart disease.

The school environment and kindergartens are suitable settings to target and implement behavioural change interventions aiming at promoting healthy habits. Besides, they offer the opportunity to target the majority of preschool children (>95% of European children attend preschool).

Evidence suggests that a poor dietary habits, physical inactivity and sedentary lifestyle have become a major epidemic with a negative impact on the health of the population. Regardless of the PA levels, sedentary behaviour in particular total screen time, defined as the use of any device with a screen, including TV, DVD, video games, tablet, smartphone and computers, is an independent determinant of health related to chronic diseases including obesity. There is a direct association between the number of hours children spend in front of screens and a higher prevalence of obesity. Concretely, it has been observed an increase of 10 to 27% in the risk of developing overweight or obesity in children and adolescents who went from watching 1 to 3 hours of television per day. The latest data from the Childhood Obesity Surveillance Initiative (COSI) show that southern European countries have the highest rate of child obesity. In Cyprus, Greece, Italy, Malta, San Marino and Spain, approximately 1 in 5 boys (ranging from 18% to 21%) are obese. Denmark, France, Ireland, Latvia and Norway are among the countries with

the lowest rates, ranging from 5% to 9% in either sex. High intakes of sugar-sweetened beverages, diets high in energy and fat and low consumption of fruits and vegetables in combination with suboptimal PA levels and sleeping patterns and excessive sedentary lifestyles are the major determinants of these increases. According to the guidelines issued by Australian guidelines and the American Academy of Paediatrics, children < two years should not spend time in front of a screen and for children 2-5 years the maximum time in front of any screen is set to one hour per day. These recommendations are based on the following different guidelines: (1) limit total screen time; (2) remove TV from children's rooms; (3) Encourage children < 6 to participate in activities that promote brain development, such as talking, playing, singing and reading; (4) control the programs that children see and as long as they can be seen together with the children. Few studies examined the association between the use of different types of sedentary time and food consumption in preschool children. However, this association has been widely examined in school-age children and adolescents; as result observed a higher consumption of sugar sweetened beverages and a lower consumption of fruits and vegetables is related to spend more time in front of total screen time.

The aim of this Doctoral Thesis is to assess the association between sedentary behaviour and consumption of food and beverages in European preschool children participating in the multicentre ToyBox-study. The objectives were i) to examine the evidence on the associations between pedometer-determined physical activity and adiposity; ii)to track prospective adherence to physical activity (PA) and screen time (ST) recommendations at baseline (T0) and follow-up (T1) and to assess the association between changes or not in the adherence of PA and ST recommendations and food and beverage consumption at follow-up (T1); and iii) to explore how parents 'education influences the children's lifestyle as well as the influence of parental perceptions, attitudes and knowledge about screen time spent by children, over time.

The ToyBox-study where data obtained from, is a prospective multicenter study aiming to promote healthy lifestyles in early childhood in order to prevent obesity. As part of the study, a preschool-based, family-involved intervention to influence obesity-related behaviour, adjusting for cultural, legislative and infrastructural diversities in the participating countries (Germany, Belgium, Bulgaria, Spain, Greece and Poland) was developed. Key targeted behaviours at the intervention included water consumption, snack consumption, sedentary lifestyle and consumption of fruits and vegetables all of which related to early childhood obesity. The total sample was 7,056 children between 3.5 and 5.5 years old, from six European countries, recruited from May to June 2012 and follow up from May to June 2013.

In this sample of European preschool children, sedentary behaviours were associated with the consumption of energy density foods and sweetened beverages. The sample was divided according to different groups of behaviours, taking into account the habits of the children. The healthiest group characterized by high consumption of water, fruits and vegetables and physical activity practice was more frequent among children with at least one parent with middle or higher education. It was identified that children with lower levels of maternal and paternal education and both were less likely to be assigned to the "healthy lifestyle" group and more likely to be assigned to the "unhealthy lifestyle" group. It was observed that 50.4% of the sample did not comply with the daily recommendations of physical activity or screen time, neither at the beginning nor at the end of the study. Preschool children who complied with both recommendations consumed less sweetened beverages, sweetened juices, sweets, desserts and snacks, and consumed more water, fruits and vegetables, dairy products, pasta and rice than those who did not meet the recommendations. It was also observed that those children whose parents had rules limiting their sedentary time were less likely to spend a lot of screen time, while children with permissive parents were associated with high levels of screen display.

In summary, findings from this Doctoral Thesis highlight the importance of developing and implementing public health interventions and prevention strategies that consider the sedentary behaviour plays a key role in the health of children and focus on lifestyles of children and families. Considering the educational level of the parents is one of the key factors that should be considered when developing interventions to prevent childhood obesity. Our results support the evidence of limiting children's exposure to screen-based activities so that has been observed a positive association with the consumption of high energy density foods. Improving parenting practices can be a promising approach to decrease screen time for young children.

4. Introducción [Introduction]

El sobrepeso y la obesidad infantil siguen siendo una de las principales preocupaciones de salud pública del siglo XXI. La infancia representa el mejor momento para prevenir la obesidad y sus consecuencias adversas. Y es que la obesidad infantil se ha visto asociada a corto plazo con problemas psicológicos y rendimiento escolar bajo (1) y con un mayor riesgo de muchas comorbilidades en el futuro, como diabetes mellitus tipo 2, dislipidemia, hipertensión, enfermedad coronaria y cardiaca (2).

Durante la última década, Europa ha mostrado un gradiente norte-sur en la prevalencia de sobrepeso y obesidad (del 9 al 43% entre los niños y del 5 al 43% entre las niñas) y la obesidad aislada (del 2 al 21% entre los niños) y (del 1 al 19% entre las niñas) (3). En los niños españoles, la prevalencia de obesidad ha ido en aumento en las últimas décadas hasta estabilizarse en los últimos años en torno al 20.4% de niños y el 15.8% de las niñas, según datos de la Organización para la Cooperación y el Desarrollo Económicos (2016) (4). Según los últimos datos presentados por el Centro Nacional para la Estadística de Salud de Estados Unidos (5) dos de cada diez niños y adolescentes de 2 a 17 años tienen sobrepeso. En la actualidad aproximadamente el 17% (12.5 millones) de los niños y adolescentes estadounidenses con edades comprendidas entre los 2 y los 19 años tienen obesidad.

Numerosos estudios científicos evidencian la relación que existe entre la inactividad física, el comportamiento sedentario y los hábitos dietéticos y las enfermedades crónicas no transmisibles como enfermedad cardiovascular, diabetes y diferentes tipos de cáncer (6). Independientemente de la actividad física realizada, el comportamiento sedentario (entre otros el uso de pantallas) implica por sí mismo un factor de riesgo para ciertas enfermedades crónicas como diabetes tipo 2 (7), enfermedad cardiovascular (7, 8) y obesidad (9). Es un hecho

contrastado, la relación directa entre el número de horas que los niños pasan delante de las pantallas y una mayor prevalencia de obesidad (10).
Además de la inactividad física, debida a la elevada frecuencia de comportamientos sedentarios (11), entre los factores asociados a la obesidad se encuentran también los factores dietéticos, entre los que destaca la ingesta de bebidas azucaradas (12), la alimentación con elevada densidad energética, y deficiente en frutas y verduras (6), así como el escaso número de horas de sueño (13).

4.1. Comportamientos sedentarios

4.1.1 Definición

Bernstein, Morabia y Sloutskis (1999) (14) estudiaron a 919 residentes en Ginebra y Suiza, evaluando los requerimientos diarios de energía y el metabolismo basal y propusieron que los individuos son sedentarios cuando gastan menos del 10% de su gasto energético diario en actividades diarias. Plantearon que no solo la falta de actividad física diaria (energía gastada) define el sedentarismo, sino que, además, la falta de intensidad de las actividades diarias también debía ser tenida en cuenta. En los últimos años la definición sobre el comportamiento sedentario ha ido cambiando. En 2012, la Red de investigación de comportamientos sedentarios (SBRN, una red que conecta a investigadores de comportamientos sedentarios y profesionales de la salud de todo el mundo interesados en la investigación de conductas sedentarias) logró llegar a un consenso entre todas las definiciones que existían, considerando comportamiento sedentario a cualquier actividad realizada por el individuo en posición sentada o inclinada con un gasto energético $\leq$ 1.5 METs (equivalente metabólico), mientras se está despierto (15) y no la ausencia de actividad física moderada-intensa como se entendía tradicionalmente. Entendiendo por MET como la unidad de medida del índice metabólico (cantidad de energía que consume un individuo en situación de reposo) y que corresponde a 3,5 ml O_2/kg x

min, que es el consumo mínimo de oxígeno que el organismo necesita para mantener sus constantes vitales. La definición actual hace referencia y especifica según la edad dando como ejemplo en la edad prescolar al uso de dispositivos electrónicos (p. ej. TV, ordenador/computador, tablet, teléfono) en posición sentado, reclinado o acostado; leer/dibujar/pintar mientras se está sentado; estar sentado en un carrito de paseo; estar sentado en silla de bebé o sofá mientras come; estar sentado en un autobús, automóvil o tren (15).

4.1.2 Valoración de los comportamientos sedentarios

Los comportamientos sedentarios se pueden medir utilizando evaluaciones subjetivas o mediante evaluaciones objetivas en función del objetivo del estudio (16). Ambos métodos de evaluación tienen una serie de fortalezas y debilidades.

Métodos subjetivos

Las medidas subjetivas de los comportamientos sedentarios se obtienen mediante el uso de autoinformes, cuestionarios, diarios etc. Son reportados por los participantes y a través de ellos se pueden distinguir entre varios tipos de comportamientos como por ejemplo, ver la televisión, el uso de video consolas o el uso de Internet entre otros. Sin embargo, las medidas subjetivas son propensas a sesgos de recuerdo retrospectivos dado que dependen de la capacidad del individuo para recordar con precisión los comportamientos anteriores. Otra limitación es que requiere tiempo por parte del participante para reportar toda la información conllevando así a no cumplimentar todo lo requerido en el cuestionario además que requiere mucha mano de obra para el investigador (17). No obstante, las mediciones subjetivas son altamente utilizadas en estudios epidemiológicos puesto que tienen un bajo coste y nos dan información sobre comportamientos específicos.

Métodos objetivos

Las mediciones objetivas se basan en el uso de aparatos como acelerometría, monitores de postura, monitores de frecuencia cardiaca etc. (16). Proporcionan una evaluación detallada del nivel de sedentarismo de los individuos, pero no distinguen entre los diferentes tipos de comportamientos. El coste puede ser elevado dependiendo los sujetos a estudiar pero aun así son ampliamente utilizados en estudios epidemiológicos. Los acelerómetros se pueden usar para estimar el volumen total del comportamiento sedentario a través de la acumulación de bajos conteos de movimiento en puntos de corte específicos. También pueden usarse para detectar breves interrupciones en el tiempo, definidas por períodos en los que los conteos de movimiento exceden el umbral especificado, que pueden no ser registradas mediante autoinformes (18).

4.1.3 Recomendaciones internacionales

El tiempo total de pantalla se define como la visualización o uso de cualquier aparato con pantalla, incluyendo televisión (TV), DVD, video juegos, tablets, smartphone y ordenadores. Según las guías australianas (19) y basándose en la Academia Americana de Pediatría (20), los niños menores de dos años no deberían pasar tiempo frente a una pantalla, y en el caso de los niños con edades comprendidas entre los 2 y los 5 años, el tiempo limitado frente a cualquier pantalla se ha establecido en una hora al día. Estas recomendaciones están también vinculadas con las pautas establecidas por la Academia Americana de Pediatría que son las siguientes: (1) limitar el tiempo total de pantallas; (2) retirar los televisores de las habitaciones de los niños; (3) animar a que los niños menores de 6 años sean partícipes de actividades que promuevan el desarrollo del cerebro adecuadamente como hablar, jugar, cantar y leer; (4) controlar los programas que los niños ven y siempre que se pueda verlos juntos con los niños.

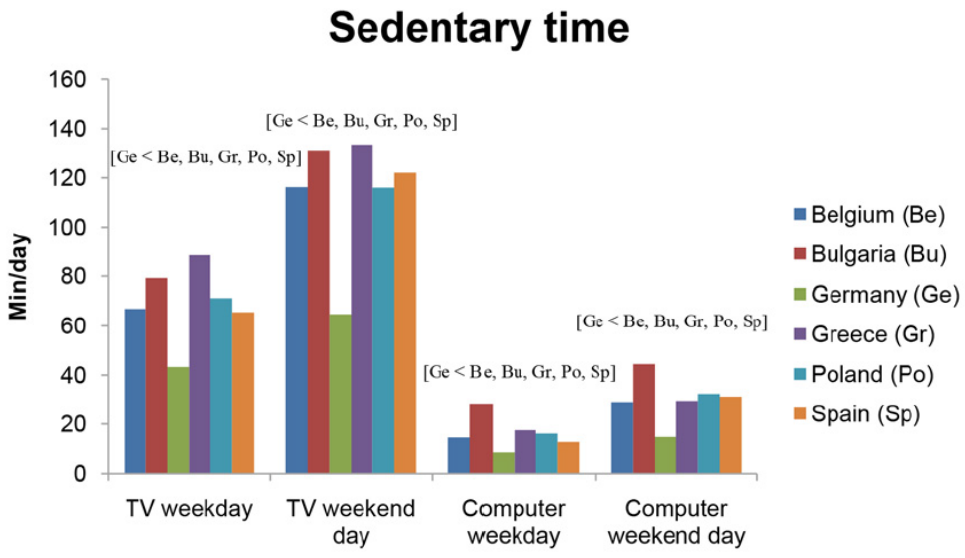
4.1.4 Epidemiologia descriptiva

Dada la importancia que ocupa el cambio de hábitos desde la edad infantil, el estudio de los comportamientos sedentarios se ha incrementado en la última década. Numerosos estudios llegan a la conclusión de que cada vez los niños son más sedentarios (21) y que con la edad se incrementan los comportamientos sedentarios (22-24). En la última Encuesta Nacional de Salud de España 2017 (ENSE 2017) se concluyó que el 58% de los niños de 1 a 4 años pasaban una hora o más al día de su tiempo libre frente a una pantalla y aumentaba hasta un 63% durante los fines de semana. Conforme aumentaban de edad también aumentaban el tiempo de exposición siendo el 76% de los niños de 5 a 9 años los que pasaban una hora o más al día entre semana y el 87.63% de los niños lo hacían los fines de semana.

En la **figura 1** se muestra el tiempo sedentario de los niños (3.5-5.5 años) participantes en el estudio ToyBox, en diferentes países europeos. Durante los días entre semana, se observó que los niños alemanes en edad preescolar eran los que menos tiempo pasaban frente a la TV (43.3 min / día; SE = 1.5; p <0,001), mientras que los niños griegos eran los que más tiempo pasaban frente a la TV (88.5 min / día; SE = 1.4; p <0.001). En relación a los días de fin de semana, de nuevo los preescolares alemanes presentaron la menor cantidad de tiempo viendo TV (64.8 min / día; SE = 2.3; p <0.001), mientras que los niños de Bulgaria (131.1 min / día; SE = 2.7) y los griegos (133.5 min / día; SE = 2.0) reportaron más tiempo viendo la TV (p <0.05). En resumen, el 71.4% de los preescolares alemanes cumplieron con las recomendaciones de menos de una hora de pantalla al día. Mientras que solamente el 43.9% de los niños españoles cumplieron con estas recomendaciones, reduciéndose éste durante los días de fin de semana, a tan solo 12.3% de los niños en edad preescolar españoles que cumplieron con las recomendaciones. En el caso de los niños de 6 a 9 años participantes del estudio Idefics se observó que los niños de Estonia eran los que más tiempo pasaban frente a pantallas durante la semana ya que solo el 37% de los niños cumplieron con las recomendaciones de < de 2 horas al día. Durante los fines de semana fueron los niños de Suecia los que más tiempo

pasaron frente a pantallas puesto que solo un 28% de los niños cumplieron con las recomendaciones de < de 2 horas al día (25). Un estudio realizado en España a niños de 6 a 12 años, observó que un 63,4% de la muestra pasaban entre 2 o más horas al día en actividades sedentarias como ver la televisión o jugar con videojuegos (26). El estudio ANIBES que evaluó a más de 400 niños y adolescentes españoles corroboró que un alto porcentaje (48,4%) de niños y adolescentes en España no cumplían con las recomendaciones sobre comportamientos sedentarios, especialmente durante los fines de semana (84,0%) (27).

Figura 1. Tiempo dedicado a actividades sedentarias en niños en edad prescolar de diferentes países Europeos . Estudio ToyBox.



Fuente: De Craemer M, Lateva M, Iotova V, De Decker E, Verloigne M, De Bourdeaudhuij I, et al. (2015) Differences in Energy Balance-Related Behaviours in European preschool Children: The ToyBox-Study.PLoS ONE 10(3): e0118303.

El estudio AFINOS que evaluaba una muestra de niños y adolescentes españoles encontró diferencias significativas en cuanto al género. Siendo los niños los que más jugaban con video consolas y juegos de ordenador y las niñas las que más

navegaban por internet. Además había una proporción mayor de niños que tenían televisión en su habitación y por consiguiente éstos pasaban más tiempo haciendo uso de ella (28). En base a otros estudios revisados, se puede concluir que en general los niños pasan más tiempo viendo TV que las niñas (29, 30).

4.1.5 Consecuencias

Comportamiento sedentario y obesidad

En términos generales la principal causa del sobrepeso y la obesidad infantil es un desequilibrio energético entre las calorías consumidas y las calorías gastadas. No obstante y atendiendo al incremento de los comportamientos sedentarios, como ver la TV, el uso de video juegos y ordenador han contribuido en gran parte a este desequilibrio (31), contribuyendo a la disminución del gasto energético. Numerosos estudios confirman que ver la TV en la infancia un tiempo prolongado se asocia con un aumento del índice de masa corporal (32-35). En un estudio realizado en niños y adolescentes procedentes de 37 países, se observó un aumento del 10 al 27% en el riesgo de desarrollar sobrepeso u obesidad en niños y adolescentes, que pasaron de ver de 1 a 3 horas la televisión al día (32) concluyendo así que el aumento del uso de pantallas contribuye a aumentar el índice de masa corporal en la infancia. Un estudio de 70 niños (4 a 7 años de edad) con IMC por encima del percentil 75 mostró que reducir el tiempo de visualización de TV y PC en un 50% durante 2 años produjo una reducción significativa del IMC y la ingesta de energía atribuyendo la reducción del IMC a la disminución de la ingesta de energía y no tanto a los cambios en la actividad física (36).Un ensayo controlado y aleatorizado comprobó que incorporando en el currículo escolar una intervención basada en disminuir el comportamiento sedentario se presentaba una disminución de la grasa corporal (33). La intervención consistía en motivar a los niños a reducir el tiempo que dedicaban a estas actividades, además de animarles a seguir un plan de no más 7 horas a la semana utilizando pantallas. Se concluyó que

la mejor intervención consistiría en combinar la reducción del comportamiento sedentario, el ejercicio físico junto con un programa nutricional adecuado, con el objetivo de aumentar considerablemente la pérdida de grasa corporal. En Australia, una intervención curricular en niños de 10 años comprobó la eficacia de ésta en una mejora del IMC además de una disminución del tiempo dedicado a comportamientos sedentarios y un mejor disfrute de la actividad física (37).

Comportamiento sedentario y salud cardiovascular

Se ha observado que un excesivo tiempo invertido en actividades sedentarias de pantalla se ha asociado con peores marcadores de salud cardiovascular. Tanto es así, que el incremento de los comportamientos sedentarios en la infancia aumenta el riesgo de padecer enfermedades no transmisibles como las enfermedades cardiovasculares y los accidentes cerebrovasculares entre otras. De hecho, se ha observado que las conductas saludables en la primera etapa de la vida pueden mejorar hasta un 35% la salud cardiovascular en la edad adulta (38). Una revisión sistemática que examino a más de 1,5 millones de niños y adolescentes de todo el mundo, concluyó que en la mayoría de los indicadores de salud examinados, una mayor duración del comportamiento sedentario se asoció con una salud desfavorable, indicando así que un comportamiento menos sedentario, especialmente el tiempo de pantallas, se asoció con una mejor salud (39). En un estudio Europeo, los autores concluyeron en la importancia de reducir el tiempo dedicado a ver la TV entre los niños y adolescentes para reducir directamente la grasa corporal e indirectamente los factores de riesgo cardiovascular (40). Los hallazgos de un meta-análisis de estudios prospectivos en adultos sugirieron que una mayor duración del tiempo de visualización de TV se asociaba con un mayor riesgo de diabetes tipo 2, enfermedad cardiovascular y mortalidad por todas las causas (41).

Comportamiento sedentario y dieta

Uno de los posibles mecanismos que explica la asociación entre los comportamientos sedentarios y la obesidad es debido a la mayor ingesta de energía durante los momentos de inactividad (42). La TV contribuye a aumentar el tiempo sedentario, ya que desplazaría actividades que impliquen un mayor consumo energético y que por lo tanto podrían ayudar a consumir las calorías excesivas (43). Otra de las razones por las que la televisión tiene ese efecto negativo es debido a que tanto los alimentos como las bebidas con una mayor densidad energética es la categoría de productos alimentarios que más se anuncia en la programación de televisión infantil, y se ha observado que la exposición a los anuncios de comida promueve el mayor consumo de los productos anunciados (44). Numerosos estudios apoyan la hipótesis que un exceso de tiempo en pantallas se asocia con una mayor ingesta calórica y de alimentos poco saludables como refrescos azucarados, snack salados, zumos, entre otros, y un menor consumo de alimentos considerados saludables (42, 45, 46). Esta asociación también ha sido observada cuando se estudias la ingesta de alimentos mientras los niños ven la TV. En un estudio Europeo se observó que los adolescentes que consumían alimentos en frente de la TV tenían una mayor ingesta de alimentos y bebidas con alta densidad energética (47). Una reciente revisión sistemática observó una asociación entre el bajo nivel socioeconómico y la mayor probabilidad de comer mientras se ve la TV, asociándose ésta con una peor calidad de la dieta de los niños (48). Sin embargo, un estudio muy reciente llevado a cabo en población preescolar no encontró asociación entre ver la TV durante la comida con la calidad de la dieta consumida (49).

4.2. Actividad física

4.2.1 Definición

La actividad física (AF) se define como cualquier movimiento del cuerpo producido por los músculos que requiere un gasto energético (50). En cambio ejercicio físico se refiere a la actividad física que es planificada, estructurada, repetitiva e intencional (51). La actividad física incluida en la población infantil incluye caminar, gatear, correr, saltar, balancearse, trepar a través y sobre objetos, bailar, montar en juguetes con ruedas, montar en bicicleta, saltar la cuerda, etc. (50).

La AF se diferencia según la intensidad. En los niños, la "intensidad moderada" se describe como una actividad aeróbica que le permite al individuo notar un aumento en la frecuencia cardíaca y la frecuencia respiratoria. En una escala de 0 a 10, la intensidad moderada sería un 5 o 6. La "actividad vigorosa" se describe como sentir el corazón latiendo mucho más rápido y respirar mucho más fuerte de lo normal. En una escala de 0 a 10, la intensidad vigorosa sería de 7 u 8 (51). La AF moderada equivale a un gasto energético de 4–7 MET en niños, es decir, 4–7 veces el gasto de energía en reposo. Cuando hablamos de AF vigoroso es equivalente a > 7 METs.

4.2.2 Valoración de la actividad física

Para conocer con mayor precisión los niveles de AF durante la infancia es necesario desarrollar y validar instrumentos capaces de evaluar la AF en las poblaciones escolares. La valoración de ésta en condiciones naturales y reales es extremadamente difícil de realizar, especialmente en niños y adolescentes. Existen más de 30 métodos diferentes descritos en la literatura para evaluar la actividad física de una persona, y se resumen en 2 categorías (52):

Métodos de observación directa u objetiva

Los métodos directos que incluyen calorimetría y agua doblemente marcada, ofrecen una medida muy precisa de la actividad física, pero son muy costosos y complicados por lo que resultan poco viables para ser usados en estudios

poblacionales (53). Los monitores de movimiento (acelerómetros y podómetros) y de frecuencia cardiaca son algo menos precisos y más baratos, pero siguen resultando difíciles de usar en grandes poblaciones y en la práctica pediátrica (54).
Una revisión sistemática concluyó que la frecuencia de estudios que utilizaban podómetros y monitorización de la frecuencia cardíaca fue menor que el número de estudios con acelerometría, pero hubo un alto grado de coherencia en las conclusiones entre los estudios que utilizaron los tres tipos de medidas de exposición (55). Los acelerómetros miden la frecuencia y la magnitud de las aceleraciones y desaceleraciones de los movimientos corporales. El gasto energético total puede ser estimado basándose en la edad, sexo, talla y peso del individuo. En cambio, los podómetros son dispositivos con sensores de movimiento que generalmente se usan en la cadera y están diseñados para contar los pasos caminados en el día. Detectan el movimiento de caminar o correr, y los pasos acumulados se pueden visualizar digitalmente en una pantalla, proporcionando al usuario una respuesta inmediata (56). Son pequeños, ligeros, no invasivos y fáciles de usar además de tener un coste inferior al de los acelerómetros.

Métodos de observación indirecta o subjetiva

Los métodos subjetivos incluyen los cuestionarios, entrevistas y diarios de actividad física en otros. Este método resulta más sencillo y útil para valorar la actividad física en grandes muestras de población. Los diarios de actividad física implican el recuerdo de actividades diarias y está limitado por la cooperación del sujeto (57). Éstos proporcionan una manera conveniente de evaluar los patrones de actividad en poblaciones grandes. Uno de los cuestionarios más utilizados para estimar la AF en niños es el PAQ-C. Se trata de un cuestionario simple que evalúa la AF, que un niño ha realizado en los últimos 7 días obteniendo una puntuación de 1 a 5 puntos que permite obtener el nivel de AF realizado por cada sujeto (58). Una de las limitaciones es la subjetividad inherente cuando se les pide a las personas que respondan preguntas sobre su comportamiento.

4.2.3 Recomendaciones internacionales

Los niños en edad preescolar deben ser físicamente activos durante todo el día para mejorar el crecimiento y el desarrollo. La Organización Mundial de la Salud (50) establece las recomendaciones para niños en edad prescolar en 180 minutos de actividad física a cualquier intensidad siendo al menos 60 minutos de actividad física de intensidad moderada a intensa, distribuida a lo largo del día.

4.2.4 Beneficios para la salud

La actividad física ha sido identificada como un agente importante en la prevención de enfermedades crónicas como la obesidad, las enfermedades cardiovasculares y el síndrome metabólico (59). La evidencia sobre los beneficios para la salud de la AF regular está bien establecida y la investigación continúa proporcionando información sobre los beneficios a nivel tanto individual como a nivel comunitario. La participación en el ejercicio disminuye la grasa corporal, aumenta la capacidad cardiorrespiratoria y la fuerza muscular, mejora la salud ósea (60) y tiene beneficios cognitivos y psicosociales (61).

Las intervenciones proyectadas desde la escuela están reconocidas como las estrategias más universales y los caminos más efectivos para contrarrestar los bajos niveles de AF. Influir en la cultura escolar permite que las transformaciones lleguen a las familias y en definitiva al conjunto de la comunidad educativa. Es por ello que cada vez más existen programas en el medio escolar que tratan de favorecer la AF en el entorno educativo además de favorecer el desplazamiento activo al centro escolar (62).

5. Objetivos

El objetivo general de la presente Tesis Doctoral es valorar la asociación entre los comportamientos sedentarios y el consumo de alimentos y bebidas en niños europeos en edad prescolar, así como ampliar el conocimiento científico actual sobre la relación existente entre ambos y los factores sociodemográficos, percepciones, conocimiento y reglas de la familia.

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

Artículo I: Evaluar la evidencia científica mediante una revisión sistemática sobre las asociaciones entre la actividad física determinada por podómetros y la adiposidad.

Artículo II: Valorar la asociación entre el tiempo dedicado a diferentes comportamientos sedentarios, como ver la TV/DVD, jugar a juegos de ordenador y juegos tranquilos en relación con el consumo de alimentos y bebidas en una muestra de niños europeos en edad prescolar.

Artículo III: Identificar la agrupación de comportamientos sobre estilos de vida (alimentación, actividad física y comportamientos sedentarios) y explorar su asociación con los niveles de educación de los padres y la composición corporal (IMC) de los niños, en una muestra de niños preescolares de 6 países europeos (Bélgica, Bulgaria, Alemania, Grecia, Polonia y España) que participan en el estudio ToyBox.

Artículo IV: Valorar de forma prospectiva el seguimiento del cumplimiento de las recomendaciones de actividad física (AF) y tiempo de pantalla (TP) al inicio y seguimiento del estudio ToyBox, así como evaluar la asociación entre la evolución del cumplimiento de las recomendaciones de AF y TP o no y el consumo de alimentos y bebidas.

Artículo V: Valorar la asociación transversal de las percepciones, conocimiento y reglas de los padres sobre las recomendaciones de tiempo de pantalla de los niños,

en relación con el tiempo que los niños pasan enfrente de las pantallas, tanto al inicio como en el seguimiento del estudio.

5. Objectives

The general objectives of this Doctoral Thesis are to assess the association between sedentary behaviour and the consumption of food and beverages in European preschool children. As well as, to explore how parents 'education influences the children's lifestyle as well as the influence of parental perceptions, attitudes and knowledge about screen time spent by children, over time.

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

Manuscript I: To examine the evidence on the associations between pedometer-determined physical activity and adiposity.

Manuscript II: To examine the association between time spent on different sedentary behaviours such as watching TV and DVDs, playing computer/video games and quiet play/activities and the consumption of a number of foods and beverages included in the food frequency questionnaire used in the baseline sample of the ToyBox-study.

Manuscript III: To identify clusters of EBRB and explore their association with parental education and child´s BMI in a sample of preschool children of 6 European countries (Belgium, Bulgaria, Germany, Greece, Poland and Spain) participating in the ToyBox study.

Manuscript IV: To track prospective adherence to physical activity (PA) and screen time (ST) recommendations at baseline (T0) and follow-up (T1) and to assess the association between changes or not in the adherence of PA and ST recommendations and food and beverage consumption at follow-up (T1).

Manuscript V: To examine the cross-sectional association of parental perceptions, attitudes and knowledge on screen time (TV/video/DVD) recommendations with child's total screen time both at baseline and follow-up periods. Also, to assess the tracking of parenting attitudes, perceptions and knowledge and children' total

screen time recommendations between baseline and follow-up and its association with children's TV/video/DVDs viewing and total screen time at follow up.

6. Material y métodos

La presente Tesis Doctoral se ha elaborado teniendo en cuenta los resultados del proyecto ToyBox (Enfoque basado en la evidencia multifactorial utilizando modelos de comportamiento para la comprensión y promoción de una alimentación saludable, el juego y políticas para la prevención de la obesidad en la infancia).

6.1 Muestra y diseño de estudio

El estudio ToyBox es un estudio Europeo prospectivo cuyo diseño se trata de un ensayo clínico por conglomerados desarrollado en 6 países Alemania, Bélgica, Bulgaria, España, Grecia y Polonia, que se elaboró con el objetivo de desarrollar y analizar un programa innovador de prevención de la obesidad basado en la evidencia científica focalizado en cuatro comportamientos clave relacionados con el equilibrio del balance energético, como son el consumo de agua, de frutas y verduras, de snacks, el tiempo dedicado a comportamientos sedentarios y la actividad física en niños de 4 a 6 años, involucrando a las familias. Los objetivos específicos del estudio ToyBox fueron los siguientes:

1. Identificar los comportamientos clave de los niños en edad prescolar y sus determinantes relacionados con la obesidad infantil temprana, evaluando los modelos de comportamiento existentes y las estrategias educativas que mejor apoyen el cambio de comportamiento en este grupo de edad.
2. Desarrollar una intervención familiar, realizada en las escuelas infantiles, que permita influir en los comportamientos relacionados con la obesidad en niños de 4 a 6 años, ajustándose a las diversidades culturales, legislativas y de infraestructura en los países participantes.
3. Implementar el programa de intervención en seis países europeos, evaluando su proceso, impacto y los resultados, así como la rentabilidad del mismo.

4. Difundir los resultados, que permitan establecer las recomendaciones necesarias para las políticas europeas de salud pública.

Se presenta a través de la Figura 2 el cronograma de realización del estudio ToyBox.

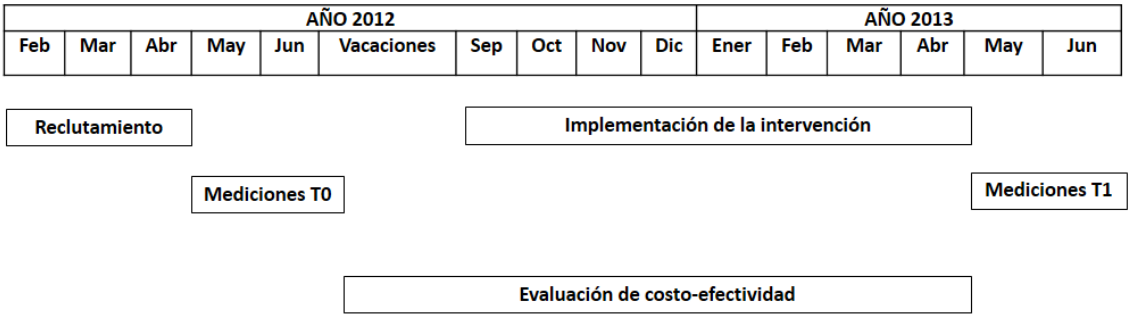


Figura 2. Cronograma del estudio ToyBox.

Se aplicó un enfoque de reclutamiento estandarizado en todos los países participantes (Alemania, Bélgica, Bulgaria, España, Grecia y Polonia). Primero se creó una lista de todos los municipios ubicados en las provincias seleccionadas de cada país, dentro de un radio de 50 km alrededor de los grupos de investigación. Se establecieron las variables para valorar el estatus socioeconómico (SES) como los años de educación de los padres/tutores o el ingreso familiar promedio anual. Según los valores medios de las variables SES seleccionadas, los municipios se dividieron en tres grupos (es decir, SES bajo, SES medio y SES alto). De cada uno de estos grupos SES, se seleccionaron al azar cinco municipios en cada país y se crearon listas de todas las escuelas infantiles ubicadas dentro de cada uno de estos municipios. El reclutamiento empezó desde la parte superior de la lista para cada uno de los municipios seleccionados. Si la tasa de participación era inferior al 50%, se excluía la escuela infantil y se continuaba con la siguiente de la lista.

En resumen, las escuelas infantiles se consideraron elegibles si (i) se encontraban dentro de un radio de 50 km de los grupos de investigación locales; (ii) los

directores y los profesores proporcionaron un consentimiento firmado y (iii) la tasa de participación dentro de la escuela infantil fue de al menos el 50%. Del mismo modo, los niños/as dentro de las escuelas infantiles reclutados eran elegibles si (i) tenían entre 3,5 y 5,5 años en el momento del reclutamiento (es decir, habían nacido entre enero de 2007 y diciembre 2008); (ii) sus padres y/o tutores firmaron el consentimiento y (iii) no estaban participando en ningún otro proyecto de investigación orientado a la salud durante los cursos académicos 2012-2013 y 2013-2014.

La asignación al azar de los municipios reclutados al grupo de intervención y control se llevó a cabo de manera centralizada por el centro de coordinación. Los municipios se asignaron al grupo de intervención o control en una proporción de 2: 1 dentro de cada grupo de SES. Dado que la asignación al azar se realizó a nivel de municipio, las escuelas infantiles de cada municipio se asignaron automáticamente al grupo de intervención o control.

Al inicio del estudio (T0), se incluyó una muestra de 7.056 niños con edades comprendidas entre 3.5 y 5.5 años, procedentes de los seis países europeos. Se reclutaron entre mayo y junio de 2012, a través de las escuelas infantiles, con el acuerdo del equipo directivo de cada centro, y tras la aceptación por parte de los padres y/o tutores de cada uno de los participantes. El seguimiento del estudio (T1) se llevó a cabo un año más tarde (de mayo a junio de 2013) aplicándose los mismos métodos estandarizados de valoración, reclutándose una muestra total de 5.529 niños. (78% de la muestra total al inicio del estudio).

En la siguiente figura (**Figura 3**) se presentan el número total de participantes por países y por escuelas infantiles participantes en el estudio ToyBox.

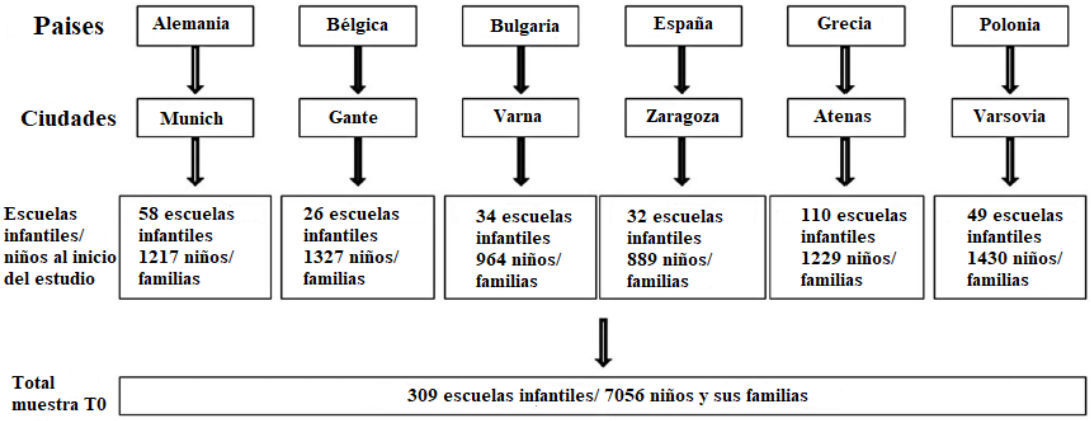


Figura 3 Número de niños por pais con datos completos al inicio del estudio. Estudio ToyBox

Para la realización de la presente Tesis Doctoral se han utilizado datos del estudio ToyBox, excepto para el **artículo I** que es una Revisión Sistemática. El artículo II y el artículo II han incluido datos derivados de la valoración inicial de los participantes en el estudio (T0). Los artículos **IV y V** han incluido datos de los análisis prospectivos (T0-T1), por lo que el tamaño de la muestra se ha reducido al precisarse de la información completa en ambos periodos de tiempo (T0 y T1).

El **artículo II** incluyó información procedente de 6.401 niños (51.8% chicos), en los que se requería que los participantes hubieran cumplimentado al menos el 75% de la información sobre la frecuencia de consumo de alimentos completa en T0, y haber respondido a las preguntas relacionadas con los comportamientos sedentarios del cuestionario general.

El **artículo III** incluyó la información de 5.387 niños (51% chicos), en los que además de los requisitos mencionados en el artículo II, los padres debían haber cumplimentado la información relativa sobre la actividad física de sus hijos mediante la participación de los niños en actividades deportivas.

Para el **artículo IV** se incluyó una muestra de 2321 niños (52.1% chicos), en la que adicionalmente a los requisitos del artículo II y III, toda la información debía estar recogida en ambos periodos de tiempo (T0 y T1). Adicionalmente, los participantes

debían haber registrado sus niveles de actividad física de forma objetiva (podómetros/ acelerómetros) en ambos momentos de tiempo (T0 y T1).

El **artículo V** incluyó información procedente de 4.836 niños (51.8% chicos), en la que se requería que los padres de los participantes hubieran registrado la información relativa a las percepciones, conocimiento y reglas de ellos mismos sobre las recomendaciones del tiempo de pantalla y el tiempo que sus hijos destinaban a las mismas tanto entre semana como en fin de semana, en ambos momentos de tiempo (T0 y T1).

6.2 Comités de ética

El estudio ToyBox se realizó siguiendo las pautas éticas de la Declaración de Helsinki y las convenciones del Consejo de Europa sobre los derechos humanos y biomedicina. El protocolo del estudio fue aprobado por los comités éticos locales correspondientes para cada centro participante en el estudio. En el caso de Zaragoza, fue aprobado por el Comité Ético de Investigación Clínica de Aragón (CEICA). Los padres o tutores legales de los niños participantes en el estudio firmaron un consentimiento informado mostrando su aceptación para la participación en el estudio.

6.3 Métodos de medida

6.3.1 Factores socio-demográficos (Artículo II-V)

Los padres y/o tutores respondieron a un cuestionario general, mediante el cual se obtuvo información sociodemográfica como la edad y el género de los participantes, entre otros aspectos. A través del mismo cuestionario se obtuvo información acerca del nivel educativo y la ocupación laboral de los padres y/o tutores. Para los análisis estadísticos se utilizó como variable de ajuste la educación de la madre, identificado como uno de los mejores indicadores de estatus socioeconómico (63, 64). Los niveles de educación de la madre y del padre (años de educación) se obtuvieron a través de la siguiente pregunta: ¿Cuántos años de educación habéis completado tu pareja y tú? Por favor, marca una opción para ti y

una opción para tu pareja (no cuentes los años de preescolar y empieza a contar desde los 6 años). La respuesta estaba dividida en cinco categorías: <7 años, 7–12 años, 13–14 años, 15–16 años y más de 16 años. Para los análisis las variables fueron re-categorizadas en tres variables considerando de <7 a 12 años nivel de educación bajo, de 13 a 16 años nivel medio y más de 16 años el nivel más alto de educación.

6.3.2 Antropometría (Artículo II-V)

La valoración antropométrica fue realizada por personal del estudio previamente entrenado. El peso (kilogramos, kg) se midió con una báscula electrónica (SECA 861 y SECA 813; Seca, Hamburgo, Alemania). La altura (centímetros, cm) se midió mediante un estadiómetro telescópico (SECA 225 y SECA 214; Seca, Hamburgo, Alemania) y la circunferencia de cintura mediante una cinta métrica (tipos SECA 200 y SECA 201; Seca, Hamburgo, Alemania). Se midieron a los participantes en ropa interior y sin zapatos. Para cada participante se calculó el índice de masa corporal dividiendo el peso en kg por la altura en metros al cuadrado. A continuación se calcularon los correspondientes valores normalizados (z-score) para la edad y el género, y se clasificaron de acuerdo a los puntos de corte desarrollados por Cole y cols (65).

6.3.3 Consumo de alimentos y bebidas (Artículo II, III y IV)

Para valorar los hábitos alimentarios de los niños participantes, los padres rellenaron un cuestionario semi-cuantitativo de frecuencia de consumo que comprendía 44 ítems, abordando así los patrones de consumo de alimentos y bebidas relevantes para los objetivos de la intervención del estudio ToyBox. Además, el cuestionario incluía siete preguntas sobre los alimentos y bebidas consumidas entre las comidas principales, así como el consumo de suplementos. El cuestionario fue validado, observándose una validez relativa de baja a moderada que varía según el grupo de alimentos y bebidas; las correlaciones estimadas

oscilaron entre 0,52 y 0,79 (66). El consumo de alimentos y bebidas se expresó como número de porciones por semana. Los padres debían de rellenar para cada uno de los grupos de alimentos y bebidas la cantidad media consumida que su hijo/a había tenido en los últimos dos meses. Las categorías de respuesta para cada ítem incluían las siguientes categorías: "nunca o menos de una vez al mes", "1 a 3 días al mes", "1 día a la semana", "2 a 4 días a la semana", "5 a 6 días a la semana" y "todos los días". El cuestionario incluía la estimación del tamaño de las porciones para guiar a los padres en sus respuestas. Para los análisis estadísticos y permitir comparaciones, el número de porciones a la semana y al día fue calculado equiparando el "número de veces por día" tal como se informa en el FFQ a "número de porciones por día". Se multiplicó la frecuencia de consumo por el tamaño de la porción de cada alimento.

6.3.4 Comportamientos sedentarios (Artículos II-V)

Los padres y/o tutores registraron la informaron relativa al tiempo que pasaban sus hijos viendo la TV/DVDs, jugando a la consola o al ordenador y jugando de forma pasiva con muñecas, coches etc. Cada una de las actividades se preguntaban de forma separada y de forma específica para los días entre semana y de fin de semana, de la siguiente forma: "¿Cuántas horas al día ve tu hijo/a habitualmente la TV (incluyendo DVD y videos) en su tiempo libre?", "¿Cuántas horas al día está tu hijo/a habitualmente utilizando el ordenador para jugar, también con consolas (por ejemplo, PlayStation, Xbox) durante su tiempo de ocio?" y "¿Cuántas horas al día juega tu hijo/a de manera pasiva (mirando, leyendo libros, jugando con muñecas, a coches, pintando, construcción) durante su tiempo de ocio?". Los padres debían seleccionar una de las siguientes categorías: "Nunca", "<30 minutos al día", "30 minutos a <1hora al día", "1-2 horas al día", 3-4 horas al día" "5-6 horas al día", "7-8 horas al día", "8 horas al día", "> 8 horas al día" y "no lo sé". Los intervalos de tiempo fueron re-categorizados a minutos de manera que cuando la respuesta era "nunca", los minutos fueron 0, "<30 minutos al día" equivalía a 15 minutos, "30

minutos a <1hora al día" equivalía a 45 minutos, "1-2 horas al día" equivalía a 119.5 minutos, 3-4 horas al día" siendo 239.5 minutos, "5-6 horas al día" 359.5 minutos, "7-8 horas al día" equivalía a 449.5 minutos, "8 horas al día" siendo 509.5 minutos, "> 8 horas al día" equivalía a 540 minutos y por ultimo cuando la respuesta era "no lo sé" se suponían como valores perdidos en el sistema.

El tiempo de pantalla total diario se calculó como: (5 * tiempo dedicado los días entre semana + 2 * tiempo dedicado los días de fin de semana) / 7. En base a las recomendaciones de comportamientos sedentarios de las guías australianas y canadienses, y recientemente las recomendaciones de la Organización Mundial de la Salud (OMS) que establecen que los niños en edad preescolar deben limitar su tiempo frente a la pantalla a un máximo de 1 hora por día (19, 50, 67), se agruparon los participantes del estudio en dos grupos, ≤1 h por día (aquellos que cumplían las recomendaciones) y > 1 h por día (aquellos que excedían las recomendaciones).

6.3.5 Actividad física (Artículo III y IV)

La actividad física (AF) fue evaluada de forma subjetiva mediante el cuestionario general que los padres rellenaban, y de forma objetiva mediante el número de pasos al día, registrado con podómetros Omron Walking Style Pro (HJ-720IT-E2), excepto en Bélgica, que los pasos se evaluaron mediante acelerómetros ActiGraph (Pensacola, FL). Los participantes llevaron los dispositivos en la cadera derecha, durante seis días consecutivos, incluidos dos días de fin de semana.

En el **artículo III** la AF sólo se evaluó a través del cuestionario, seleccionando la pregunta que registraba la participación deportiva extracurricular a través de la siguiente pregunta: "¿Cuánto tiempo está tu hijo/a practicando deporte en el club deportivo a la semana?" Los padres y/o tutores debían reportar el número de horas que su hijo/a practicaba AF en clubs deportivos a la semana. La evaluación de la AF a través de 'deportes participación' fue identificada en estudios europeos previos mostrando la mayor correlación con la AF moderada e intensa medida con acelerometría (68).

Para el **artículo IV** se utilizaron los pasos registrados mediante los podómetros y los acelerómetros categorizados en base al punto de corte de 11500 pasos por día, que estaban correlacionados con las recomendaciones diarias de AF, basados en los estudios de Reilly y cols. (69) y De Craemer y cols. (70). Aquellos que cumplían con las recomendaciones eran los que realizaban ≥11500 pasos/día, y aquellos que no las cumplían <11500 pasos/día.

6.3.6 Sueño (Artículo III)

Los padres y/o tutores informaron sobre el número de horas y minutos que sus hijos dormían de media, por noche, atendiendo a las diferencias entre los días de entre semana y los días de fin de semana. Para calcular el promedio de sueño diario se hizo a través de la siguiente formula: (5 * valores de la semana + 2 * valores de fin de semana)/ 7.

6.3.7 Percepción, conocimiento y reglas de los padres (Artículo V)

Las percepciones, conocimiento y reglas de los padres se recopilaron mediante el cuestionario general a través de las siguientes afirmaciones: “Los niveles de visualización de televisión de mi hijo/a se encuentran dentro de las recomendaciones apropiadas", "Creo que es necesario limitar las actividades de visualización de pantalla para mi hijo/a” y “A mi hijo/a se le permite ver la televisión todo el tiempo que quiera”. Las tres preguntas tenían las siguientes categorías de respuesta: "Totalmente en desacuerdo", "En desacuerdo", "Ni de acuerdo ni en desacuerdo", "De acuerdo" y "Muy de acuerdo". Para el análisis de la información, se agruparon las respuestas en tres categorías, siendo las siguientes: "En desacuerdo" incluyendo las categorías "totalmente en desacuerdo" y "en desacuerdo"; "Ni de acuerdo ni en desacuerdo", y "De acuerdo", que incluía las categorías "muy de acuerdo" y "de acuerdo".

Por último, el conocimiento de los padres y/o tutores sobre las recomendaciones sobre comportamiento sedentario en niños en edad preescolar se evaluó a través de la siguiente pregunta: “Creo que la recomendación para ver la televisión para niños

de 4 a 6 años es", la cual incluía nueve respuestas posibles: "No ver la televisión en absoluto", "Ver la televisión no más de unas pocas veces por semana", "Ver la televisión durante 1 a 2 h por día", "Ver la televisión de 3 a 4 h por día", "Ver la televisión de 5 a 6 h por día", "Ver la televisión de 7 a 8 h por día", "Ver la televisión durante más de 8 h por día", "Ver la televisión con la frecuencia que quiera" y "No sé". Para los fines del análisis y en base a las recomendaciones, se reclasificaron en cuatro categorías; "≤ 1 h / día", "> 1 h a ≤ 3 h / día". "> 3 h / día" y "No sé".

6.4. Análisis estadístico: consideraciones generales

Las características generales de los participantes, se presentan en forma de porcentajes en el caso de las variables categóricas y como media y desviación estándar para el caso de las variables continuas. Las diferencias entre género y edad para las variables continuas se analizaron mediante análisis de varianza (ANOVA) o test de muestras independientes (t de Student); para el caso de las variables categóricas se analizaron mediante el test Chi-cuadrado.

El análisis de covarianza (ANCOVA) junto con el test de Bonferroni (**Artículo II y IV**) se usó para analizar el consumo de alimentos y bebidas (porciones por día y semana) y los respectivos comportamientos sedentarios ajustado por país, la educación de la madre y el IMC. En el **artículo IV,** además de estas variables, se ajustó también por el género y la edad ya que la muestra se estudió en dos periodos de tiempo. En el **artículo V** se utilizó el análisis de ANCOVA para presentar las medias del tiempo de visualización de TV/video/DVD y el tiempo de pantalla total, en función de las percepciones, conocimiento y reglas de los padres y/ o tutores. El análisis se ajustó por la educación de la madre, z-IMC en T1, género, edad y país de origen.

Para el **Artículo II** se utilizó un modelo lineal generalizado para evaluar la asociación entre los comportamientos sedentarios y el consumo de alimentos y bebidas ajustado por la educación de la madre, IMC y país de origen.

El análisis de conglomerados o clusters (cluster analysis) **(Artículo III)** se utilizó para agrupar a los participantes e identificar grupos con comportamientos de estilo de vida similares. Se evaluó la estabilidad de los agrupamientos obtenidos siguiendo el modelo de ward, seguido de k-medias dividiendo aleatoriamente la muestra en dos partes y repitiendo el análisis de clusters valorando la estabilidad de los grupos. Las nuevas agrupaciones fueron comparadas con el original y se encontró una excelente concordancia (κ de Cohen valores = 0.95). Posteriormente, una regresión logística multinivel fue aplicada estimando las Odds Ratio (OR) para explorar la probabilidad de pertenecer a cada agrupación de estilo de vida en función del nivel de educación de la madre, padre o ambos.

El consumo medio de diferentes tipos de alimentos y bebidas y su relación con las recomendaciones de tiempo de comportamientos sedentarios y de actividad física diaria se analizaron con un modelo lineal de efectos mixtos controlado por el efecto del país de origen **(Artículo IV)**. Ajustado por la educación de la madre, z-IMC, género y país de origen.

Por último, el análisis de regresión logística multinivel (**Artículo V**) se utilizó para valorar la probabilidad de exceder o no las recomendaciones de tiempo de pantalla en función de las percepciones, conocimiento y reglas de los padres en dos puntos temporales, controlando por el efecto del país de origen y el nivel socioeconómico.

Todos los análisis estadísticos se realizaron con el paquete estadístico SPSS versión 20 excepto la regresión logística multinivel que se realizó utilizando Stata / SE 13 (Stata Corp LP, College Station, TX, EE.UU) (**artículo V).** Como norma general, el nivel de significación se estableció en el 5%.

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

7. Resultados

Los resultados y discusión de la presente Tesis Doctoral quedan reflejados en los siguientes artículos científicos.

7. Results

The results and discussion of this Doctoral Thesis are shown in the following research manuscripts.

Paper I:

Associations between pedometer-determined physical activity and adiposity in children and adolescents: Systematic Review

Asociación entre la actividad física valorada por podómetros y la adiposidad en niños y adolescentes: Revisión Sistemática.

Associations Between Pedometer-Determined Physical Activity and Adiposity in Children and Adolescents: Systematic Review

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Abstract

Objective: The present review sought to examine the evidence on the associations between pedometer-determined physical activity and adiposity. **Design:** Of 304 potentially eligible articles, 36 were included. A search for observational studies was carried out using Cochrane Library (CENTRAL), the OVID (MEDLINE, Embase, and PsycINFO), EBSCOhost (Sportdiscus), and PEDro database from their commenced to July 2015. Of 304 potentially eligible articles, 36 were included. **Results:** Most studies (30/36; 83%) were cross sectional and all used proxies for adiposity, such as body mass index (BMI) or BMI z-score as the outcome measure. Few studies (2/36; 6%) focused on preschool children. There was consistent evidence of negative associations between walking and adiposity; significant negative associations were observed in 72% (26/36) of studies overall. **Conclusions:** The present review supports the hypothesis that higher levels of walking are protective against child and adolescent obesity. However, prospective longitudinal studies are warranted; there is a need for more research on younger children and for more "dose-response" evidence.

Key Words: pedometers, physical activity, obesity

(*Clin J Sport Med* 2017;0:1–12)

INTRODUCTION

A high proportion of youth in Europe and the United States do not meet current physical activity (PA) guidelines, highlighting the importance of promoting a physically active lifestyle among youth, despite the increasing recognition of the health benefits associated with PA participation.[1] Physical activity levels play a determinant role in the onset and development of obesity as well as in the maintenance of overall health in youth.[2] The use of objective methods for measuring PA has been highlighted as necessary for a proper understanding of associations of PA with health-related parameters such as adiposity.[1]

Since pedometers were suggested for the first time in 1997 as a potential tool for monitoring daily or weekly PA in children,[2] several reviews have been focused on the utility of pedometers for measuring PA.[3–9] Pedometers have been used successfully in a variety of ways to promote PA among youth,[6] and the validity of pedometers has been studied in depth, raising this method as appropriate.[3,4,7–9] Moreover, Tudor-Locke et al[5] revised the evidence on the number of steps per day which should be recommended and concluded that this should range from approximately 12 000 to 16 000 and from 10 000 to 14 000 steps per weekday in boys and girls, respectively (on weekend days allowing for an average decrease of 2000 steps/d). Duncan et al[10] proposed a similar optimal step count cutoff point based on associations with body fat (16 000 and 13 000 steps/d for boys and girls, respectively).

In recent years, there has been an increased interest in objective monitoring of daily PA using simple and inexpensive methods; however, it is not clear whether pedometers could provide a suitably accurate estimate of PA to enable the detection of a significant association with adiposity or not. Jiménez-Pavón et al,[1] who reviewed the literature in 2008, found consistent evidence of negative associations between objectively measured physical activity and adiposity, although few studies used pedometers at that time. More recent reviews on associations between objectively measured PA, particularly moderate-to-vigorous PA (MVPA), and adiposity have noted a very limited evidence base.[11]

The wide variety of accelerometer data reduction methods in the literature also means that it is difficult to determine a dose–response association between accelerometer measured MVPA and adiposity. Walking behavior, as measured by pedometers, is a much simpler concept than MVPA, leading to simpler measurement and lending itself to simpler translation to public health messages. Therefore, because of the growing number of studies using pedometers, and the public health value of walking as a concept, and the practical utility of pedometers in population-based approaches to obesity prevention, an updated revision regarding the association of PA determined by pedometers and adiposity would be of interest. In the present review,

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the main objective was to systematically review the original studies investigating the relationship between walking and adiposity of children and adolescents.

METHODS

The protocol used for the systematic review is Preferred Reporting Items for Systematic reviews and Meta Analyses (PRISMA).[12] For the assessment of the quality of the included studies where it are shown in the Table 3, was used The Evidence Analysis Manual was created by the Academy of Nutrition and Dietetics.[13]

Search Strategy

The search was conducted in the following databases—Cochrane Library (CENTRAL), the OVID (MEDLINE, Embase, and PsycINFO), EBSCOhost (Sportdiscus), and PEDro—from the beginning to July 2015. PubMed database was also used for double checking. The search period was chosen as pedometer usage is recent, and we wanted to include all the literature available. In addition, manual searching of reference lists were carried out and results combined in EndNote. Keywords used were "pedometer" and "pedometer and physical activity."

The searches by these terms resulted in 304 potentially eligible articles, from which duplicates, checking titles, and

TABLE 1. Recent Longitudinal/Intervention Studies of Associations Between Walking Behavior by Pedometers and Adiposity in Youth

Study	Exposure Variable	Outcome Variable	Location/Participants	Conclusions	Overall Result
14	Number of daily steps 7 days, waking hours (pedometer Digiwalker SW-200)	Continuous variable	N = 589 children (310 intervention, 287 boys) aged 7-11 years at baseline 10 months intervention, Northeast of England	Both control and intervention participants had increased their physical activity at follow-up. There was no clear effect of increased PA on body composition.	(NA)
		BMI			
		WC			
		SC and TC skinfolds			
		% body fat			
16	Number of daily steps 4 consecutive weekdays (Yamax pedometers Digiwalker SW-200, Tokyo, Japan)	Continuous variable	N = 93 children aged 7-14 years at baseline 3-year follow-up, Sweden	Year 3: an SIG increase in BMI in boys and girls, while an SIG decrease in daily steps in. boys were found.	—
		BMI			
17	Number of daily steps 7 consecutive days (5 times) (Yamax Digiwalker SW-200)	Categorical variable	N=177 children (89 intervention, 45 boys) aged 6-9 years at baseline 2-year intervention, The Czech Republic	Year 1: PA increase and the odds of being overweight or obese in the intervention children were almost 3 times lower than that of control children. Year 2: these odds steadily decreased with the duration of the intervention.	—
		Obesity			
		Overweight			
		Normal weight			
19	Number of daily steps 8 consecutive days (Yamax pedometer, Tokyo, Japan, MLS-2000)	Continuous variable	N = 606 (315 girls) aged 9.8 years at baseline 12-week intervention, Arizona, United States	Results indicated the treatment was effective at increased PA level of children, especially girls. NSIG differences between were found for BMI.	(NA)
		BMI			
20	Number of daily steps 4 days (including weekend day) (Yamax Digiwalker SW700, Tokyo, Japan)	Categorical variable	N = 85 girls, aged 16 year, 12-week intervention, Australia	PA increases do not provide postintervention changes in any group for BMI.	(NA)
		Obesity			
		Normal weight			
		Underweight			
18	Number of daily steps 7 days (pedometer Omron HJ-720ITC; Omron Healthcare, Lake Forest, Illinois)	Continuous variable	N = 285 children (147 intervention and 138 control) aged 6-12 years at baseline 9-month intervention, Singapore	PA increases do not provide changes in BMI	(NA)
		BMI			

BMI, body mass index; PA, physical activity; NSIG, no significant; SIG, significant; SC, Subscapular, TC, triceps; WC, waist circumference.

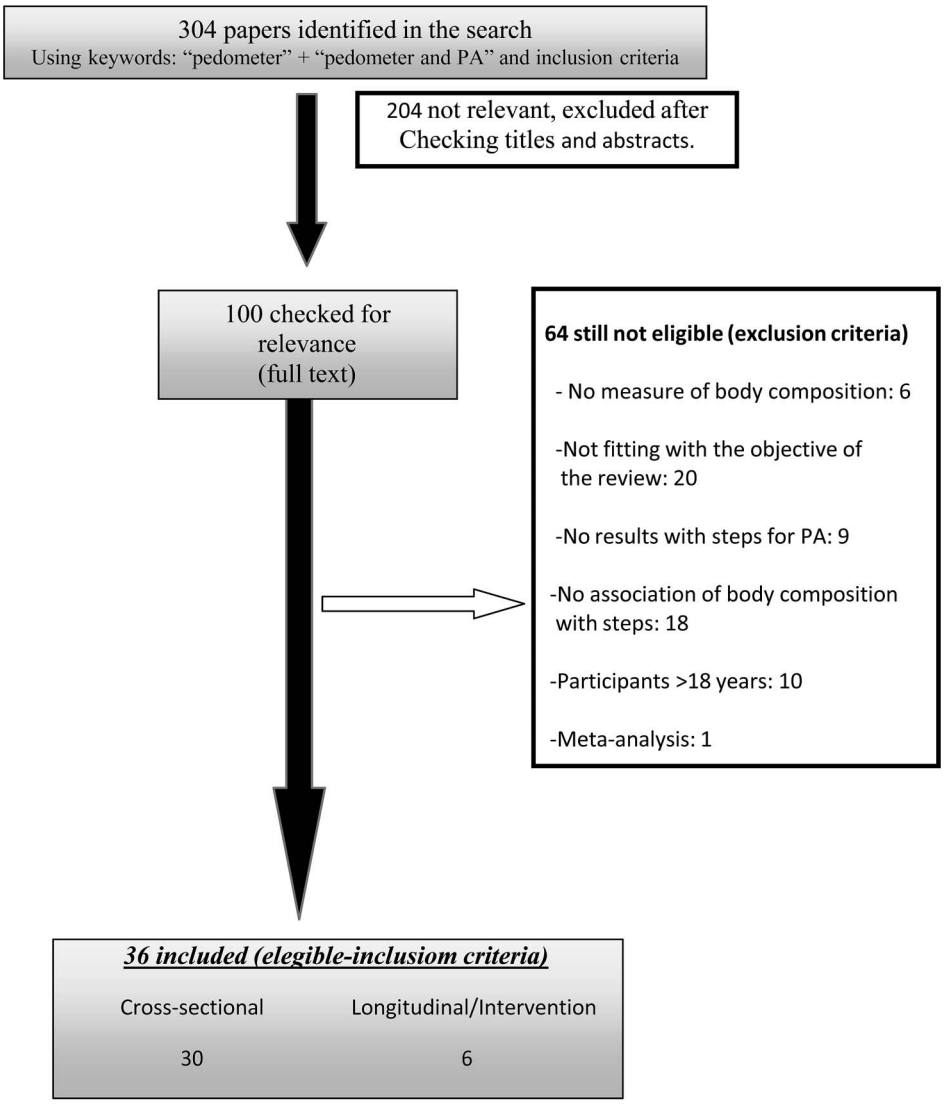

Figure 1.
Flow diagram of the literature search and article selection.

abstracts were eliminated by applying the inclusion and exclusion criteria derived in the final eligible articles (Figure 1).

Eligibility Criteria

Eligible studies were longitudinal and cross-sectional observational studies of healthy children and adolescents (0-18 years) that tested for the existence of associations between walking using pedometers and adiposity. Studies were only included when they attempted to measure typical or "habitual" freeliving PA; studies that measured PA in confined conditions (eg, within whole-body calorimeters) were excluded. Community-based (nonclinical) studies with a measure of walking (pedometer-determined) as the exposure variable and with at least one weight-based outcome indicative of adiposity were included. Studies that used, exclusively, other objective methods for PA such as accelerometry or heart rate monitor were excluded. Studies in clinical populations, not in the English/Spanish languages, or proxy measures of habitual PA (eg, physical education time) were also excluded. In addition, duplicate publications were excluded, and in all cases of duplicates, the first publication was selected for inclusion. Doubts over eligibility of individual articles/studies were resolved by discussion and consensus between the authors. Reasons for excluding articles were noted and are available from the corresponding author on request.

Data Management and Extraction

Characteristics of each study were extracted and summarized: the exposure variable (s) used; methodology for measurement of the exposure variable; the outcome variable (s) used; methodology for measurement of the outcome variable (s) (adiposity measure, proxy, or index); sample size, location, and characteristics; and results and main conclusions relevant to the present review.

Sensitivity Analyses

Age of Study Participants

Studies were stratified by age range of study participants into preschool children (up to 5.5 years), children (5.5-10.5

TABLE 2. Cross-Sectional Studies of Associations Between Walking Behavior by Pedometers and Adiposity in Youth

Study	Exposure Variable	Outcome Variable	Location/Participants	Conclusions	Overall Result
43	Number of daily steps, 4 consecutive weekdays (Yamax, SW-200, Digiwalker, Tokyo, Japan)	Categorical variable	N = 871 children, aged 7-9 years, Sweden.	Analysis of step counts and BMIs for boys and girls revealed NSIG correlations in any age group.	(NA)
		Overweight/obesity			
		Normal weight			
45	Number of daily steps, 7 days (Digiwalker 200SW)	Continuous variable	N = 120 children, aged 9-11 years, United States.	Overweight children were more sedentary at baseline than underweight and normal weight children (cross-sectional data)	—
		BMI (kg/m^2)			
30	Number of daily steps, 7 days (at least 4 days; 3 weekdays and 1 weekend) (Yamax Digiwalker SW-200)	Continuous variable	N = 301 (153 boys) aged 6-9 years, Dublin.	Significant differences were found in normal and overweight, and normal and obese children's step counts	—
		BMI (kg/m^2)			
33	Number of daily steps, 3 weekdays and 2 weekend days (pedometers Model NL-2000, New Lifestyles)	Categorical variable	N = 1115 children (536 boys) aged 5-12 (8.5) years, New Zealand.	Categorical variable	—
		Normal weight		SIG difference in weekend PA among the weight status categories	
		Overweight			
		Obesity			
		Continuous variables		Continuous variables	
		BMI (kg/m^2)		SIG negative associations between PA and %BF, BMI, and WC. Stronger association with %BF categories	
		WC			
		% BF (by BIA)			
35	Step count quartiles– I: <10 000; II: 10 000-12 000; III: 12 000-14 000; and IV: >14 000, 7 days (at least 4 days; 3 weekdays and 1 weekend). (Digiwalker 200SW)	Categorical variables	N = 608 children, aged 9.6 years, United States.	Categorical variables	—
		Overweight		SIG increase in odds of overweight and obesity and high WC with lower count quartiles	
		Obese			
		Continuous variables		Continuous variables	
		BMI (kg/m^2)		SIG negative associations between step count, BMI, and WC	
		WC			
36	Number of daily steps, 3 days (pedometer Yamax Digiwalker SW-200)	Categorical variables	N = 315 children (162 boys), aged 9-13 years, London.	Categorical variables	—
		Underweight		Male and female obese individuals had the lowest total step counts per day	
		Normal weight			
		Overweight			
		Obese			
		Continuous variables		Continuous variables	
		BMI Z-score		There was a SIG negative correlation between BMI z-scores and number of steps per day in girls	
39	Number of daily steps, 7 days (at least 4 days; 3 weekdays	Categorical variables	N = 709 children, aged 7-12 years, United States.	Categorical variables	—

TABLE 2. Cross-Sectional Studies of Associations Between Walking Behavior by Pedometers and Adiposity in Youth *(Continued)*

Study	Exposure Variable	Outcome Variable	Location/Participants	Conclusions	Overall Result
	and 1 weekend) (pedometer Digiwalker SW-200)				
		Underweight		Boys and girls accumulating fewer than 13 000 and 11 000 steps per day, respectively, were 2.74 and 2.37 times more likely to be overweight than those that met the recommendations	
		Normal weight			
		Overweight			
		Obese			
		Continuous variables		Continuous variables	
		BMI		There was a SIG negative correlation between BMI and number of steps per day in boys and girls	
32	Number of daily steps, 3 weekdays (pedometer Yamax SW-200 Digiwalker, Yamasa Corp., Tokyo, Japan)	Continuous variables	N = 178 children, aged 9-12 years, Canada.	BMI z-score and WC were negatively correlated with pedometer step counts	—
		BMI z-score			
		WC z-score			
34	Number of daily steps, 4 consecutive days (2 weekdays, 2 weekend days) (pedometer New Lifestyles, NL-2000, Montana, USA)	Categorical variables	N = 496 children (224 boys) aged 8-14 years, England.	Categorical variables	—
		Normal weight		PA in the weekdays SIG decreases across weight status categories in children	
		Overweight			
		Obese			
		Continuous variables		Continuous variables	
		BMI		Mean steps taken during weekend days are SIG associated with reduced BMI and LBMI in children	
		LBMI			
28	Number of daily steps, 3 consecutive weekdays (pedometer Digiwalker)	Categorical variables	N = 224 (109 boys) aged 3, 4-6, and 4 years, Arabia Saudi.	Categorical variables	(NA)
		Nonobese		Nonobese children had higher steps count per day than obese peers (7064.5 versus 5374.6), but the difference was NSIG.	
		Obese			
		Continuous variables		Continuous variables	
		Sum of 2 SC and TC		No differences were found between active (≥10 000) and inactive children for any of the adiposity indexes calculated	
		FMI			
		%FM			
		FM			
		FFM			
		FFMI			
38	Number of daily steps, 8 days (at least 4 days) (pedometer Yamax Digiwalker SW-700)	Categorical variables	N = 1539 adolescents (787 boys) aged 9-16 years, Australia.	Categorical variables	—

TABLE 2. Cross-Sectional Studies of Associations Between Walking Behavior by Pedometers and Adiposity in Youth *(Continued)*

Study	Exposure Variable	Outcome Variable	Location/Participants	Conclusions	Overall Result
		Normal vs high trunk fat (WC)		There were a trend to higher levels of PA in normal weight group compared with the ow/ob group, but only SIG in the age groups 9-10 and 9-11 years in boys and girls, respectively. Similarly, those with normal trunk fat had higher PA levels compared with those with high trunk fat in age groups 15-16 and 7-12 years in boys and girls, respectively	
		obese versus normal weight			
		Continuous variables		Continuous variables	M (-), F (NA)
		BMI		There was no relationship between BMI and mean daily steps count for either male or females and only a small but significant relationship between WC and PA for males	
		WC			
27	Number of daily steps, 3 continuous weekdays (pedometer Yamax Digiwalker SW-701)	Categorical variables	N = 296 children aged 8-12 years, Arabia Saudi.	Categorical variables	—
		Obese versus normal weight		Mean step counts for the obese group were significantly lower than in the normal group	
		Obesity (>25% FM) versus normal weight		Continuous variables	
		Continuous variables			
		TC and SC skinfolds		There were SIG differences between active (>13 000 steps/day) and inactive boys in body weight, BMI, triceps and subscapular skinfolds, % FM, and FMI	
		FM			
		FMI			
29	Number of daily steps, 4 consecutive weekdays (pedometer Walk4Life MLS 2525, Plainfield, IL, and YAMAX SW-200, Tokyo, Japan for the 60% and 40% of the sample, respectively)	Categorical variables	N = 1067 children (434 boys) aged 6-12 years, United States.	Descriptive information shows a tendency to lower levels of PA in those at risk of overview compared with normal weight, but no statistical analyses were performed. Further analyses showed that steps counts were unable to distinguish between youth in a healthy or unhealthy weight.	(NA)
		Normal weight			
		At risk of an overweight			
41	Number of daily steps, 7 days (pedometer Lifecorder EX, Suzuken Co., Nagoya, Japan)	Continuous variables	N = 216 (105 boys) aged 9-10 years, Japan.	The steps counts were negatively correlated with obesity indices in both sexes (stronger in girls)	—
		BMI			
		%BF by BIA			
42	Number of daily steps, 2 weekdays (pedometer Yamax SW-200 Digiwalker, Yamasa Corp., Tokyo, Japan)	Categorical variables	N = 82 adolescents (34 males) aged 9-12 years, E Canada.	The pedometer step counts did not differ among body weight categories	(NA)
		Normal weight			
		Overweight			
		Obese			

TABLE 2. Cross-Sectional Studies of Associations Between Walking Behavior by Pedometers and Adiposity in Youth *(Continued)*

Study	Exposure Variable	Outcome Variable	Location/Participants	Conclusions	Overall Result
40	Number of daily steps, 3 days (electronic pedometer, Yamasa, Japan)	Categorical variables	N = 30 children, aged 12 years, Japan.	Categorical variables	—
		Obese vs nonobese (>30% BF)		There was significant difference in step counts per day between the obese and the nonobese.	
		Continuous variables		Continuous variables	
		% BF (from skinfolds)		There was a correlation between the pedometer step counts and the percentage of body fat	
46	Number of daily steps, 4 consecutive weekdays. Yamax pedometers (namely as My Life Stepper MLS-2000; or New Lifestyles Digiwalker SW-200)	Categorical variables	N = 1954 children aged 6-12 years, United states, Australia, and Sweden	The direction confirms the intuitive expectation that children who are less active tend to have higher values of BMI. Correlation analysis found few SIG negative relationships between step counts and BMI with an age- and country-specific effect	—
		Normal weight			
		Overweight/obese			
		Continuous variables			
		BMI			
31	Average of daily steps, 5-8 days (Yamax Digiwalker SW-701)	Continuous variables BMI	N = 297, aged 13-15-years, Australia	SIG negative association between BMI and PA	—
47	Average of daily steps, 6 days (Yamax SW-200)	Continuous variables	N = 296 (163 girls, 129 boys), aged 11-14 years, United states.	SIG negative association between %BF and PA	—
		% Body fat			
44	Average of daily steps, 4 consecutive days (Yamax SW700 Digiwalker)	Categorical variables	N = 415 girls, aged 16 years, Australia.	The girls who achieved less than 10 000 steps/day were SGI more likely to be overweight or obese	—
		Underweight			
		Normal weight			
		Overweight			
		Obese			
37	Number of daily steps, 4 days (1 weekend) (Yamax Digiwalker SW-200; Tokei Keiki Co. Ltd., Tokyo, Japan)	Continuous variable	N = 1585 adolescents (771 girls, 814 boys), aged 14 years, Australia.	BMI did not significantly correlate with physical activity for the males and females. Multiple regression analyses showed aerobic fitness and body composition were significant predictors of PA only for males	(-, only males)
		BMI			
10	Number of daily steps, 3 weekdays and 2 weekend days. (Model NL-2000, New Lifestyles Inc., Lee's Summit, MO)	Continuous variables	N = 969 children (454 boys, 515 girls), aged 5-12 years, Auckland, New Zealand.	Children classified as overweight using %BF had significantly lower step counts than their nonoverweight counterparts.	—
		BMI			
		% Body fat			
21	Average of daily steps, 5 consecutive days, (Yamax SW-200)	Continuous variable	N = 829 students (400 boys, 429 girls), aged 9.6 years, University Review Board.	Normal weight children had higher step counts than obese children. Normal weight group had significantly more steps than the overweight group.	—
		BMI			
22	Number of daily steps, 2 weekdays and 2 weekend days (New Lifestyles, NL-2000; New Lifestyles Inc., MT, USA)	Continuous variable	N = 536 (255 boys, 281 girls) aged 9.6 years, Asian children.	BMI was negatively associated with steps/day	—
		BMI			

TABLE 2. Cross-Sectional Studies of Associations Between Walking Behavior by Pedometers and Adiposity in Youth *(Continued)*

Study	Exposure Variable	Outcome Variable	Location/Participants	Conclusions	Overall Result
23	Number of daily steps during 1 week. New Lifestyles SW-200 pedometers.	Continuous variable	N = 114 children, aged 8-12 years, United States.	Children with normal weight took 1858 more steps per day than children with overweight at day	—
		BMI			
24	Average of daily steps, 7 consecutive days (Yamax SW-200)	Continuous variable	N = 491 children (56.4% females) aged 7.9-11.9 years, Ottawa, Canada.	Weight status was not significantly correlated with step counts	(NA)
		BMI			
		Waist circumference			
25	Average of daily steps, 5 consecutive days. Yamax Digiwalker DW-200, Tokyo, Japan)	Continuous variable	N = 104 children (54 boys, 50 girls), aged 7.9-11.9 years, Cypriot.	Children with a BMI value above the 85th percentile scored significantly lower steps/d than children with a BMI value below the 85th percentile	—
		BMI			
26	Average of daily steps, 5 school days. (Yamax Digiwalker SW-200, New Lifestyles, Lee's Summit, Missouri).	Continuous variable	N = 916 (53% male), aged 5-6 years, Bronx, New York.	There were no statistically significant differences found in average number of steps taken per school day among normal weight, overweight, and obese students	(NA)
		BMI			
48	New Lifestyles 1000	Categorical variables	N = 2200 children, aged 9-16 years, Australia.	Thin adolescents walked significantly further than obese adolescents with the mean values of 10 916 steps/day and 9552 steps/day, respectively	—
		Underweight			
		Normal weight			
		Overweight			
		Obese			
49	Average of daily steps, 7 school days. The Yamax SW-200 (Yamax Corp., Tokyo, Japan)	Categorical variables	N = 133 children, aged 8-11 years, Midwestern US.	Children's BMI and BMI z-score were negatively correlated with pedometer steps. Overweight and obese children took fewer pedometer steps than normal weight children	—
		Normal weight			
		Overweight			
		Obese			
		Normal weight			

BMI, body mass index; FMI, fat mass index; LBMI, lean body mass index; ob, obesity; ow, overweigth; SC, Subscapular, TC, triceps; WC, waist circumference; PA, physical activity.

years), and adolescents (10.5-18 years) to examine possible age-dependence of relationships between walking and adiposity.[14] The precise age categories chosen made little difference to the conclusions of the present review.

Outcome Measure(s)

A variety of different measures of adiposity or indices of adiposity were used in the studies reviewed, falling into 2 categories: proxies for adiposity [body mass index (BMI) and waist circumference] and more precise measures of adiposity such as skinfolds thickness or bioelectrical impedance analysis (BIA).

Exposure Measure

The method used to measure PA was only pedometry. This has become a popular PA assessment tool,[10] capturing objective PA data,[8] specifically walking behavior.

2.7 Sample Size

The studies reviewed were characterized by a very wide range of sample sizes. Sample size is likely to determine the ability to detect associations between walking behavior and adiposity. Publication bias is also possible, and small studies that find no association between walking and adiposity are less likely to be published than small studies that find significant associations. In an attempt to address the influence of sample size on the confidence in any conclusions reached, studies were categorized by sample size in the present review as "large studies" $n > 1000$ participants; "medium sized studies," $n \geq 100$ to 1000 participants; and "small studies," $n < 100$ participants.

Consistency of Evidence

The scheme proposed by Sallis et al[15] was used to summarize the consistency of the body of evidence as

previously used to infer the degree of confidence in the conclusions. "Strong evidence" of an association exists when 60%-100% of studies find significant associations in the same direction.

RESULTS

Overall Results

Of the 304 potentially eligible articles, 36 were eligible and included and are summarized in the present review (Figure 1 is a flow diagram describing the search and selection process).

Only 17% (6/36) of eligible studies were longitudinal[14,16–20] (Table 1), from which 83% (5/6) were intervention studies. Most studies [83% (30/36)] were cross sectional[10,21–49] (Table 2). Only 6% (2/36) of studies focused on children younger than 5.5 years old. Most studies [80% (29/36)] included children and adolescents aged 5.5 to 10.5 years, whereas 5/36 (14%) studies included adolescents aged >10.5 to 18 years. However, all the studies included BMI as a proxy for adiposity, and 19% of studies (7/36) also measured waist circumference. However, only 25% (9/36) of studies used more precise measures of body composition such as skinfolds and/or BIA. The studies reviewed here consistently reported significant and negative associations between walking and adiposity (25/35; 71%), indicating "strong evidence" that such an association exists with higher levels of walking being associated with lower measures or indices of adiposity. In the cross-sectional studies, 24/30 (80%) of them found significant negative associations, and in the longitudinal studies, 2/6 (33%) of studies found significant negative associations while the other studies found a nonsignificant trend in the "expected" direction.

Results by Outcome Measure

Significant negative associations between pedometer-determined physical activity and adiposity were found in 16/23 (70%) of studies that used simple proxies for adiposity as the outcome measure and 10/13 (77%) of studies that used more precise body composition variables such as skinfolds and waist circumference as the outcome measure.

Results by Sample Size

7/36 (19%) of studies were "large" (n > 1000 participants), 25/36 (69%) "medium size" (n = 100-1000 participants), and 4/36 (11%) "small size" (n < 100 participants). 86% (6/7) of the large studies found significant negative associations, whereas the corresponding percentage was 72% (18/25) in the medium sized studies and 50% (2/4) in the small studies.

Results by Pedometers Model

Twenty of 36 (56%) of studies used the same pedometer model, the Yamax Digiwalker SW-200 series which has consistently been found among the most accurate of the pedometers. The Yamax SW-200 is recommended as a reliable monitor for use in children[2] and is the most commonly used pedometer to assess PA and walking among children.[49]

Only one meta-analysis was found, and the results support the fact that the use of pedometers has a moderate and positive effect on the increase of PA in intervention studies.

DISCUSSION

The studies summarized in the present review represent a large body of evidence that reported significant and negative associations between pedometer-determined physical activity and adiposity with a high degree of consistency, probably indicating "strong evidence" that such an association exists.[15] The present review therefore supports the view that variation in the level of walking in youth is a contributor to variation in weight status. This study supports the hypothesis that higher levels of walking are protective against increased adiposity in youth and so supports the use of walking as a promotion as a strategy for obesity prevention.

This study found a number of evidence gaps and weaknesses which future research could address. Relatively few studies tested for associations between pedometer-determined physical activity and adiposity in the preschool population, and among the studies on school-age children and adolescents, there were far fewer studies of adolescents than children. Many studies did not consider differences in associations between pedometer-determined physical activity and adiposity between the sexes, but it may be noteworthy that the evidence summarized here contained a suggestion that significant negative associations may be found more commonly among boys than girls and that associations may be stronger in boys than girls. Future research would be required to address the issue of sex differences more conclusively, but boys are usually more physically active than girls, as suggested by many reviews,[1,2,6,8,9,14,29,35,36,41,43] and in a previous systematic review of associations between accelerometer measured physical activity (not specifically walking) and adiposity in youth, there was a suggestion of consistently stronger associations in boys than girls.[1]

Numerous descriptive studies have implemented pedometers to assess weekday walking in children and adolescents, yet comparatively few have obtained separate data representing weekend days. The number of steps taken by children on the weekends is of particular interest, given the current evidence that young people are less active when outside the school environment.[3] The strong associations highlighted in this review provide support to the use of pedometers in studies of the etiology of obesity in youth, although the limitations of measuring only the numbers of steps should always be considered, and where resources permit alternative methods of measuring physical activity (eg accelerometry) should also be considered. Only one meta-analysis was found, and the results support the fact that the use of pedometers has a moderate and positive effect on the increase of PA in intervention studies.[50]

Publication bias may well have influenced the literature on associations between pedometer-determined physical activity and adiposity in youth. No formal test for publication bias was performed in this study, but the conclusions of larger studies (n > 1000) reviewed were actually more supportive (86% of studies found significant negative associations) of the hypothesis that higher levels of walking protects against high adiposity than the conclusions of smaller studies (n < 100; 50% of studies found significant negative associations), and this conclusion was independent of the method used to

TABLE 3. Quality Assessment of the Included Studies by the Evidence Analysis Manual

Author	Overall	Was the Research Question Clearly Stated?	Was the Selection of Study Subjects/ Patients Free From Bias?	Were Study Groups Comparable?	Was the Method of Handling Withdrawals Described?	Was Blinding Used to Prevent Introduction of Bias?	Were Intervention/ Therapeutic Regimens/ Exposure Factor or Procedure and Any Comparison Described in Detail? Were Intervening Factors Described?	Were Outcomes Clearly Defined and the Measurements Valid and Reliable?	Was the Statistical Analysis Appropriate for the Study Design and Type of Outcome Indicators?	Are Conclusions Supported by Results With Biases and Limitations Taken Into Consideration?	Is a Bias Due to Study's Funding or Sponsorship Unlikely?
14	+	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
16	+	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
17	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
19	−	Yes	No	No	No	No	Yes	No	No	Yes	No
20	+	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
18	Ø	Yes	Yes	N/A	No	No	N/A	No	N/A	Yes	No
43	Ø	Yes	Yes	N/A	Yes	No	Yes	Yes	Yes	Yes	Yes
45	+	No	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
30	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
33	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	N/A
35	−	Yes	Yes	No	No	No	No	N/A	Yes	Yes	Yes
36	Ø	Yes	Yes	N/A	Yes	No	Yes	Yes	Yes	Yes	N/A
39	Ø	Yes	Yes	N/A	No	No	Yes	Yes	Yes	Yes	Yes
32	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
34	+	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
28	Ø	Yes	Yes	N/A	No	No	Yes	Yes	Yes	Yes	Yes
38	Ø	Yes	Yes	N/A	No	No	Yes	Yes	Yes	Yes	N/A
27	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
29	Ø	Yes	Yes	N/A	No	No	Yes	Yes	Yes	Yes	N/A
41	−	N/A	Yes	No	No	No	No	N/A	Yes	Yes	N/A
42	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	N/A
40	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	N/A
46	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
31	Ø	Yes	Yes	No	No	No	N/A	Yes	Yes	Yes	Yes
47	−	Yes	Yes	No	No	No	Yes	No	No	No	Yes
44	Ø	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No
37	−	Yes	No	No	No	No	Yes	N/A	Yes	Yes	No
10	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	N/A
21	−	Yes	No	No	No	No	Yes	N/A	Yes	Yes	No
22	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	N/A
23	−	Yes	No	No	No	No	Yes	N/A	Yes	Yes	No
24	Ø	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No
25	Ø	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No
26	Ø	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No
48	+	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	N/A
49	−	Yes	No	No	No	No	Yes	N/A	Yes	Yes	No

categorize sample size. An additional limitation of the literature was that because of the predominance of cross-sectional studies, it is difficult to rule out bidirectionality–the possibility that higher adiposity might reduce walking. Greater confidence about causal relationships between pedometer-determined physical activity and adiposity would also require a greater body of evidence from longitudinal and intervention studies–the present review suggests that there is

a distinct lack of evidence from these study designs. Finally, the body of evidence identified from this study was too limited and too heterogeneous to attempt to assess "dose-response" relationships between physical activity and adiposity–future research should attempt to identify the "dose-response."

CONCLUSION

The present review supports the hypothesis that higher levels of walking behavior are against higher levels of child and adolescent adiposity. However, prospective longitudinal studies using more precise methods of body composition are warranted; there is a need for more research on younger children, in a wider variety of settings and populations, and for more "dose-response" evidence.

Detecting strong evidence of this association using pedometers not only implies its utility in monitoring walking levels but also could help us as a tool in promoting physical activity patterns by means of motivational aspects.

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Paper II:

Associations between food and beverage consumption and different types of sedentary behaviours in European preschoolers: the ToyBox-study

Asociaciones entre el consumo de alimentos y bebidas y diferentes tipos de comportamientos sedentarios en preescolares europeos: estudio ToyBox.

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ORIGINAL CONTRIBUTION

Associations between food and beverage consumption and different types of sedentary behaviours in European preschoolers: the ToyBox-study

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Abstract
Objective To examine the association between food and beverage consumption and time spent in different sedentary behaviours such as watching TV and DVDs, playing computer/video games and quiet play/activities in preschoolers.
Methods A sample of 6431 (51.8 % males) European preschoolers aged 3.5–5.5 years from six survey centres was included in the data analyses. Data on dietary habits and sedentary behaviours [watching TV, playing computer and quiet play (both during weekdays and weekend days)] were collected via standardized proxy-administered questionnaires. One-way analysis of covariance and general linear model (adjusted for sex, maternal education, body mass index and centre) were conducted.
Results The results of the generalized linear model showed that the more strong associations in both males and females who were watching TV for > 1 h/day during weekdays were positively associated with increased consumption of fizzy drinks ($\beta = 0.136$ for males and $\beta = 0.156$ for females), fresh and packed juices ($\beta = 0.069$, $\beta = 0.089$), sweetened milk ($\beta = 0.119$, $\beta = 0.078$), cakes and biscuits ($\beta = 0.116$, $\beta = 0.145$), chocolate ($\beta = 0.052$, $\beta = 0.090$), sugar-based desserts and pastries ($\beta = 0.234$, $\beta = 0.250$), salty snacks ($\beta = 0.067$, $\beta = 0.056$), meat/poultry/processed meat ($\beta = 0.067$, $\beta = 0.090$) and potatoes ($\beta = 0.071$, $\beta = 0.067$), and negative associations were observed for the consumption of fruits ($\beta = -0.057$, $\beta = -0.099$), vegetables ($\beta = -0.056$, $\beta = -0.082$) and fish ($\beta = -0.013$, $\beta = -0.013$). During weekend days, results were comparable.
Conclusions In European preschoolers, sedentary behaviours were associated with consumption of energy-dense foods and fizzy drinks. The present findings will contribute to improve the strategies to prevent overweight, obesity and nutrition-related chronic diseases from early childhood.

Keywords Sedentary behaviour · Food intake · Screen time

Abbreviations

BMI	Body mass index
FFQ	Food frequency questionnaire
ANCOVA	Analysis of covariance
CI	Confidence intervals

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Introduction

Obese children are at increased risk of becoming obese adults and of developing chronic diseases (type 2 diabetes and cardiovascular diseases) [1]. The preschool age is an important period for adopting healthy lifestyle behaviours including eating and physical activity habits [2]. Early adiposity rebound is strongly associated with increased body mass index (BMI) [3] and fatness in adolescence and forms a critical window of opportunity where the above-mentioned modifiable lifestyle behaviours can be targeted and potentially improved [4]. Parents and caregivers have a significant influence on the eating and physical activity habits of children. Families are such a prominent part of children's social environment, especially at such young ages; they may play an important role in determining sedentary behaviours as well as food intake [5].

Sedentary behaviour is defined as any waking behaviour characterized by low energy expenditure ($\leq$1.5 METs) [6]. Evidence suggests that the type of sedentary behaviour such as screen-based sedentary behaviours (e.g. TV watching, use of video games) may be more important in predicting childhood obesity to overall sedentary time [7]. A cross-sectional study in the Netherlands suggested that children (4–13 years) who watch TV > 1.5 h a day were 1.65 times more likely to be overweight [8]. There are few studies examining the relationship of multiple screen-based sedentary behaviours and the consumption of foods and beverages in young population groups [9]. In children and adolescents, TV watching is associated with lower fruit and vegetables and higher fizzy drinks consumption [10]. In European adolescents, Santaliestra-Pasias et al. [9] recently reported that increased TV viewing, computer and internet use were associated with higher odds of fizzy drinks consumption and lower odds of consuming fruit. During TV time, adolescents with high daily TV watching had high consumption of energy-dense foods and beverages such as fizzy drinks, savoury snacks and pastries [11].

Food consumption has been also shown to be determined by socioeconomic status (SES) such as parental education, household income and parental occupation [12, 13]. Children of parents from low income, occupation and education population groups tend to consume more sweets, fizzy drinks and less fruit and vegetables than their counterparts [14].

The aim of this study was to examine the association between time spent on different sedentary behaviours such as watching TV and DVDs, playing computer/video games and quiet play/activities such as looking into books, colouring, playing with dolls and/or cars and the consumption of a number of foods and beverages included in the food frequency questionnaire used in the baseline sample of the ToyBox-study. To the authors' knowledge, this is the first study conducted in European preschool population addressing such associations.

Methods

Study design

The ToyBox-study (www.toybox-study.eu) is a cluster-randomized study aiming to prevent obesity in preschool children and their families. It was conducted in six European countries, namely Belgium, Bulgaria, Germany, Greece, Poland and Spain [15]. The detailed protocol is described elsewhere [15, 16].

In total, 309 kindergartens and 7056 children aged 3.5–5.5 years were recruited at baseline [17]. Of those, 6431 children (51.8 % males) were included in the current study. Information on maternal education was obtained from a self-administered questionnaire (study's core questionnaire [18, 19]) including the number of years the mother studied. Mother's education level was divided in five categories such as less than 7 years, 7–12 years of studies, 13–14 years, 15–16 years and more than 16 years of mother studied. Parents/caregivers were informed about the study, and written informed consents were obtained. The ToyBox-study adhered to the Declaration of Helsinki and the conventions of the Council of Europe on human rights and biomedicine. In all countries, ethical approval was obtained from their respective ethical committees and local authorities [17].

Anthropometric measurements

Data collection was carried out in May–June 2012. Height and weight were measured by trained personnel. Weight was measured in underwear and without shoes with an electronic scale (Type SECA 861 or SECA 813) to the nearest 0.1 kg, and height was measured barefoot in the Frankfort plane with a telescopic height instrument Type SECA 225 or SECA 214 to the nearest 0.1 cm [20]. Intra-observer technical error had a reliability above 99 %, and inter-observer technical error had a reliability higher than 98 % [20]. BMI (kg m^{-2}) was calculated [21].

Sedentary behaviours

Data on children's sedentary behaviour were collected via a standardized proxy-administered questionnaire (i.e. Primary Caregivers' Questionnaire). Detailed information on the development of this questionnaire and on the data collection procedure is given elsewhere [18, 19]. Behaviours assessed included watching TV and DVDs,

playing computer/video games and quiet play/activities such as looking into books, colouring, playing with dolls and/or cars [18]. Parents/caregivers reported frequency both for weekdays and weekend days. The frequency categories included: 'never', 'less than 30 min/day', '30 min to 1 h/day', '1–2 h/day', '3–4 h/day', '5–6 h/day', '7–8 h/day', '8 h/day' and 'more than 8 h/day'. These answers were further aggregated into two categories including ≤1 h per day and >1 h per day. These categories are based on the Australian and Canadian sedentary behaviour recommendations for children stating that preschool children should limit their screen time to maximum 1 h per day [22, 23]. Average hours per day of TV/video viewing and personal computer use separately for weekdays and weekend days were summed up to obtain the screen time. Reliability of the sedentary questionnaire showed lower reliability [18].

Food and beverage consumption

Food and beverage consumption was assessed using a 37-item semi-quantitative food frequency questionnaire FFQ [19]. This questionnaire was based on a previously developed and validated FFQ for Flemish preschool children by Huybrechts et al. [24] and was adapted and validated for the purposes of the ToyBox-study. Low–moderate relative validity was observed which varied by food and beverage group; for some of the 'key' foods/drinks targeted in the ToyBox-intervention (e.g. water and soft drinks) however, the validity was good (unpublished data). In the current analysis, the 37 original food groups from the food frequency questionnaire were merged into 21 groups. Food groups were aggregated according to their nutritional content (main nutrient of protein, carbohydrates and fat).

Of those 21, 15 were chosen and entered in the current analysis based on their association with obesity development [25]: (1) water, (2) soft drinks and light drinks, (3) fresh fruit juices and packed juices, (4) sweetened milk, (5) milk and milk products, (6) dried, canned and fresh fruits, (7) raw and cooked vegetables, (8) cakes and biscuits, (9) chocolate and chocolate spreads, (10) sugar-based desserts and pastries, (11) salty snacks, (12) fish, (13) meat, poultry and processed meat, (14) pasta and rice and (15) potatoes. Food and beverage consumption was expressed by number of portions per day.

Statistical analysis

The Predictive Analytics Software (IBM SPSS Statistics for Windows) version 20 was used to analyse the data. Statistical analysis was stratified by sex because of significant differences in sedentary behaviours and food and beverage consumption patterns between males and females founded in our sample. Initially, consumption and respective sedentary behaviours were analysed by one-way analysis of covariance (ANCOVA), adjusted for centre, maternal education and BMI. Bonferroni corrections were used for post hoc multiple comparison tests.

Additionally, a generalized linear model with the inclusion of a random intercept for study centre and maternal education was used to examine the relationship between sedentary behaviours and food consumption. Maternal education and BMI were included as covariates. Values are presented as adjusted β values (estimated unstandardized regression coefficients) and 95 % confidence intervals (CI). All statistical tests and corresponding p values lower than 0.05 were considered statistically significant.

Results

Table 1 presents descriptive information about the mean and confidence interval of age, body mass index, maternal education, sedentary behaviours and country. There were significant differences regarding maternal education level and between sexes. Also, significant differences were shown between sexes with the majority of sedentary behaviours. However, there were no significant differences regarding age and body mass index between sexes nor between countries.

Tables 2 and 3 present the results of the ANCOVA (means and SD) for food and beverage consumption by sedentary behaviour categories, both for males and females, respectively. In general, both in males and females, and for school days and weekend days, children spending >1 h per day watching TV or total screen time had a higher consumption of fizzy drinks, juices, sweetened milk, cakes and biscuits, chocolate, sugar-based desserts and pastries, salty snacks and potatoes than those spending ≤1 h per day. Furthermore, the results also showed a lower consumption of vegetables, fruits and fish when preschoolers spent >1 h of TV or total screen time per day.

Results for computer time and quiet play were less consistent in both sexes. For instance, males who spent >1 h/day on quiet play during school days significantly consumed more water, fruits, vegetables, fish, potatoes and pasta and rice. Females who spent >1 h/day on quiet play during school days consumed significantly more water, fruits, vegetables, cakes and biscuits, sugar-based desserts and pastries, pasta and rice. Similar results were found for weekend days except for several food groups as fruit or sugar-based desserts in females and potatoes in males ($p > 0.005$).

Table 1 Descriptive characteristics of the European pre-schoolers sample participating in the ToyBox-study (n = 6431)

Variable	Boys (3336) Mean (95 % CI)	Girls (3095) Mean (95 % CI)	*p* value[a]
Age	4.76 (4.74–4.77)	4.76 (4.74–4.77)	0.97
Body mass index	15.87 (15.82–15.92)	15.88 (15.83–15.94)	0.70
Maternal education	% (n)	% (n)	
<7 years, 1	1.3 (43)	1.1 (34)	
7–12 years, 2	17.6 (587)	20.3 (627)	0.02*
13–14 years, 3	21.4 (714)	20.4 (630)	
15–16 years, 4	22.9 (763)	22.3 (690)	
More than 16 years, 5	36.9 (1230)	36.0 (1114)	
Sedentary behaviours	Mean %	Mean %	
TV weekday			
≤1 h/day	55.5	57.6	0.08*
>1 h/day	44.5	42.4	
TV weekend			
≤1 h/day	29.1	29.5	0.74
>1 h/day	70.9	70.5	
PC weekday			
≤1 h/day	94.2	97	0.00*
>1 h/day	5.8	3	
PC weekend			
≤1 h/day	14.2	7.6	0.00*
>1 h/day	85.8	92.4	
Quiet play weekday			
≤1 h/day	46.1	36.2	0.00*
>1 h/day	53.9	63.8	
Quiet play weekend			
≤1 h/day	27	18.6	0.00*
>1 h/day	73	81.4	
Screen total days			
≤1 h/day	29.2	31.3	0.07
>1 h/day	70.8	68.7	
Screen total weekday			
≤1 h/day	41.9	46.5	0.00*
>1 h/day	58.1	53.5	
Screen total weekend			
≤1 h/day	20	22.1	0.03*
>1 h/day	80	77.9	
Center	*n*	*n*	
Belgium	480	438	
Bulgaria	382	385	
Germany	646	597	0.22
Greece	892	853	
Poland	722	647	
Spain	468	388	

* Significant differences ($p < 0.05$)

[a] Sex differences using Pearson's Chi-square test for categorized variables and *t* test for continuous variables

Table 4 presents the results of the generalized linear regression models. High total screen time both in males and females, during school days and weekend days, was positively associated with high consumption of fizzy drinks, juices, sweetened milk, cakes and biscuits, chocolate, sugar-based desserts and pastries, salty snacks and potatoes. In both males and females, during school days and weekend days, negative associations were observed for consumption of fruits and vegetables.

Both in males and females, watching TV for >1 h/day during school days was positively associated with fizzy drinks, juices, sweetened milk, cakes and biscuits, chocolate, sugar-based desserts and pastries, salty snacks, meat and potatoes, whereas it was negatively associated with fruits, vegetables and fish. During weekend days, results were in the same direction, but in the case of females no significance was observed for chocolate and fish, and for males no significance was observed for pasta and rice.

During school days, both in males and females, spending >1 h per day of quiet play was positively associated with consumption of water, fruits, vegetables, pasta and rice. During weekend days, in both males and females, quiet play was positively associated with consumption of water and vegetables. In males, it was also positively associated with fruits, fish, pasta and rice and in females with cakes and biscuits and meat.

Discussion

To the authors' knowledge, this is the first study to examine associations between various sedentary activities and the consumption of food and beverages in European preschoolers. Due to lack of evidence in preschoolers, findings were related to those of adolescents. The main findings of this study show that TV watching and total screen time are positively associated with energy-dense foods and beverages and negatively associated with the consumption of fruit and vegetables consistent with previously reported literature in school-aged groups [26]. For instance, a Canadian study found that TV time was negatively associated with fruit and vegetable consumption and positively associated with consumption of sweets, fizzy drinks, pastries, potato chips and juices [10]. In school-aged US children, TV time was associated with lower odds of consuming fruits or vegetables and high odds of consuming candy and fizzy drinks [27]. Moreover, a study in adolescents from Massachusetts showed that TV viewing was inversely associated with the intake of fruit and vegetables [28]. Santaliestra-Pasias et al. [9] reported an association

Table 2 Analysis of covariance in food by sedentary behaviour categories in 3336 European male preschoolers participating in the ToyBox-study

Portions/day[c]	Water	Fizzy drinks[a]	Juices	Milk	Sweetened milk[b]	Fruits	Vegetables	Cakes and biscuits
	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)
TV school days								
≤1 h/day	2.68 (0.03)	0.29 (0.01)*	0.95 (0.02)*	2.11 (0.02)	0.54 (0.01)*	1.18 (0.02)*	0.91 (0.02)*	0.88 (0.02)*
>1 h/day	2.60 (0.03)	0.43 (0.02)*	1.03 (0.02)*	2.17 (0.03)	0.66 (0.01)*	1.12 (0.02)*	0.86 (0.02)*	1.00 (0.02)*
TV weekend								
≤1 h/day	2.68 (0.04)	0.24 (0.02)*	0.89 (0.03)*	2.10 (0.04)	0.51 (0.02)*	1.23 (0.02)*	0.95 (0.02)*	0.87 (0.03)*
>1 h/day	2.63 (0.02)	0.39 (0.01)*	1.02 (0.02)*	2.15 (0.02)	0.63 (0.01)*	1.13 (0.01)*	0.86 (0.01)*	0.95 (0.02)*
PC school days								
≤1 h/day	2.65 (0.02)	0.34 (0.01)*	0.98 (0.01)	2.14 (0.02)	0.59 (0.01)	1.17 (0.01)*	0.90 (0.01)*	0.92 (0.01)*
>1 h/day	2.51 (0.09)	0.59 (0.05)*	1.05 (0.06)	2.14 (0.08)	0.60 (0.04)	1.03 (0.05)*	0.75 (0.05)*	1.09 (0.06)*
PC weekend								
≤1 h/day	2.65 (0.02)	0.32 (0.01)*	0.97 (0.02)	2.14 (0.02)	0.59 (0.01)*	1.17 (0.01)*	0.91 (0.01)*	0.91 (0.01)*
>1 h/day	2.54 (0.06)	0.49 (0.03)*	1.01 (0.04)	2.12 (0.05)	0.64 (0.02)*	1.09 (0.03)*	0.80 (0.03)*	1.01 (0.04)*
Quiet play school days								
≤1 h/day	2.570.03)*	0.35 (0.02)	0.95 (0.02)	2.10 (0.03)	0.60 (0.01)	1.12 (0.02)*	0.82 (0.02)*	0.92 (0.02)
>1 h/day	2.71 (1.25)*	0.35 (0.02)	1.00 (0.02)	2.17 (0.03)	0.61 (0.01)	1.19 (0.02)*	0.95 (0.02)*	0.94 (0.02)
Quiet play weekend								
≤1 h/day	2.49 (0.04)*	0.35 (0.02)	0.94 (0.03)	2.10 (0.04)	0.57 (0.02)	1.07 (0.02)*	0.80 (0.02)*	0.94 (0.03)
>1 h/day	2.69 (0.02)*	0.35 (0.01)	1.00 (0.02)	2.15 (0.02)	0.60 (0.01)	1.18 (0.01)*	0.92 (0.01)*	0.93 (0.02)
Screen time school days								
≤1 h/day	2.66 (0.03)	0.27 (0.02)*	0.93 (0.02)	2.10 (0.03)	0.53 (0.01)*	1.20 (0.02)*	0.92 (0.02)*	0.87 (0.02)*
>1 h/day	2.63 (0.03)	0.41 (0.01)*	1.02 (0.02)	2.16 (0.03)	0.64 (0.01)*	1.13 (0.02)*	0.86 (0.02)*	0.97 (0.02)*
Screen time weekend								
≤1 h/day	2.68 (0.05)	0.2 (0.03)*	0.87 (0.04)*	2.06 (0.05)	0.51 (0.02)*	1.21 (0.03)*	0.96 (0.03)*	0.89 (0.03)
>1 h/day	2.63 (0.02)	0.38 (0.01)*	1.00 (0.02)*	2.16 (0.02)	0.61 (0.01)*	1.14 (0.01)*	0.87 (0.01)*	0.94 (0.02)
Weekly screen time/day								
≤1 h/day	2.69 (0.04)	0.25 (0.02)*	0.88 (0.03)*	2.08 (0.04)	0.50 (0.02)*	1.24 (0.02)*	0.95 (0.02)*	0.86 (0.03)*
>1 h/day	2.62 (0.02)	0.39 (0.01)*	1.02 (0.02)*	2.16 (0.02)	0.63 (0.01)*	1.12 (0.01)*	0.86 (0.01)*	0.96 (0.02)*

Portions/day[c]	Chocolate	Sugar dessert and pastries	Salty snacks	Meat	Fish	Pasta and rice	Potatoes
	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)
TV school days							
≤1 h/day	0.55 (0.01)*	0.63 (0.02)*	0.11 (0.01)*	1.18 (0.02)*	0.22 (0.01)*	0.48 (0.00)	0.67 (0.01)*
>1 h/day	0.60 (0.01)*	0.86 (0.02)*	0.18 (0.01)*	1.24 (0.02)*	0.20 (0.01)*	0.49 (0.01)	0.74 (0.01)*
TV weekend							
≤1 h/day	0.54 (0.01)	0.60 (0.03)*	0.10 (0.01)*	1.16 (0.02)*	0.22 (0.00)	0.46 (0.01)*	0.66 (0.02)*
>1 h/day	0.58 (0.01)	0.78 (0.02)*	0.16 (0.01)*	1.22 (0.01)*	0.21 (0.00)	0.49 (0.01)*	0.71 (0.01)*
PC school days							
≤1 h/day	0.56 (0.01)*	0.72 (0.02)*	0.14 (0.01)*	1.20 (0.01)	0.21 (0.00)*	0.48 (0.00)	0.69 (0.01)*
>1 h/day	0.65 (0.03)*	0.90 (0.06)*	0.24 (0.02)*	1.25 (0.05)	0.18 (0.01)*	0.48 (0.02)	0.78 (0.04)*
PC weekend							
≤1 h/day	0.56 (0.01)*	0.71 (0.02)*	0.13 (0.01)*	1.20 (0.01)	0.21 (0.00)	0.48 (0.01)	0.69 (0.01)*
>1 h/day	0.63 (0.02)*	0.84 (0.04)*	0.22 (0.01)*	1.25 (0.03)	0.20 (0.01)	0.48 (0.01)	0.74 (0.02)*
Quiet play school days							
≤1 h/day	0.57 (0.01)	0.72 (0.02)	0.15 (0.00)	1.20 (0.02)	0.20 (0.00)*	0.47 (0.01)*	0.68 (0.01)*

Table 2 continued

Portions/day[c]	Chocolate	Sugar dessert and pastries	Salty snacks	Meat	Fish	Pasta and rice	Potatoes
	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)
>1 h/day	0.57 (0.01)	0.74 (0.02)	0.14 (0.00)	1.21 (0.02)	0.22 (0.00)*	0.50 (0.01)*	0.72 (0.01)*
Quiet play weekend							
≤1 h/day	0.55 (0.02)	0.73 (0.03)	0.14 (0.01)	1.18 (0.02)	0.20 (0.00)*	0.46 (0.01)*	0.67 (0.02)
>1 h/day	0.58 (0.01)	0.74 (0.02)	0.15 (0.00)	1.21 (0.01)	0.21 (0.00)*	0.49 (0.01)*	0.71 (0.01)
Screen time school days							
≤1 h/day	0.54 (0.01)*	0.59 (0.02)*	0.11 (0.01)*	1.18 (0.02)	0.22 (0.00)*	0.48 (0.01)	0.66 (0.01)*
>1 h/day	0.59 (0.01)*	0.83 (0.02)*	0.17 (0.01)*	1.22 (0.02)	0.20 (0.00)*	0.49 (0.01)	0.72 (0.01)*
Screen time weekend							
≤1 h/day	0.54 (0.02)	0.58 (0.04)*	0.09 (0.01)*	1.18 (0.03)	0.21 (0.01)	0.48 (0.01)	0.70 (0.02)
>1 h/day	0.57 (0.01)	0.77 (0.02)*	0.16 (0.00)*	1.21 (0.01)	0.21 (0.00)	0.48 (0.01)	0.70 (0.01)
Weekly screen time/day							
≤1 h/day	0.54 (0.02)*	0.57 (0.03)*	0.09 (0.01)*	1.18 (0.02)	0.22 (0.01)	0.47 (0.01)	0.65 (0.02)*
>1 h/day	0.58 (0.01)*	0.80 (0.02)*	0.16 (0.00)*	1.22 (0.01)	0.21 (0.00)	0.49 (0.01)	0.72 (0.01)*

Covariates were maternal education, body mass index and centre

TV Television, *PC* personal computer

* Significant differences between ≤1 h and >1 h ($p < 0.05$)

[a] Fizzy drinks include beverages carbonated, soft drinks, and light soft drinks

[b] Sweetened milk include smoothies, other yogurt and milk-based desserts

[c] Portions per day

between different sedentary behaviours and consumption of energy-dense food and beverage such as soft drinks, savoury snacks and pastries. In Australian adolescents, Pearson et al. [29] observed that TV viewing was associated with energy-dense snack consumption. In both studies, 'healthier' dietary patterns were consistently associated with less time spent in front of a screen and more 'unhealthy' dietary patterns were associated with more time spent in front of a screen [30, 31].

An often observed sedentary behaviour in preschool children is quiet play. Low levels of physical activity and high levels of sedentary behaviours are common in preschoolers as they tend to spend most of time seated or moving quietly in a limited space area [32, 33]. To our knowledge, there is no study assessing the association between quiet play and food and beverage consumption in preschool children. In our study, the association between quiet play and food and beverage consumption was different to those observed for TV watching or screen time. Our results support the notion that sedentary time in children encompasses a variety of behaviours that may or may not be associated with the consumption of specific food items. Associations between specific sedentary behaviours and food and beverage consumption seem to be dependent on age (preschool children vs school-aged children or adolescents) and/or the time in which the study was performed as media technologies have gained tremendous popularity in the past decade [34, 35].

The most relevant sedentary behaviour, in terms of its association with food and beverage consumption, is TV watching [36]. One reason could be that TV viewing acts as an enhancing factor to frequently consume energy-dense advertised foods, leading to the replacement of fruit and vegetables [37, 38]. There are specific recommendations for screen time for preschool children. The Australian and Canadian recommendations for limiting screen time media time to no more than 1 h/day for preschool children were recently established [22, 23]. In order to reduce screen time, several strategies have been suggested such as removing TV sets out of children's bedrooms, enhancing alternatives for entertainment for preschoolers such as reading, sports, creative games and promoting activities for improving their neurodevelopment [22, 39]. Our results support these specific screen time recommendations for preschool children, as we observed significant differences in energy-dense food and beverage consumption according to meeting or not meeting screen time recommendations [36].

Table 3 Analysis of covariance in food by sedentary behaviour categories in 3095 European female preschoolers participating in the ToyBox-study

Portions/day[c]	Water	Fizzy drinks[a]	Juices	Milk	Sweetened milk[b]	Fruits	Vegetables	Cakes and biscuits
	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)
TV school days								
≤1 h/day	2.61 (0.03)	0.27 (0.01)*	0.89 (0.02)*	2.06 (0.03)	0.51 (0.1)*	1.19 (0.02)*	0.95 (0.02)*	0.82 (0.02)*
>1 h/day	2.53 (0.03)	0.43 (0.02)*	0.98 (0.02)*	2.03 (0.03)	0.59 (0.1)*	1.09 (0.02)*	0.87 (0.02)*	0.96 (0.02)*
TV weekend								
≤1 h/day	2.64 (0.04)	0.21 (0.02)*	0.89 (0.03)	2.03 (0.04)	0.48 (0.02)*	1.23 (0.02)*	1.01 (0.02)*	0.75 (0.03)*
>1 h/day	2.56 (0.02)	0.39 (0.01)*	0.95 (0.02)	2.05 (0.02)	0.56 (0.01)*	1.12 (0.01)*	0.89 (0.01)*	0.93 (0.02)*
PC school days								
≤1 h/day	2.58 (0.02)*	0.33 (0.01)*	0.92 (0.01)*	2.04 (0.02)	0.54 (0.00)*	1.16 (0.01)*	0.92 (0.01)	0.87 (0.01)*
>1 h/day	2.29 (0.13)*	0.57 (0.07)*	1.11 (0.09)*	2.15 (0.12)	0.67 (0.05)*	0.98 (0.07)*	0.85 (0.07)	1.18 (0.09)*
PC weekend								
≤1 h/day	2.59 (0.02)	0.33 (0.01)*	0.92 (0.01)	2.04 (0.02)	0.53 (0.00)*	1.16 (0.01)*	0.92 (0.01)	0.87 (0.01)*
>1 h/day	2.45 (0.08)	0.44 (0.04)*	1.02 (0.05)	2.07 (0.07)	0.61 (0.03)*	1.06 (0.04)*	0.90 (0.05)	0.99 (0.05)*
Quiet play school days								
≤1 h/day	2.50 (0.04)*	0.33 (0.02)	0.9 (0.02)	2.04 (0.03)	0.52 (0.01)	1.11 (0.02)*	0.84 (0.02)*	0.80 (0.02)*
>1 h/day	2.62 (0.03)*	0.34 (0.01)	0.94 (0.02)	2.06 (0.02)	0.55 (0.01)	1.17 (0.02)*	0.96 (0.02)*	0.92 (0.02)*
Quiet play weekend								
≤1 h/day	2.43 (0.05)*	0.35 (0.02)	0.92 (0.03)	1.99 (0.05)	0.51 (0.02)	1.10 (0.03)	0.81 (0.03)*	0.78 (0.03)*
>1 h/day	2.61 (0.02)*	0.34 (0.01)	0.93 (0.02)	2.06 (0.02)	0.54 (0.01)	1.16 (0.01)	0.94 (0.01)*	0.90 (0.02)*
Screen time school days								
≤1 h/day	2.63 (0.03)*	0.27 (0.02)*	0.87 (0.02)	2.07 (0.03)	0.49 (0.01)*	1.20 (0.02)*	0.96 (0.02)*	0.79 (0.02)*
>1 h/day	2.53 (0.03)*	0.40 (0.02)*	0.98 (0.02)	2.03 (0.03)	0.59 (0.01)*	1.11 (0.02)*	0.88 (0.02)*	0.96 (0.02)*
Screen time weekend								
≤1 h/day	2.65 (0.05)	0.20 (0.03)*	0.86 (0.03)*	2.04 (0.05)	0.46 (0.02)*	1.23 (0.03)*	1.00 (0.03)*	0.76 (0.03)*
>1 h/day	2.56 (0.02)	0.37 (0.02)*	0.95 (0.02)*	2.05 (0.02)	0.56 (0.01)*	1.13 (0.01)*	0.90 (0.01)*	0.91 (0.02)*
Weekly screen time/day								
≤1 h/day	2.61 (0.04)	0.20 (0.02)*	0.85 (0.03)*	2.04 (0.04)	0.48 (0.02)*	1.22 (0.02)*	0.98 (0.02)*	0.73 (0.03)*
>1 h/day	2.57 (0.03)	0.39 (0.01)*	0.96 (0.02)*	2.04 (0.02)	0.56 (0.01)*	1.13 (0.01)*	0.89 (0.01)*	0.94 (0.02)*

Portions/day[c]	Chocolate	Sugar dessert and pastries	Salty snacks	Meat	Fish	Pasta and rice	Potatoes
	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)
TV school days							
≤1 h/day	0.52 (0.01)*	0.63 (0.02)*	0.11 (0.01)*	1.12 (0.02)*	0.21 (0.00)*	0.46 (0.01)	0.65 (0.01)*
>1 h/day	0.62 (0.01)*	0.88 (0.02)*	0.17 (0.01)*	1.21 (0.02)*	0.20 (0.00)*	0.48 (0.01)	0.71 (0.01)*
TV weekend							
≤1 h/day	0.50 (0.02)*	0.60 (0.03)*	0.09 (0.01)*	1.10 (0.02)*	0.22 (0.00)*	0.46 (0.01)	0.64 (0.02)*
>1 h/day	0.59 (0.01)*	0.80 (0.02)*	0.15 (0.01)*	1.18 (0.01)*	0.20 (0.00)*	0.48 (0.01)	0.69 (0.01)*
PC school days							
≤1 h/day	0.55 (0.01)*	0.72 (0.02)*	0.13 (0.01)*	1.15 (0.01)*	0.20 (0.00)	0.47 (0.00)	0.67 (0.01)*
>1 h/day	0.90 (0.05)*	1.36 (0.01)*	0.22 (0.02)*	1.42 (0.07)*	0.21 (0.02)	0.55 (0.03)	0.81 (0.06)*
PC weekend							
≤1 h/day	0.55 (0.01)*	0.72 (0.02)*	0.13 (0.01)*	1.15 (0.01)*	0.21 (0.00)	0.47 (0.01)*	0.66 (0.01)*
>1 h/day	0.68 (0.03)*	0.99 (0.06)*	0.22 (0.01)*	1.25 (0.04)*	0.19 (0.01)	0.54 (0.02)*	0.79 (0.03)*

Table 3 continued

Portions/day[c]	Chocolate	Sugar dessert and pastries	Salty snacks	Meat	Fish	Pasta and rice	Potatoes
	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)	Mean (error measures)
Quiet play school days							
≤1 h/day	0.56 (0.01)	0.68 (0.03)*	0.13 (0.00)	1.14 (0.02)	0.20 (0.00)	0.45 (0.01)*	0.66 (0.02)
>1 h/day	0.57 (0.01)	0.77 (0.02)*	0.13 (0.00)	1.17 (0.01)	0.21 (0.00)	0.48 (0.01)*	0.69 (0.01)
Quiet play weekend							
≤1 h/day	0.57 (0.02)	0.72 (0.04)	0.14 (0.01)	1.10 (0.03)*	0.19 (0.01)	0.45 (0.01)	0.66 (0.02)
>1 h/day	0.56 (0.01)	0.74 (0.02)	0.13 (0.00)	1.17 (0.01)*	0.21 (0.00)	0.48 (0.01)	0.68 (0.01)
Screen time school days							
≤1 h/day	0.52 (0.01)*	0.59 (0.02)*	0.10 (0.01)*	1.11 (0.02)*	0.21 (0.00)*	0.47 (0.01)	0.64 (0.01)*
>1 h/day	0.60 (0.01)*	0.87 (0.02)*	0.16 (0.00)*	1.20 (0.02)*	0.20 (0.00)*	0.48 (0.01)	0.70 (0.01)*
Screen time weekend							
≤1 h/day	0.51 (0.02)*	0.58 (0.04)*	0.09 (0.01)*	1.10 (0.03)*	0.21 (0.01)	0.46 (0.01)	0.62 (0.02)*
>1 h/day	0.58 (0.01)*	0.78 (0.02)*	0.14 (0.00)*	1.17 (0.01)*	0.20 (0.00)	0.48 (0.01)	0.69 (0.01)*
Weekly screen time/day							
≤1 h/day	0.50 (0.02)*	0.55 (0.03)*	0.09 (0.01)*	1.10 (0.02)*	0.22 (0.01)*	0.46 (0.01)	0.62 (0.02)*
>1 h/day	0.59 (0.01)*	0.82 (0.02)*	0.15 (0.00)*	1.19 (0.01)*	0.20 (0.00)*	0.48 (0.01)	0.69 (0.01)*

Covariates were maternal education, body mass index and centre

TV Television, *PC* personal computer

* Significant differences between ≤1 h and >1 h ($p < 0.05$)

[a] Fizzy drinks include beverages carbonated, soft drinks and light soft drinks

[b] Sweetened milk include smoothies, other yogurt and milk-based desserts

[c] Portions per day

The current study has some limitations. This is a cross-sectional study not allowing to establish causal relationships. Generalizability of the findings is limited due to the fact that there is a specific age group studied in the current study. Dietary and behavioural information was collected via parental self-reported questionnaires, which are prone to over- or under-reporting. Consequently, the quality of diet can suffer more error, but acknowledging this limitation can help to interpret it appropriately [40]. However, it was developed/adapted and validated for the purposes of the study. In addition, assessment of energy balance-related behaviours (physical activity, diet and sedentary activities) has been shown to be difficult and complex to assess in young population groups [4]. Time spent using new technologies as tablets or internet for recreational reasons was not assessed in the current study.

The main strengths of our study include the use of a large, culturally and socioeconomically diverse sample of children from six different countries across Europe. The collected information about diet and sedentary behaviours was assessed via standardized and harmonized procedures [19]. The inclusion of a homogeneous sample of preschool children is also strength. The present study includes essential information on energy balance-related behaviours for a population group that is within a critical period in lifestyle habits acquisition. Moreover, parents and caregivers must continually be reminded of their substantial influence in setting on positive habits such as physical activity and healthy diet.

Conclusions

The present findings have important implications for further studies assessing energy balance-related behaviours in European preschool children. This study provides evidence on the associations between different sedentary behaviours and food and beverage consumption in a sample of European preschoolers. Longitudinal studies are needed to confirm our results in order to confirm the associations between changes during time in the studied variables. From a public health point of view, it is important to identify screen time alternatives and supply healthy foods in order to provide an appropriate environment for obesity

Table 4 Analysis of general linear model of food group consumption by sedentary behaviours categories in both male and female European preschoolers participating in the ToyBox-study ($n = 6431$)

	Water	Fizzy drinks[a]	Juices	Sweetened milk[b]	Milk
	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)
TV					
School days					
Male	−0.08 (−0.170;0.011)	0.14 (0.089;0.183)	0.07 (0.004;0.133)	0.12 (0.080;0.158)	0.06 (−0.025;0.141)
Female	−0.08 (−0.172;0.009)	0.16 (0.110;0.203)	0.09 (0.028;0.150)	0.08 (0.041;0.116)	−0.04 (−0.117;0.046)
Weekend					
Male	−0.05 (−0.153;0.047)	0.14 (0.090;0.197)	0.12 (0.048;0.192)	0.12 (0.076;0.163)	0.05 (−0.047;0.140)
Female	−0.08 (−0.185;0.018)	0.18 (0.129;0.233)	0.06 (−0.007;0.130)	0.08 (0.036;0.119)	0.02 (−0.067;0.115)
PC					
School days					
Male	−0.13 (−0.316;0.056)	0.23 (0.138;0.233)	0.06 (−0.071;0.192)	0.00 (−0.077;0.080)	0.00 (−0.163;0.173)
Female	−0.30 (−0.559; − 0.049)	0.23 (0.099;0.367)	0.19 (0.007;0.365)	0.13 (0.026;0.238)	0.11 (−0.128;0.344)
Weekend					
Male	−0.11 (−0.236;0.012)	0.16 (0.100;0.229)	0.04 (−0.050;0.125)	0.05 (0.002;0.108)	−0.02 (−0.131;0.095)
Female	−0.15 (−0.309;0.013)	0.11 (0.027;0.195)	0.10 (−0.011;0.212)	0.07 (0.005;0.139)	0.03 (−0.119;0.177)
Quiet play					
School days					
Male	0.13 (0.047;0.221)	0.00 (−0.043;0.049)	0.06 (−0.002;0.122)	0.03 (−0.008;0.066)	0.07 (−0.108;0.150)
Female	0.12 (0.026;0.210)	0.01 (−0.040;0.054)	0.04 (−0.021;0.104)	0.03 (−0.012;0.063)	0.02 (−0.065;0.101)
Weekend					
Male	0.19 (0.092;0.287)	0.00 (−0.046;0.0.056)	0.06 (−0.008;0.130)	0.03 (−0.009;0.074)	0.04 (−0.049;0.130)
Female	0.18 (0.063;0.290)	−0.01 (−0.067;0.049)	0.02 (−0.058;0.095)	0.03 (−0.014;0.078)	0.07 (−0.032;0.171)
Screen time total					
School days					
Male	−0.03 (−0.126;0.060)	0.13 (0.082;0.180)	0.08 (0.014;0.148)	0.11 (0.074;0.154)	0.07 (−0.018;0.153)
Female	−0.11 (−0.197; − 0.015)	0.13 (0.086;0.179)	0.11 (0.044;0.167)	0.10 (0.063;0.137)	0.01 (−0.122;0.041)
Weekend					
Male	−0.05 (−0.165;0.065)	0.14 (0.079;0.203)	0.13 (0.044; 0.212)	0.11 (0.056;0.157)	0.09 (−0.016;0.203)
Female	−0.08 (−0.200;0.031)	0.16 (0.102;0.220)	0.08 (0.008;0.163)	0.09 (0.047;0.141)	0.01 (−0.094;0.112)
Weekly screen time/day					
Male	−0.07 (−0.167;0.036)	0.14 (0.086;0.194)	0.14 (0.064;0.211)	0.14 (0.092;0.180)	0.09 (−0.004;0.187)
Female	−0.04 (−0.144;0.059)	0.19 (0.137;0.240)	0.11 (0.04;0.177)	0.08 (0.042;0.124)	0.01 (−0.081;0.101)

	Fruits	Vegetables	Cakes and biscuits	Chocolate	Sugar dessert and pastries
	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)	β (95 % CI)
TV					
School days					
Male	−0.06 (−0.109; −0.005)	−0.06 (−0.108; −0.005)	0.12 (0.055;0.176)	0.05 (0.015;0.088)	0.23 (0.170;0.299)
Female	−0.10 (−0.151; −0.048)	−0.08 (−0.133; −0.030)	0.14 (0.087;0.204)	0.09 (0.053;0.127)	0.25 (0.184;0.317)
Weekend					
Male	−0.10 (−0.161; −0.046)	−0.09 (−0.148; −0.032)	0.08 (0.012;0.148)	0.03 (−0.008;0.074)	0.18 (0.105;0.250)
Female	−0.12 (−0.173; −0.058)	−0.13 (−0.183; −0.068)	0.18 (0.116;0.247)	0.08 (0.039;0.122)	0.19 (0.118;0.267)
PC					
School days					
Male	−0.12 (−0.228; −0.019)	−0.14 (−0.250; −0.041)	0.17 (0.051;0.296)	0.09 (0.011;0.161)	0.18 (0.050;0.313)
Female	−0.17 (−0.320; −0.025)	−0.06 (−0.214;0.085)	0.31 (0.142;0.482)	0.34 (0.237;0.450)	0.63 (0.438;0.827)

Table 4 continued

	Fruits β (95 % CI)	Vegetables β (95 % CI)	Cakes and biscuits β (95 % CI)	Chocolate β (95 % CI)	Sugar dessert and pastries β (95 % CI)
Weekend					
Male	−0.08 (−0.147; −0.007)	−0.11 (−0.178; −0.038)	0.09 (0.013;0.177)	0.07 (0.019;0.120)	0.13 (0.044;0.219)
Female	−0.10 (−0.192; −0.006)	−0.02 (−0.111;0.075)	0.12 (0.018;0.230)	0.12 (0.059;0.192)	0.27 (0.146;0.389)
Quiet play					
School days					
Male	0.07 (0.026;0.125)	0.13 (0.080;0.178)	0.01 (−0.044;0.072)	0.01 (−0.028;0.043)	0.02 (−0.042;0.083)
Female	0.06 (0.012;0.116)	0.11 (0.063;0.167)	0.12 (0.059;0.178)	0.00 (−0.033;0.043)	0.09 (0.021;0.158)
Weekend					
Male	0.11 (0.056;0.167)	0.12 (0.064;0.173)	0.01 (−0.071;0.059)	0.03 (−0.014;0.066)	0.01 (−0.059;0.081)
Female	0.06 (−0.005;0.123)	0.13 (0.070;0.198)	0.12 (0.047;0.193)	−0.01 (−0.055;0.037)	0.03 (−0.057;0.111)
Screen time total					
School days					
Male	−0.06 (−0.116; −0.010)	−0.06 (−0.114; −0.008)	0.11 (0.046;0.170)	0.06 (0.018;0.094)	0.23 (0.167;0.299)
Female	−0.09 (−0.137; −0.034)	−0.07 (−0.127; −0.024)	0.17 (0.108;0.226)	0.08 (0.045;0.119)	0.27 (0.202;0.336)
Weekend					
Male	−0.07 (−0.141; −0.007)	−0.09 (−0.155; −0.021)	0.05 (−0.029;0.128)	0.03 (−0.015;0.080)	0.18 (0.095;0.263)
Female	−0.09 (−0.159; −0.029)	−0.11 (−0.172; −0.042)	0.15 (0.074;0.223)	0.07 (0.020;0.113)	0.20 (0.115;0.285)

	Salty snacks β (95 % CI)	Meat β (95 % CI)	Fish β (95 % CI)	Pasta and rice β (95 % CI)	Potatoes β (95 % CI)
TV					
School days					
Male	0.07 (0.050;0.084)	0.07 (0.017;0.116)	−0.01 (−0.026; −0.00)	0.02 (−0.005;0.039)	0.07 (0.032;0.110)
Female	0.06 (0.041;0.072)	0.09 (0.039;0.140)	−0.01 (−0.026; −0.00)	0.02 (−0.004;0.040)	0.07 (0.028;0.107)
Weekend					
Male	0.06 (0.038;0.077)	0.06 (0.006;0.117)	−0.01 (−0.002;0.007)	0.03 (0.004;0.053)	0.05 (0.005;0.092)
Female	0.06 (0.044;0.079)	0.08 (0.019;0.132)	−0.02 (−0.037; −0.007)	0.02 (−0.006;0.043)	0.05 (0.011;0.099)
PC					
School days					
Male	0.11 (0.071;0.142)	0.04 (−0.059;0.142)	−0.03 (−0.055; −0.001)	−0.01 (−0.049;0.040)	0.09 (0.09;0.166)
Female	0.09 (0.046;0.137)	0.27 (0.121;0.416)	0.01 (−0.033;0.042)	0.08 (0.017;0.144)	0.14 (0.022;0.251)
Weekend					
Male	0.09 (0.068;0.115)	0.05 (−0.017;0.117)	−0.01 (−0.033;0.002)	−0.01 (−0.036;0.023)	0.05 (0.001;0.106)
Female	0.09 (0.062;0.119)	0.10 (0.004;0.188)	−0.01 (−0.036;0.011)	0.07 (0.034;0.113)	0.13 (0.059;0.202)
Quiet play					
School days					
Male	−0.01 (−0.023;0.011)	0.01 (−0.037;0.058)	0.01 (0.005;0.026)	0.03 (0.008;0.050)	0.04 (0.002;0.076)
Female	−0.00 (−0.016;0.015)	0.04 (−0.015;0.087)	0.01 (−0.004;0.022)	0.03 (0.008;0.053)	0.03 (−0.013;0.067)
Weekend					
Male	0.01 (−0.012;0.025)	0.03 (−0.021;0.085)	0.02 (0.005;0.033)	0.03 (0.012;0.059)	0.04 (−0.004;0.078)
Female	−0.01 (−0.026;0.012)	0.08 (0.014;0.139)	0.01 (−0.002;0.030)	0.02 (−0.043;0.050)	0.02 (−0.025;0.073)
Screen time total					
School days					
Male	0.06 (0.046;0.082)	0.04 (−0.009;0.094)	−0.02 (−0.032; −0.005)	0.01 (−0.010;0.035)	0.06 (0.018;0.098)
Female	0.06 (0.043;0.074)	0.08 (0.034;0.135)	−0.01 (−0.028; −0.002)	0.01 (−0.012;0.032)	0.06 (0.024;0.103)
Weekend					
Male	0.06 (0.041;0.086)	0.03 (−0.033;0.097)	−0.00 (−0.018;0.016)	0.01 (−0.027;0.030)	0.01 (−0.046;0.055)
Female	0.05 (0.030;0.070)	0.07 (0.004;0.132)	−0.01 (−0.027;0.006)	0.02 (−0.005;0.050)	0.07 (0.022;0.152)

Table 4 continued

	Salty snacks β (95 % CI)	Meat β (95 % CI)	Fish β (95 % CI)	Pasta and rice β (95 % CI)	Potatoes β (95 % CI)
Weekly screen time/day					
Male	0.07 (0.053;0.093)	0.04 (−0.015;0.098)	−0.01 (−0.024;0.006)	0.02 (−0.004;0.046)	0.06 (0.021;0.109)
Female	0.06 (0.047;0.082)	0.09 (0.031;0.143)	−0.02 (−0.034; −0.005)	0.02 (−0.008;0.040)	0.07 (0.024;0.113)

Covariates were maternal education, body mass index and centre

TV television, *PC* personal computer

[a] Fizzy drinks include beverages carbonated, soft drinks and light soft drinks

[b] Sweetened milk include smoothies, other yogurt and milk-based desserts

prevention in children. Our results support evidence calling for limiting children's exposure to screen-based activities associated with energy-dense food consumption.

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Paper III:

Clustering of energy balance-related behaviours and parental education in European preschool children: the ToyBox study.

Agrupación de comportamientos relacionados con el equilibrio energético y la educación de los padres en niños preescolares europeos: estudio ToyBox.

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Clustering of energy balance-related behaviours and parental education in European preschool children: the ToyBox study

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Abstract

Energy balance-related behaviours (EBRB) are established in childhood and seem to persist through to adulthood. A lower parental educational level was associated with unhealthy behavioural patterns. The aim of the study is to identify clusters of EBRB and examine their association with preschool children's BMI and maternal, paternal and parental education. A subsample of the ToyBox study (*n* 5387) conducted in six European countries was used. Six behavioural clusters ('healthy diet and low activity', 'active', 'healthy lifestyle', 'high water and screen time; low fruits and vegetables (F&V) and physical activity (PA)', 'unhealthy lifestyle' and 'high F&V consumers') emerged. The healthiest group characterised by high water and F&V consumption and high PA *z* scores ('healthy lifestyle') was more prevalent among preschool children with at least one medium- or higher-educated parent and showed markedly healthier trends for all the included EBRB. In the opposite, the 'unhealthy lifestyle' cluster (characterised by high soft drinks and screen time *z* scores, and low water, F&V and PA *z* scores) was more prevalent among children with lower parental, paternal and maternal education levels. OR identified that children with lower maternal, paternal and parental education levels were less likely to be allocated in the 'healthy lifestyle' cluster and more likely to be allocated in the 'unhealthy lifestyle' cluster. The 'unhealthy lifestyle' cluster was more prevalent among children with parents in lower parental educational levels and children who were obese. Therefore, parental educational level is one of the key factors that should be considered when developing childhood obesity prevention interventions.

Key words: Clustering: Energy balance-related behaviours: Preschool children: Parental education levels

Childhood obesity is an important public health issue, as it affects health, educational attainment and long-term quality of life[1]. In addition, childhood obesity seems to track into later life[1–3]. It is estimated that 40–70 % of the variation in BMI is heritable according to classic genetic analyses[4]. Environmental contribution, however, seems to also have a major role in the obesity epidemic[5].

Weight gain has been associated with various lifestyle behaviours related to diet, physical activity (PA) and sedentary behaviours, referred to collectively as energy balance-related behaviours (EBRB)[6]. Such behaviours are established in early childhood and persist into adulthood[7–9]. A systematic review of the association between EBRB and overweight and obesity in preschool children reported a strong inverse association between total PA and being overweight and a moderate positive association between sedentary behaviour (especially television viewing) and overweight but provided insufficient evidence for the association between dietary behaviours and overweight[10]. Consumption of sugar-sweetened beverages

Abbreviations: EBRB, energy balance-related behaviours; F&V, fruits and vegetables; PA, physical activity.

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(SSB)[11] is proposed to be related to increased body weight whereas the opposite is observed for fruits and vegetables (F&V)[12,13], dairy products[14] and water consumption[15,16]. In addition, short sleep duration is associated with overweight and obesity in preschool children[17,18].

Clustering is a combination of behaviours that are more prevalent than expected from the prevalence of the separate behaviours[19]. Several studies have examined the co-occurrence or 'clustering' of EBRB in school-aged children and adolescents[20], but evidence in younger children is scarce. Dietary clusters were reported in 2- to 3-year-old children from low-income US families[21] and in 4-year-old children of south-west England[22], reflecting behavioural combinations that contribute either positively or negatively to the energy balance. An inverse association between television viewing and time spent being physically active was found in 3- and 4-year-old American children[23].

Few studies have examined cross-behavioural clustering (dietary intake and PA) in preschool European children[24–26]. Lioret *et al.*[24] reported 2 EBRB clusters in 3- to 6-year-old children, namely, the 'varied food and physically active' and the 'snacking and sedentary' pattern. Gubbels *et al.*[25] reported the 'sedentary-snacking' cluster, characterised by high screen time, snacking and SSB consumption, and the 'fibre' cluster, composed of vegetables, fresh fruits, and brown bread consumption in 5-year-old children. Recently, Leech *et al.*[26] identified three clusters (the 'most healthy', the 'energy-dense consumers who watch television' and the 'high sedentary behaviour/low moderate-to-vigorous PA) in a study of Australian children aged 5–6. In addition, a study of children from eight European countries identified six clusters. A high proportion of children with low socio-economic status were allocated in the cluster with the highest SSB consumption. In addition, children in the clusters with the highest mean sedentary time had statistically significant higher BMI[27]. In the same direction, Fernandez-Alvira *et al.*[28] found that clusters with high sugared drinks consumption, high screen time and low sleep duration were more prevalent in the group of children with lower educated parents. There are also studies addressing clusters of eating routines, in addition to various dietary intake behaviours. Specifically, Gubbels *et al.*[29] reported four lifestyle patterns in 5-year-old children in the Netherlands, such as the 'television – snacking', the 'sports – computer', the 'fast food' and the 'traditional family' patterns, whereas Kontogianni *et al.*[30] reported a pattern (characterised by high breakfast consumption and high eating frequency in children, in combination with a Mediterranean diet) that was negatively associated with BMI in Greek children and adolescents aged 3–18 years.

Dietary and PA habits are established in early childhood and may persist through to adulthood[7,8], and the same seems to apply with sedentary behaviours[9]. However, there is limited research on the clustering of EBRB in children younger than 5 years. Moreover, several EBRBs' patterns have been associated with various background characteristics. Specifically, a low parental educational level is positively associated with unhealthy behavioural patterns and negatively with healthy patterns[22,25,26,29]. Thus, in order to prevent obesity, it is important to identify the related behavioural patterns already in early childhood and understand how these clusters differ by socio-demographic indicators. The aim of the study was to identify cross-behavioural clusters of EBRB and explore their association with parental education and child´s BMI in a sample of preschool children of 6 European countries (Belgium, Bulgaria, Germany, Greece, Poland and Spain) participating in the ToyBox study.

Methods

Study design

The ToyBox study (www.toybox-study.eu) is a cluster-randomised study aiming to prevent overweight and obesity in preschool children from six European countries, namely, Belgium, Bulgaria, Germany, Greece, Poland and Spain[31]. The ToyBox intervention targeted four lifestyle behaviours: water consumption, healthy snacking (promoting water and F&V consumption), PA and limiting/interrupting their sedentary behaviour by improving children's physical and social environment both at the kindergarten and at home[31]. Recruitment and baseline data collection occurred from May 2012 until June 2012. In total, 309 kindergartens and 7056 children aged 3·5–5·5 years were recruited[32]. In this study, 5387 preschool children were included, which were the children for which all required questions were completed. All questionnaires were completed by parents/legal guardians who gave written informed consent. Ethics approval was obtained from the research ethics authority of each participating centre: in Belgium, by the Medical Ethics Committee of the Ghent University Hospital; in Bulgaria, by the Ethics Committee of the Medical University of Varna; in Germany, by the Ethics Committee of the Ludwig Maximilian University of Munich; in Greece, by the Bioethics Committee of Harokopio University and the Greek Ministry of Education; in Poland, by the Bioethics Committee of the Children's Memorial Health Institute and the Department of Information and Publicity of the Polish Ministry of Education; and in Spain, by the Clinical Research Ethics Committee and the Department of Consumers' Health of the Government of Aragón.

Data collection

Information regarding preschool children's EBRB (questions regarding PA, screen time and sleep time), socio-demographic and socio-economic characteristics were obtained via the primary caregivers' questionnaire specifically developed and tested for the purposes of the study[33,34].

Socio-economic variables

The questionnaire included a set of indicators/determinants out of which educational level, in particular, maternal educational level, was identified as one of the best proxy indicators of socio-economic status[35]. Maternal and paternal education levels (the years of education) were obtained as five categories: <7 years, 7–12 years, 13–14 years, 15–16 years and more than 16 years of education. Thereafter, the variables were

re-categorised into three categories: <7–12 years, 13–16 years and more than 16 years of education. Parental education was considered as the highest education level of both parents.

Anthropometric measures

Anthropometric measures were performed by trained researchers according to standardised protocols[34]. Body weight was measured in underwear and without shoes using an electronic scale (Type SECA 861 or SECA 813) to the nearest 0·1 kg, and body height was measured with a telescopic height instrument (Type SECA 225 or SECA 214) to the nearest 0·1 cm. The intra- and inter-observer reliability for weight and height was excellent (>99 and 98 %) in all participating countries[36]. BMI (kg/m^2) was calculated[37].

Diet assessment

Food and beverage consumption was assessed using a 37-item semi-quantitative FFQ[34]. The questionnaire was based on a previously developed and validated FFQ for Flemish preschool children by Huybrechts *et al.*[38] and was adapted and validated for the purposes of the ToyBox study. Low-moderate relative validity was observed, which varied by food and beverage group (0·52–0·79), and estimate correlations ranged; however, for some of the 'key' foods/drinks targeted in the ToyBox intervention (e.g. water and soft drinks), the validity was good (unpublished results). In the current study, three food groups/items, reflecting the aims of the study, were selected and analysed: 1 – water, 2 – sugar-sweetened and light beverages (soft drinks), and 3 – F&V consumption, expressed in portions per d. The selection of these food groups was based on the fact that they are some of the goals of the ToyBox intervention.

Physical activity

PA was assessed by a questionnaire and pedometers. However, in this study, only PA assessed via sports participation (number of hours per week that children participated in one or two sports) was included. The assessment of PA through 'sports participation' was identified in previous European studies as showing the highest correlation with the moderate-to-vigorous PA as measured with accelerometers[39].

Screen time

Screen time (i.e. television and computer time) was assessed, both for week and weekend days, by two questions: (1) minutes spent watching television (including video and DVD) and (2) minutes spent on computer activities per day. Responses included were 'never', '<30 min/d', '30 min to 1 h/d', '1–2 h/d', '3–4 h/d', '5–6 h/d', '7–8 h/d', '8 h/d' and 'more than 8 h/d'. To obtain the daily screen time, the average minutes per day, both for week and weekend days, were summed up and divided by 7 d.

Sleep duration

Parents reported the number of hours and minutes the child slept per night on average; they were reported separately for weekdays and weekend days and were then summed up and divided by 7 d to calculate average daily sleep duration.

Statistical analysis

All statistical analyses were performed using the Predictive Analytics Software (IBM SPSS Statistics for Windows) version 20. The analyses were done with the overall sample due to the lack of sex differences analysed using a t test for continuous variables and χ^2 test for categorical variables. The EBRB variables (soft drinks, F&V, water intake, PA, screen time and sleep duration) were chosen because they were the key messages in the ToyBox intervention objective in order to promote water, F&V consumption, PA and limit/interrupt the sedentary behaviour. Before clustering, the variables were standardized into their z scores. A combination of hierarchical method and k-means cluster analysis was used to identify clusters with similar lifestyle behaviours[40]. In the first step, a hierarchical cluster analysis was carried out using Ward's method based on the Euclidean distances. As Ward's method is sensitive to the influence of univariate outliers (more than 3 SD), extreme values were omitted from the subsequent analyses; additionally, individuals with multivariate outliers (high Mahalanobis values) were omitted. We performed Ward's method to obtain clusters of a meaningful size. In the second step, an iterative non-hierarchical cluster k-means clustering procedure was applied in which initial cluster centres based on Ward's hierarchical method were used as non-random starting points. To examine the stability of the obtained clusters, the sample was randomly split into halves and the full two-step procedure (Ward, followed by k-means) was then applied to each half. The elements of each half of the sample were assigned to a new cluster based on their Euclidean distances to the clusters centres of the other half of the sample. These new clusters were then compared for agreement with the original by means of Cohen's κ[41] and excellent concordance was found (Cohen's κ values = 0·95). Analysis of variance tests with *post hoc* Bonferroni tests were used to investigate differences between each cluster on all indices adjusted for child's BMI and maternal and paternal education. χ^2 tests were performed to investigate differences in cluster distribution by country, child's BMI category, and maternal and paternal education level. Odds ratios for specific clusters of maternal, paternal and parental education levels were also calculated (adjusting for age, sex and child's BMI). All statistical tests and corresponding P values lower than 0·05 were considered statistically significant.

Results

Table 1 shows the characteristics of the study population (n 5387). The mean age of the participants was 4·7 (SD 0·4) years. Approximately 35·3 % of the mothers and 29·8 % of the fathers were allocated in the high educational level; 41·9 % of the parents were allocated in the high educational level when considering their highest education attainment. The prevalence of overweight and obesity in studied preschool children were 10·2 and 3·6 %, respectively.

Fig. 1 presents the six EBRB clusters (mean z scores) derived from the cluster analysis. Cluster 1 was labelled 'healthy diet

Table 1. Descriptive characteristics of the total sample (Mean values and standard deviations; numbers and percentages)

	Mean/*n*	SD/%
Age (years)	4·74	0·44
Sex		
Boys	2826	51
Girls	2561	49
BMI status (kg/m^2)*		
Normal weight	4179	86·0
Overweight	514	10·2
Obesity	143	3·6
Maternal education (years)		
<7–12	1383	18·7
13–16	3055	41·3
>16	2607	35·3
Paternal education (years)		
<7–12	1873	25·4
13–16	2750	37·2
>16	2205	29·8
Parental education (years)		
<7–12	1153	23·7
13–16	2960	40·1
>16	3095	41·9
Country		
Belgium	1263	17·1
Bulgaria	917	12·4
Germany	1276	17·3
Greece	1768	23·9
Poland	1345	18·2
Spain	820	11·1

* BMI according to Cole's cut-off[37].

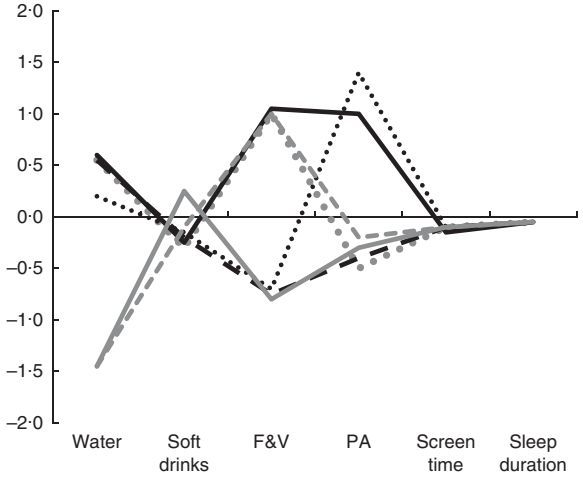

Fig. 1. Standard deviation scores of clusters on energy balance-related behaviours in boys and girls participating in the ToyBox study. F&V, fruits and vegetables; PA, physical activity; ····, Healthy diet and low activity; ·····, active; ——, healthy lifestyle; — —, high water and screen time; low F&V & PA; ——, unhealthy lifestyle; – – –, high F&V consumers.

and low activity', and it was characterised by high water and F&V z scores and low PA z scores. Cluster 2, labelled 'active', had high PA and water z scores and very low F&V z scores. Cluster 3 was labelled 'healthy lifestyle' and was characterised by high water, F&V, PA and sleep time z scores and low soft drinks and low screen time z scores. Cluster 4 was labelled 'high water and screen time; low F&V & PA' with high water z scores and screen time z scores combined with low F&V and PA. Cluster 5 was labelled 'Unhealthy lifestyle' as it was characterised by high soft drinks and screen time z scores, combined with low F&V, water and PA z score. Finally, cluster 6 was named 'high F&V consumers' as it was characterised by high F&V z scores and low water and low z scores of PA.

Table 2 presents the means and standard deviations of EBRB for each cluster. The smallest consumption of soft drinks was observed in the 'healthy lifestyle' cluster (cluster 3) and the highest was in cluster 5 ('unhealthy lifestyle'). All clusters were characterised by increased screen time, with the highest in the cluster 5.

Associations between the six clusters and socio-demographic variables (country, BMI and maternal, paternal and parental education level) are presented in Table 3. Significant differences in EBRB clusters were found by country, maternal and paternal education level. Moreover, the highest proportion of preschool children with increased F&V consumption (cluster 6) was observed in Germany, whereas in Greece, the highest proportion of increased water intake was observed (clusters 2 and 4). The majority of participants with low and medium parental education (17·7 and 43·2 %, respectively) were allocated in the unhealthy lifestyle cluster (cluster 5).

After exploring the associations of sex, country and BMI with the cluster distribution, OR were calculated for being allocated in a specific cluster by parental education level, adjusted for the other socio-demographic characteristics (Table 4). The results showed that preschool children with lower maternal, paternal, and parental education levels (OR: 0·55; 95 % CI 0·40, 0·75; OR 0·56; 95 % CI 0·43, 0·73; OR 0·48; 95 % CI 0·34, 0·68, respectively) were significantly less likely to be allocated in the healthy lifestyle cluster than those children with higher maternal, paternal, and parental education levels.

In the same direction, preschool children with lower maternal, paternal, and parental education levels (OR 1·55; 95 % CI 1·23, 1·96; OR 1·58; 95 % CI 1·25, 1·99; OR 1·70; 95 % CI 1·32, 2·16, respectively) were significantly more likely to be allocated in the unhealthy lifestyle cluster than those children with higher maternal, paternal, and parental education levels. Preschool children with medium maternal education level were also significantly more likely to be allocated in the cluster characterised by high consumption of water and low F&V (OR 1·52; 95 % CI 1·21, 1·91) than those children with higher maternal, paternal and parental education levels. In addition, preschool children with medium paternal and parental education levels (OR 1·52; 95 % CI 1·23, 1·88; OR 1·36; 95 % CI 1·13, 1·64, respectively) were significantly more likely to be allocated in the unhealthy cluster than those children with higher maternal, paternal and parental education levels.

Discussion

Six cross-behavioural clusters emerged in this study of preschool children participating in the ToyBox study. To the author's knowledge, this is the first study to identify cross-behavioural clusters of dietary behaviours, PA, sedentary behaviours and sleep duration in European preschool children.

The 'healthy lifestyle' cluster, characterised by high water and F&V intake, high PA and sleep duration, and low soft drinks

Table 2. Energy balance-related behaviours (EBRB) in the final clusters (C) obtained, ANOVA and results of Bonferroni test adjusted by maternal and paternal education and BMI
(Mean values and *z* Scores with their standard errors)

	Healthy diet and low activity (C1)		Active (C2)		Healthy lifestyle (C3)		High water and screen time; low F&V and PA (C4)		Unhealthy lifestyle (C5)		High F&V consumers (C6)		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	*F*
Water (portions/d)	4·34	0·74	3·74	1·24	4·37	0·75	4·28	0·75	1·21	0·44	1·20	0·46	2 674 509*
z Score	0·57		0·19		0·59		0·54		−1·41		−1·42		
SE	0·47		0·79		0·47		0·47		0·28		0·29		
Soft drinks (portions/d)†	0·41	0·02	0·52	0·03	0·40	0·03	0·45	0·02	0·78	0·03	0·64	0·03	29 994*
z Score	−0·23		−0·10		−0·27		−0·15		0·16		0·06		
SE	0·11		0·19		0·43		0·07		0·15		0·18		
F&V (portions/d)	4·11	0·74	1·38	0·38	4·12	0·74	1·28	0·34	1·26	0·36	4·12	0·74	4973 593*
z Score	0·98		−0·79		0·99		−0·86		−0·87		0·99		
SE	0·48		0·25		0·48		0·22		0·24		0·48		
PA (min/d)	0·23	0·85	17·22	0·96	14·00	0·98	0·60	0·06	2·00	0·35	3·00	5·60	1930 091*
z Score	−0·51		1·41		1·03		−0·46		−0·31		−0·20		
SE	0·09		0·66		0·67		0·23		0·19		0·15		
Screen time (min/d)	103·74	0·47	104·00	2·82	84·00	2·73	116·00	1·98	127·00	2·88	110	1·71	15 212*
z Score	−0·06		−0·06		−0·07		−0·06		−0·06		−0·06		
SE	0·01		0·01		0·01		0·01		0·01		0·01		
Sleep duration (h/d)	9·89	0·07	9·87	0·04	10·00	0·04	9·80	0·16	9·91	0·15	9·88	0·02	4451*
z Score	−0·25		−0·25		−0·25		−0·25		−0·25		−0·25		
SE	0·01		0·01		0·01		0·01		0·01		0·01		

F&V, fruits and vegetables; PA, physical activity.
* $P < 0·001$ ANOVA and Bonferroni *post hoc* test, adjusted by maternal, paternal education and BMI.
† Sugar-sweetened and light beverages (soft drinks).

Table 3. Socio-demographic characteristics by cluster solution in boys and girls participating in the ToyBox study

	n	Healthy diet and low activity (%)	Active (%)	Healthy lifestyle (%)	High water and screen time; low F&V and PA (%)	Unhealthy lifestyle (%)	High F&V consumers (%)	χ^2
Country								
Belgium	821	14·9	17·7	14·9	19·3	25·6	15·4	701 184*
Bulgaria	623	16·2	10·9	9·6	13·5	15·9	12·5	
Germany	778	14·8	22·3	35·3	11·8	13·3	27·2	
Greece	700	11·9	28·9	12·9	21·8	10·3	4·1	
Poland	919	22·8	4·5	7·8	15·1	27·4	24·4	
Spain	712	19·4	15·7	19·5	18·5	7·6	6·4	
BMI status (kg/m^2)†								
Normal weight	3764	88·0	86·7	84·2	86·8	85·3	85·4	11 121
Overweight	461	9·4	11·0	12·8	9·7	11·0	12·4	
Obesity	131	2·6	2·4	3·0	3·5	3·8	2·2	
Maternal education (years)								
<7–12	781	14·4	16·5	12·5	21·5	22·9	14·4	116 803*
13–16	1861	41	50·4	43·4	44	41·9	32·4	
>16	1765	44·0	33·0	44·6	34·5	35·2	52·2	
Paternal education (years)								
<7–12	1092	23·3	20	18·5	27·9	29·4	19·7	116 715*
13–16	1714	35·8	43·2	36·7	39·8	44	34	
>16	1477	38·0	32·6	40·3	26·8	25·4	44·0	
Parental education (years)								
<7–12	728	11·4	11·6	8·5	17·2	17·7	12·1	127 125*
13–16	1789	36·3	41·5	37·2	42	43·2	27·7	
>16	2070	51·1	41·8	52	39·4	37·5	51·2	

F&V, fruits and vegetables; PA, physical activity.
* $P < 0·001$.
† BMI according to Cole's cut-offs[36].

intake and screen time, was observed in 17 % of the sample. To our knowledge, such pattern has not been previously identified in European preschool children. In a previous study of children aged 2–9 years, the 'healthy' cluster was characterised by high F&V and low SSB consumption and low time spent in sedentary behaviours; however, participation in sports activities was

Table 4. Logistic regression analyses between clusters of energy balance-related behaviours and education level in boys and girls participating in the ToyBox study†
(Odds ratios and 95 % confidence intervals)

	Low		Medium		
	OR	95 % CI	OR	95 % CI	High
Maternal education					
Healthy diet and low activity	0·68*	0·55, 0·84	0·86	0·74, 1·03	Ref.
Active	1·10	0·80, 1·40	1·52*	1·21, 1·91	Ref.
Healthy lifestyle	0·55*	0·40, 0·75	0·86	0·70, 1·06	Ref.
High water and screen time; low F&V and PA	1·66*	1·37, 2·00	1·31*	1·13, 1·52	Ref.
Unhealthy lifestyle	1·55*	1·23, 1·96	1·14	0·94, 1·38	Ref.
High F&V consumers	0·65*	0·49, 0·86	0·55*	0·44, 0·68	Ref.
Paternal education					
Healthy diet and low activity	0·82*	0·68, 0·99	0·80*	0·68, 0·94	Ref.
Active	0·75	0·57, 1·00	1·14	0·90, 1·45	Ref.
Healthy lifestyle	0·56*	0·43, 0·73	0·74*	0·60, 0·92	Ref.
High water and screen time; low F&V and PA	1·82*	1·52, 2·17	1·40*	1·19, 1·65	Ref.
Unhealthy lifestyle	1·58*	1·25, 1·99	1·52*	1·23, 1·88	Ref.
High F&V consumers	0·57*	0·54, 0·74	0·62*	0·50, 0·77	Ref.
Parental education					
Healthy diet and low activity	0·68*	0·54, 0·85	0·80*	0·69, 0·93	Ref.
Active	0·82	0·58, 1·15	1·30*	1·05, 1·62	Ref.
Healthy lifestyle	0·48*	0·34, 0·68	0·76*	0·62, 0·93	Ref.
High water; low screen time and F&V and PA	1·73*	1·43, 2·11	1·33*	1·15, 1·54	Ref.
Unhealthy lifestyle	1·70*	1·32, 2·16	1·36*	1·13, 1·64	Ref.
High F&V consumers	0·72*	0·53, 0·96	0·63*	0·51, 0·77	Ref.

F&V, fruits and vegetables; PA, physical activity; Ref., reference group: high maternal, paternal and parental education, respectively.
* $P < 0·001$.
† Analysis adjusted by BMI, sex, age and country.

low[27], and it did not include sleep duration as a variable. Moreover, Fernandez-Alvira *et al.* reported a similar cluster in older school children, aged 10–12 years, labelled the 'Active' cluster[28] characterised by *z* scores above 0 for PA and *z* scores below 0 for soft drink consumption and screen time. None of these studies assessed water consumption as in our study and furthermore, our cluster demonstrated notably healthy trends for all the included EBRB.

Our results showed that preschool children with a lower parental education level were more likely to be allocated in the 'unhealthy lifestyle' and 'high water & screen time; low F&V & PA' clusters. Apart from high water consumption, the remainder of the EBRB, as well as the associations with the different socio-economic indicators, were similar between both clusters. Similar results were found in other studies examining the effect of parental educational level on EBRB clusters in preschool children[22,25,29]. Northstone & Emmett[22] found that a 'junk' diet (high in high-fat processed foods) and snack foods (high in fat and/or sugar) were positively associated with decreasing levels of maternal education in young children. Results from the Child, Parent and Health: Lifestyle and Genetic Constitution (KOALA) Birth Cohort Study of 2-year-old children showed that low and medium maternal education levels were associated with high scores of the 'sedentary-snacking' cluster[25]. Similar to our study, Gubbels *et al.*[29] assessed both paternal and maternal education levels in relation to the clustering of activity-related behaviours and eating routines in 5-year-old children. They reported that both maternal and paternal educational levels were inversely associated with the 'television – snacking pattern' and a negative association existed between low paternal educational level and the 'sports – computer pattern' cluster. Unlike our study, however, this analysis did not consider the intake of specific food groups or sleep duration.

Parents seem to have a crucial role in the lives of preschool children, controlling the availability of food, determining food intake and activity patterns and being role models, thus influencing preschool children's EBRB and weight gain[42]. Low parental education level, either parental or maternal, seems to be associated with more unhealthy lifestyles in preschool children, whereas when examining parental and maternal education level separately, higher maternal education level seems to be related to healthier eating habits, whereas higher paternal educational level is mainly associated with high PA level. Our findings still need to be interpreted with caution, accounting for the country-specific representation.

Our findings are in line with findings in slightly older school children and adolescents[20,28]. The review by Leech *et al.* examined the clustering of diet, PA and sedentary behaviours in children and adolescents aged 5–18 years. Cluster patterns characterised by high PA/sports participation were significantly associated with a higher level of parental education, whereas high sedentary behaviours clusters were associated with low parental education[20]. A study of 10- to 12-year-old children[28] reported that children of highly educated parents were more likely to be allocated in the cluster with high PA level, whereas clusters with high sugared drinks consumption, high screen time and low sleep duration were more prevalent in the group with lower educated parents. Such findings could suggest that the relationship between clustering of EBRB and parental education possibly tracks into later life.

Moreover, we assessed the potential association of the clusters with preschool children's BMI status. Our findings showed that the 'unhealthy lifestyle' pattern was more prevalent

in obese preschool children, which could indicate that unhealthy behaviours affect children's weight status. Previous studies have also suggested that patterns characterised by high television and snacking behaviour[16,29], as well as patterns mainly characterised by high consumption of noncarbonated sweetened beverages, high sedentary behaviour and low consumption of water, are positively associated with being overweight in children 3–6 years old[24]. In the contrary, no association was found in the study of Gubbels *et al.*[25]. In addition, boys participating in the IDEFICS study had increased odds of high BMI *z* scores when in the cluster with the highest time spent in sedentary activities and low PA[27]. In older school children, the results are inconsistent, with some studies suggesting a higher prevalence of overweight/obesity in unhealthy clusters, whereas other studies reporting no association[20]. It is worth mentioning that in the study of Fernandez-Alvira *et al.* the highest proportion of overweight and obese children were in the cluster characterised by both low sleep duration and low PA[28]. Our data concur with the last systematic analysis[43] where the overweight and obesity prevalence in Europe was relatively low in this population in comparison with North America.

Moreira *et al.*[44] in a study performed in children (5–10 years old) reported that television viewing, lower maternal education and lower sleep duration were positively associated with a dietary pattern that included fat and sugar-rich foods. In a systematic review performed by Leech *et al.*[20], several studies were identified where cluster patterns characterised by high PA/sports participation were significantly associated with a high parental education level. Meanwhile, high sedentary behaviour clusters were associated with low parental education. In addition, there is evidence suggesting an association between low parental SES and being overweight in children[43,44]. Parents of low SES children from Belgium, Germany and Spain, reported more hours of television viewing compared with parents of medium/high SES. One possible explanation could be based on the fact that parents of low SES had no rules regarding watching television. For this reason, it is important to inform how their rules about sedentary time could impact their children's health. Alternatives for television viewing, setting rules, turning off the television or encouraging children to participate in organised sports activities should be proposed for changing the amount of television viewing.

The main strengths of our study include a large pool of examined EBRB in a large sample of preschool children from six European countries, collected using standardised and harmonised data collection procedures[34] and reliable and validated questionnaires[33]. In addition, the study population was at a critical period regarding lifestyle habit acquisition. In addition, the use of cluster analysis provides a global view of preschool children's behaviours that are very critical at this young age.

However, our study has some limitations that may hamper the generalisation of the results. Information regarding preschool children's EBRB was provided by their parents or caregivers based on self-reported questionnaires, which, although prone to over- or under-reporting, has been shown to provide acceptably accurate and reliable data concerning children's dietary and lifestyle information[45]. Moreover, given the cross-sectional nature of this study, it does not allow the establishment of causal relationships but only associations. The authors are aware that a number of socio-demographic and lifestyle variables and factors could affect observations.

Conclusion

This is the first study providing insights into EBRB clustering in European preschool children. Further longitudinal analysis is needed to confirm whether our results track into later life and is replicated in other populations. These results have important implications not only for future research but also for public health strategies. Specifically, the development of lifestyle intervention strategies targeting low SES population groups could possibly help to prevent chronic diseases as obesity in children. The lifestyle behaviours have been linked with the SES background; for this reason, social and political efforts should be oriented to the most unfavourable SES families. Current evidence can be used to provide information for school policies and interventions targeting the school environment.

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Paper IV:

Combined longitudinal effect of physical activity and screen time on food and beverage consumption in European Preschool Children: The ToyBox-Study.

Efecto longitudinal combinado de la actividad física y el tiempo frente a la pantalla en el consumo de alimentos y bebidas en niños preescolares europeos: estudio ToyBox.

nutrients

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Article

Combined Longitudinal Effect of Physical Activity and Screen Time on Food and Beverage Consumption in European Preschool Children: The ToyBox-Study

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Abstract: Lifestyle behavioral habits such as excess screen time (ST), a lack of physical activity (PA), and high energy-dense food consumption are associated with an increased risk of children being overweight or obese. This study aimed to (1) track longitudinal adherence to PA and ST recommendations at baseline (T0) and follow-up (T1) and (2) assess the association between changes in adherence to PA and ST recommendations and food and beverage consumption at follow-up. The present study included 2321 preschool children (3.5 to 6) participating in the multicenter ToyBox-study. A lineal mixed effects model was used to examine the association between different types of food and beverages and their relationship with changes in adherence to PA and ST recommendations. Approximately half of the children (50.4%) did not meet the PA and ST recommendations at both baseline and follow-up. However, only 0.6% of the sample met both PA and ST recommendations. Preschool children who met both recommendations consumed fewer fizzy drinks, juices, sweets, desserts, and salty snacks and consumed more water, fruits and vegetables, and dairy products than did those not meeting both recommendations. In conclusion, the proportion of European preschool children adhering to both PA and ST recommendations was very low and was associated with a low consumption of energy-dense foods.

Keywords: screen time; physical activity; preschool children; food and beverage consumption

1. Introduction

Being overweight or obese during childhood and adolescence is a major public health challenge [1]. Excess weight gain during childhood is associated with long-term health risks and adult diseases such as cardiovascular disease, type 2 diabetes, and hypertension [2]. Behaviors such as excessive screen time (ST), a lack of physical activity (PA), and high consumption of energy-dense foods have been shown to be independently associated with increased risks of being overweight or obese in children, adolescents, and adults [3]. Individually and combined, high sugar-sweetened beverage and low fruit and vegetable consumption are associated with an increased obesity risk [4,5], while behaviors such as PA appear to be protective [6,7]. Hence, it is crucial that interventions during childhood target lifestyle behaviors such as diet, physical activity, and sedentary behavior, which are established in early years and track into adulthood [8].

PA guidelines for preschool children recommend that preschool children should spend at least 180 min per day doing PA [9]. Limited evidence suggests that a total daily physical activity volume of 10,000–14,000 steps per day is associated with 60–100 min of moderate vigorous PA in preschool children [10]. De Craemer et al. [11] proposed using 11,500 steps per day as an attainable and realistic cut-off for PA recommendations, helping to promote PA among preschool children. Regarding ST, established guidelines for preschool children (one- to five-year-olds) state that they should limit TV viewing and use of other electronic media such as computers, DVDs, and other electronic games to less than one hour per day [9].

ST has been shown to be associated with increased energy-dense food and beverage consumption and decreased fruit and vegetable (F & V) consumption in preschool children [12]. In European children participating in the IDEFICS study, low time spent on moderate to vigorous physical activity (MVPA) was associated with a low consumption of vegetables and yogurt and high fast food consumption [13]. A low socioeconomic status was also associated with consumption of high energy-dense foods, increased ST, and low levels of PA [14,15].

To the authors' knowledge, there are no studies that have investigated the individual and combined effects of PA and ST on food consumption in preschool children. For this reason, the current study aimed to (1) track longitudinal adherence to PA and ST recommendations at baseline (T0) and follow-up (T1) and (2) assess the association between changes in the adherence to PA and ST recommendations and food and beverage consumption at follow-up (T1).

2. Methods

2.1. Study Design

The ToyBox-study (www.toybox-study.eu) was were a cluster-randomized clinical trial aiming to prevent obesity in preschool children. It was conducted in six European countries, namely Belgium, Bulgaria, Germany, Greece, Poland, and Spain. The detailed protocol is described elsewhere [16,17]. In total, 309 kindergarteners and 7056 children aged 3.5–6 years were recruited at baseline (T0), and 5529 children continued at follow-up (T1) [18]. The ToyBox intervention aimed to promote preschool children's water consumption, healthy snacking, and PA and limit/interrupt their sedentary time by improving the children's physical and social environment both in kindergarten and at home. In this study, 2321 (33% of the baseline sample) preschool children were included with complete information from a parental questionnaire and also pedometer information at baseline (T0) and follow-up (T1). Data collection was carried out in May–June 2012 (T0) and May–June 2013 (T1). The ToyBox-study adhered to the Declaration of Helsinki and the conventions of the Council of Europe on human rights and biomedicine. In all countries, ethical approval was obtained from their respective ethical committees and local authorities.

2.2. Socioeconomic Variables

Maternal education level (years of education) was recorded in five categories: less than 7 years, 7–12 years, 13–14 years, 15–16 years, and more than 16 years of education. For the purposes of the analysis, this was then recategorized into three categories: less than 7 years to 12 years, between 13 and 16 years, and more than 16 years of education. The selection of this indicator was based on its identification as the best proxy indicator of socioeconomic status [19].

2.3. Anthropometric Measures

Body weight was measured in underwear and without shoes using an electronic scale (Type SECA 861 or SECA 813) to the nearest 0.1 kg, and body height was measured with a telescopic height instrument (Type SECA 225 or SECA 214) to the nearest 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by squared height (m^2). BMI z-scores (zBMI) were computed to classify children as being of a normal weight, being overweight, or being obese, for which the Cole et al. criteria were considered [20]. The intra- and interobserver reliability for weight and height was excellent (greater than 99% and 98%) in all participating countries [21].

2.4. Diet Assessment

Food and beverage consumption was assessed via a parentally reported semiquantitative food frequency questionnaire (FFQ) [22]. Low to moderate relative validity was observed, which varied by food and beverage group [23]. Estimated correlations ranged from 0.52 to 0.79. Food and beverage consumption was expressed as the number of portions per week. In the FFQ, 37 items were included, and in the current analysis they were merged into 21 groups according to their nutritional content (the main nutrient being proteins, carbohydrates, or fats). Of those 21, 10 were chosen and entered into the current analysis because they were considered to be associated with obesity development [24]: (1) water; (2) fizzy drinks (soft drinks and light drinks); (3) fresh fruit juices and packed juices; (4) dried, canned, and fresh fruits; (5) dairy products (milk, yogurt, and cheese); (6) sweets (chocolate and chocolate spreads, cakes, biscuits, and pastries); (7) desserts (smoothies, milk-based desserts, and sugar desserts); (8) meat and processed meat; (9) salty snacks; and (10) pasta and rice.

2.5. Physical Activity

In all of the countries except Belgium, PA was assessed by means of pedometers (Omron Walking Style Pro pedometers (HJ-720IT-E2)) assessing the number of steps per day. In Belgium, steps were measured using ActiGraph (Pensacola, FL, USA) accelerometers. Step counts from the accelerometers and pedometers were comparable. Evidence of their validity in preschool children indicated high correlations (daily, $r = 0.89$). In addition, evidence has suggested that the Omron Walking Style Pro pedometer is a valid and accurate measure to assess preschoolers' steps per hour [25]. The devices were worn on the right hip (secured by an elastic waistband) for six consecutive days, including two weekend days [22]. The steps were further categorized into two categories, including ≥11,500 steps per day (if children followed the PA recommendations) and <11,500 steps per day (if children did not follow the PA recommendations). The selected step count cut-off was based on Reilly et al. [26] and De Craemer et al. [11].

2.6. Screen Time

Data on children's screen time was collected via a standardized proxy-administered parental questionnaire (i.e., the Primary Caregivers' Questionnaire). Screen time was used as a proxy indicator of sedentary behavior. The behaviors assessed included watching TV and DVDs and playing computer/video games. Parents/caregivers reported frequency for both weekdays and weekend days. The frequency categories included "never", "less than 30 min/day", "30 min to 1 h/day", "1–2 h/day", "3–4 h/day", "5–6 h/day", "7–8 h/day", "8 h/day", and "more than 8 h/day". Average hours per day

of TV/video viewing and personal computer use (separately for weekdays and weekend days) were summed up to obtain the screen time. To obtain the daily screen time, the average minutes per day, both for week- and weekend days, were summed up and divided by 7 days. The answers were further aggregated into two categories, including ≤1 h per day (if children followed the recommendations) and >1 h per day (if children did not follow the recommendations). These categories were based on the Australian and Canadian sedentary behavior recommendations, which state that preschool children should limit their screen time to a maximum of 1 h per day [9,27,28].

2.7. Statistical Analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (version 21.0; SPSS, Inc., Chicago, IL, USA). Analysis was done for the whole sample, as there were no differences by sex in all of the included variables as tested using a *t*-test for continuous variables and a chi-squared test for categorical variables. In order to evaluate possible changes in the adherence to both behaviors (ST and PA) between T0 and T1, seven groups were established, reflecting differential combinations of meeting or not meeting the ST and/or PA recommendations. Figure 1 shows the seven groups derived from possible combinations of ST and/or PA recommendations. Two of them included children who got worse in their behaviors from T0 to T1 (meeting both recommendations at T0 and meeting one of the recommendations at T1; meeting one of the recommendations at T0 and not meeting any recommendations at T1). Two groups included children who improved in their behaviors from T0 to T1 (not meeting any recommendations at T0 and meeting one of the recommendations at T1; meeting one of the recommendations at T0 and meeting both recommendations at T1). The last three groups included children who maintained their behaviors from T0 to T1 (meeting both recommendations at T0 and T1; meeting one of the recommendations at T0 and T1; and not meeting any recommendations at T0 and T1). After establishing the potential combinations of ST and PA recommendations, a lineal mixed effects model with random effects for country and food consumption at T1 as predictor variables and z-BMI, maternal education, and intervention versus control region at T1 as covariates were analyzed. Marginal means and standard deviations (SE) were used to show differences in food and beverage consumption by PA and ST recommendation combinations. All statistical tests and corresponding *p*-values lower than 0.05 were considered statistically significant.

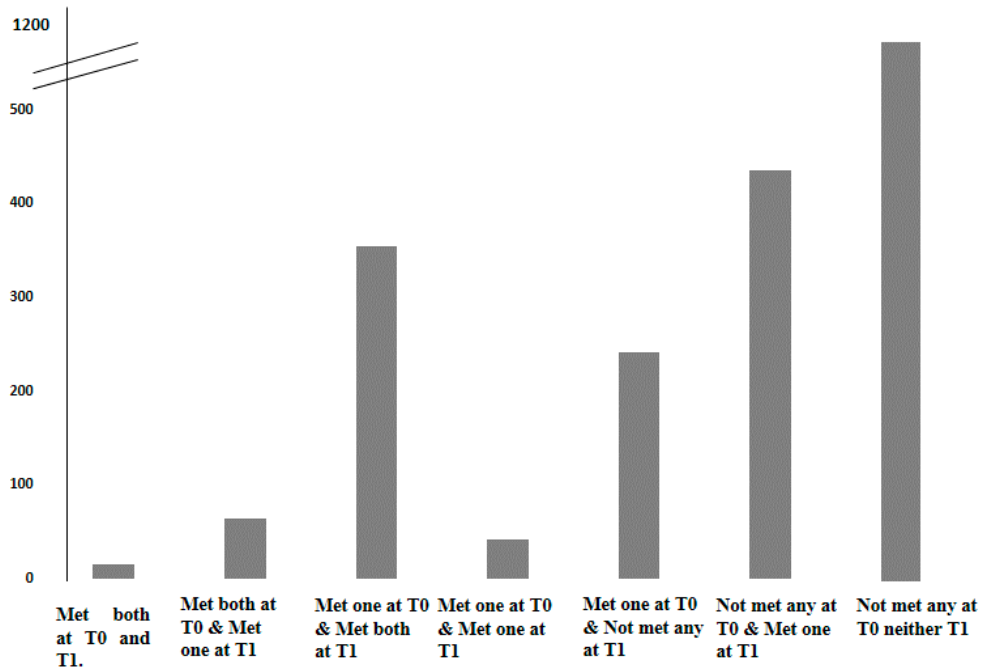

Figure 1. Proportion of European preschool children in each group. Groups are according to whether they met physical activity (PA) and/or screen time (ST) recommendations.

3. Results

Table 1 presents descriptive information on age, gender, BMI categories, z-BMI scores, maternal education, and country for the total sample, both at the T0 and T1 periods. According to BMI, 2.8% of the sample at T0 was obese and 10.6% was overweight, while 3.2% of the sample at T1 was obese and 10.3% was overweight.

Table 1. Descriptive characteristics of European preschool children participating in the ToyBox-study.

		T0	T1	*P*-Figvalue
		Mean (SE)	**Mean (SE)**	
Age (years)		4.74 (0.4)	5.72 (0.4)	<0.001
Sex	Boys	1209 (52.1)	1210 (52.1)	0.152
	Girls	1111 (47.9)	1111 (47.9)	
BMI status *	Normal weight	1988 (85.7)	1980 (85.3)	
	Overweight	245 (10.6)	240 (10.3)	<0.001
	Obese	64 (2.8)	75 (3.2)	
zBMI		0.20 (1.0)	0.27 (1.0)	<0.001
		n (%)		
Maternal education (years)	<7–12	337 (14.5)		
	13–16	947 (40.8)		0.104
	>16	965 (41.6)		
Center	Belgium	522 (22.5)		
	Bulgaria	74 (3.2)		
	Germany	284 (12.2)		0.645
	Greece	317 (13.7)		
	Poland	688 (29.6)		
	Spain	435 (18.7)		

Abbreviations: BMI, body mass index; zBMI, body mass index z-score; T0, baseline period; T1, follow-up period; * BMI according to Cole's cut-off [20].

Table 2 presents the proportion of the sample adhering to PA and ST recommendations for preschool children at both time points. Only 12.4% of children at T0 and 8.8% at T1 met the PA recommendation. In terms of ST, 30.2% of children at T0 and 27.7% at T1 met the recommendations.

Table 2. Number (%) of European preschool children participating in the ToyBox study that met or did not meet the physical activity and screen time recommendations at baseline (T0) and follow-up (T1) (n = 2321).

		T0 *n* (%)	T1 *n* (%)
Physical activity recommendations *	<11,500 steps/day	2033 (87.6)	2117 (91.2)
	≥11,500 steps/day	288 (12.4)	204 (8.8)
Screen time recommendations **	≤1 h/day	701 (30.2)	644 (27.7)
	>1 h/day	1620 (69.8)	1670 (72.3)

* Recommendations according to Reilly et al. [26] and De Craemer et al. [11] ** Recommendations on healthy eating and physical activity guidelines for early childhood settings in Australia [9,27,28].

Derived from the general linear model, Figure 2 presents the marginal means and SDs of eight food and beverage groups (F & V, dairy products, desserts, sweets, water, salty snacks, juices, and fizzy drinks), according to several grouping combinations for meeting or not meeting PA and ST recommendations at baseline (T0) and follow-up (T1). In general, preschool children who met both recommendations (PA and ST) consumed less dessert (Figure 2c), sweets (Figure 2d), salty snacks (Figure 2f), juices (Figure 2g), and fizzy drinks (Figure 2h) and more F & V (Figure 2a), dairy products (Figure 2b), and water (Figure 2e). In contrast, preschool children who failed to meet the

recommendations over time had a higher consumption of desserts (Figure 2c), sweets (Figure 2d), juices (Figure 2g), and fizzy drinks (Figure 2h), and lower consumption of F & V (Figure 2a) and water (Figure 2e).

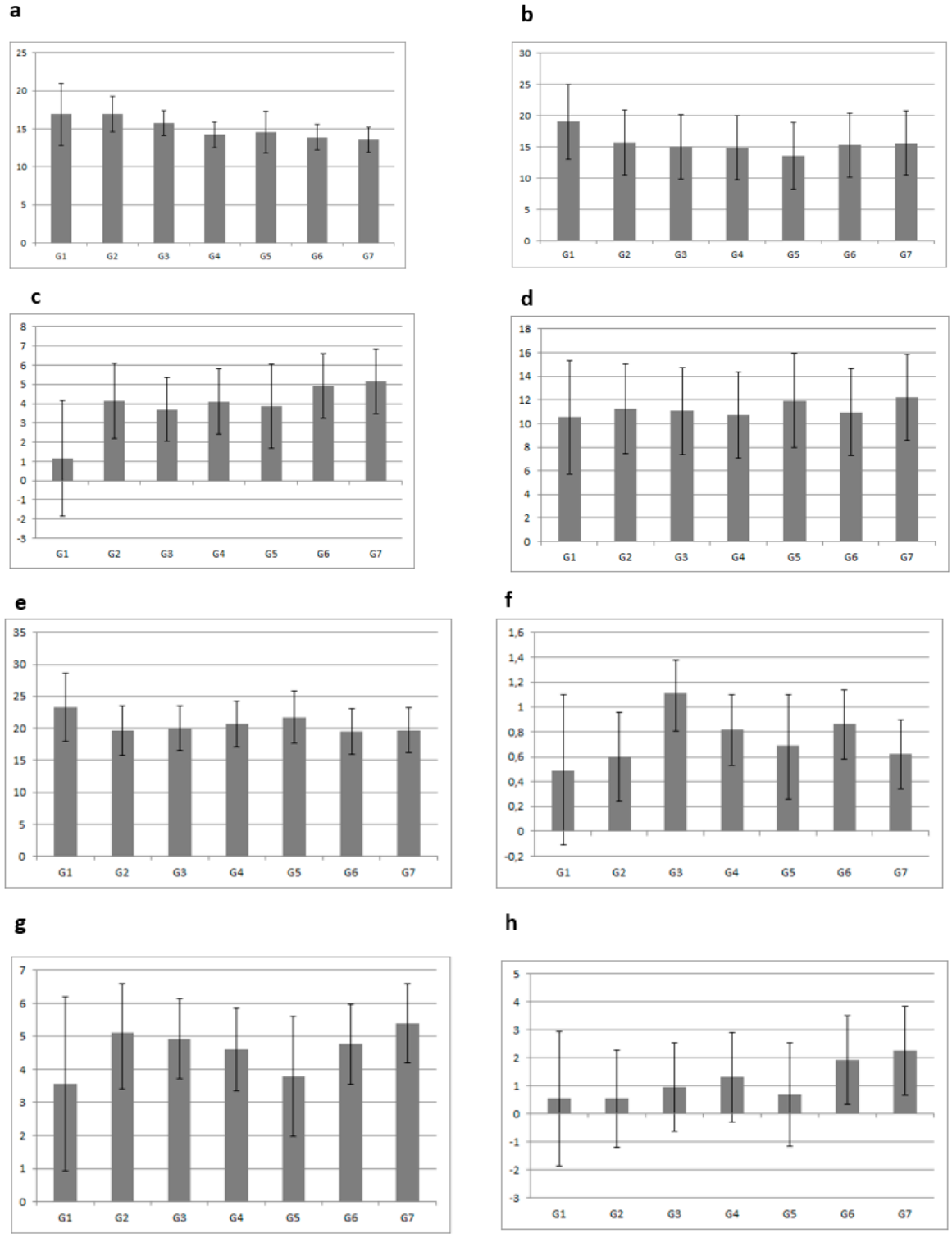

Figure 2. Marginal means and SD of food and beverage consumption (number of portions per week) according to PA and ST recommendations. G1: met both recommendations at T0 and met both recommendations at T1; G2: met both recommendations at T0 and met one of the recommendations at T1; G3: met one of the recommendations at T0 and met both recommendations at T1; G4: met one of the

recommendations at T0 and met one of the recommendations at T1; G5: met one of the recommendations at T0 and did not meet any recommendations at T1; G6: did not meet any recommendations at T0 and met one of the recommendations at T1; G7: did not meet any recommendations at T0 and did not meet any recommendations at T1. Adjusted for maternal education, body mass index z-score at T1, sex, and center. Abbreviations: PA, physical activity; ST, screen time; SD, standard deviation; T0, baseline period; T1, follow-up period; F & V, fruits and vegetables; dairy products (milk, yogurt and cheese); desserts (smoothies, milk-based desserts and sugar desserts); sweets (chocolate and chocolate spreads, cakes, biscuits and pastries); juices (fresh fruit juices and packed juices); fizzy drinks (soft drinks and light drinks). (**a**) F & V, (**b**) dairy products, (**c**) dessert, (**d**) sweets, (**e**) water, (**f**) salty snacks, (**g**) juices, (**h**) fizzy drinks.

Table 3 presents the associations between several grouping combinations of meeting or not meeting the PA and ST recommendations at T0 and at follow-up T1 and food and beverage consumption at follow up (T1). Seven possible combinations were identified. Approximately half of the sample (50.4%) did not meet either the PA or the ST recommendations in either period. With the opposite, only 0.6% of the sample met both PA and ST recommendations at both T0 and T1. Those who did not meet either recommendation at either time point (T0 and T1) were used as the reference group for analysis. Those children who met both recommendations at T0 and T1 consumed significantly fewer milk-based desserts and salty snacks in comparison to those who did not meet either recommendation at either time point. Those who met both recommendations at T0 and only one at T1 had a significantly lower consumption of fizzy drinks and salty snacks and higher consumption of F & V in comparison to the reference group. In addition, those children who met one of the recommendations at T0 and T1 had a significantly lower consumption of fizzy drinks, sweets, desserts, and salty snacks, and higher consumption of F & V. Those children who did not adhere to the recommendations at T0 and met one of them at T1 had a lower consumption of fizzy drinks, juices, sweets, desserts, and salty snacks in comparison to the reference group. At the same time, those children who met one of the recommendations at T0 and both at T1 had a lower consumption of fizzy drinks, juices, and salty snacks in comparison to not meeting either recommendation at either time point. Lastly, a significantly low consumption of juices, sweets, and salty snacks was observed in those children who met one of the recommendations at T0 and did not meet any recommendations at T1 in comparison to those who did not meet the PA and ST recommendations over time.

Table 3. Results of the lineal mixed effects model between food consumption and adherence to physical activity and screen time recommendations at baseline (T0) and follow-up (T1) periods (n = 2321).

PA and ST Recommendations at T0	PA and ST Recommendations at T1	*n* %	Water	Fizzy Drinks	Juices	F & V	Dairy Products	Sweets	Desserts	Meat and Processed Meat	Salty Snacks	Pasta and Rice
			β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Met both recommendations	Met both recommendations	15 (0.6)	3.41 (−1.22; 8.04)	−1.65 (−3.71; 0.41)	−1.84 (−4.32; 0.65)	3.32 (−0.62; 7.25)	3.43 (−0.77; 7.63)	−1.69 (−5.43; 2.04)	−4.03 (−6.75; −1.29) *	−2.38 (−5.06; 0.29)	−0.60 (−1.18; −0.02) *	0.49 (−0.51; 1.49)
Met both recommendations	Met one of the recommendations	64 (2.8)	0.25 (−2.16; 2.67)	−1.75 (−2.80; −0.69) *	−0.38 (−1.67; 0.90)	3.42 (1.41; 5.44) *	0.078 (−2.07; 2.23)	−0.93 (−2.84; 0.98)	−1,04 (−2.44; 0.35	−0.33 (−1.66; 0.99)	−0.51 (−0.80; −0.20) *	−0.26 (−0.77; 0.25)
Met one of the recommendations	Met both recommendations	354 (15.3)	1.76 (−1.09; 4.62)	−1.47 (−2.78; −0.16) *	−1.60 (−3.18; −0.02) *	0.99 (−1.50; 3.49)	−2.07 (−4.73; 0.59)	−0.32 (−2.69; 2.05)	−1.32 (−3.05; 0.40)	−0.10 (−1.77; 1.56)	−0.41 (−0.78; −0.04) *	−0.09 (−0.73; 0.55)
Met one of the recommendations	Met one of the recommendations	41 (1.8)	0.58 (−0.49; 1.66)	−1.34 (−1.82; −0.86) *	−0.47 (−1.05; 011)	2.29 (1.36; 3.20) *	−0.58 (−1.56; 0.40)	−1.15 (−2.03; −0.27) *	−1,45 (−2.08; −0.81) *	−0.56 (−1.17; 0.05)	−0.49 (−0.62; −0.35) *	0.01 (−0.22; 0.25)
Met one of the recommendations	Did not meet any recommendations	241 (10.4)	0.07 (−1.06; 1.21)	−0.34 (−0.85; 0.16)	−0.63 (−1.24; −0.01) *	0.38 (−0.58; 1.34)	−0.34 (−1.37; 0.69)	−1.24 (−2.15; −0.31) *	−0.24 (−0.90; 0.43)	−0.28 (−0.92; 0.35)	−0.24 (−0.38; −0.09) *	−0.21 (−0.46; 0.03)
Did not meet any recommendations	Met one of the recommendations	436 (18.8)	1.05 (−0.30; 2.41)	−0.97 (−1.55; −0.38) *	−0.78 (−1.49; −0.07) *	0.67 (−0.45; 1.79)	−0.74 (−1.92; 0.45)	−1.46 (−2.52; −0.40) *	−1.05 (−1.82; −0.27) *	−0.57 (−1.31; 0.17)	−0.29 (−0.46; −0.12) *	0.03 (−0.26; 0.31)
Did not meet any recommendations	Did not meet any recommendations	1170 (50.4)	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF

Adjusted for maternal education, body mass index z-score at T1, sex, and center. Abbreviations: PA, physical activity; ST, screen time; REF, reference group not meeting any recommendations at either T0 or T1; CI, confidence interval; fizzy drinks (soft drinks and light drinks); juices (fresh fruit juices and packed juices); F & V, fruits and vegetables; dairy products (milk, yogurt, and cheese); sweets (chocolate and chocolate spreads, cakes, biscuits, and pastries); desserts (smoothies, milk-based desserts, and sugar desserts). * $P < 0.001$.

4. Discussion

In this study, associations between lifestyle behaviors, i.e., PA and ST and food and beverage consumption in preschool children, were investigated. The novelty of this report included examining adherence to both PA and ST recommendations across two time points and its relationship with food and beverage consumption in a large sample of European preschool children. The main finding of our study suggests that meeting both PA and ST recommendations at T0 and T1 was associated with a high consumption of foods considered healthy (F & V and water) and a lower consumption of energy-dense products (fizzy drinks, sweets, desserts, and salty snacks). In addition, we also observed a low proportion of children adhering to both recommendations during the follow-up.

The high proportion of children who failed to meet individual PA and ST recommendations at both periods agreed with results from other longitudinal studies, which observed similar trends. To our knowledge, there is no study reporting the proportion of preschool children meeting both PA and ST recommendations at the same time. Studies focusing on PA have reported that the percentage compliance with MVPA recommendations for European children is generally low [29]. The Health Behavior in School-Aged Children (HBSC) Study found that only 26% of its sample spent at least 1 h per day in MVPA [30]. Regarding ST, the HBSC study reported that 39% of the children complied with screen time recommendations [31]. In European children, approximately one-third of the children failed to meet current screen time recommendations [32]. An Australian study with a follow-up of three years reported that less than 20% of the sample met the ST recommendations and that screen time increased over the three-year follow-up. In addition, in an Australian study, participants were less likely to meet ST recommended guidelines as they got older [33].

In our sample, we found low levels of PA and high levels of ST in preschool children. The preschool age is an important period, as lifestyle behaviors such as PA and ST are established. However, different studies have observed that PA decreases during early childhood and adolescence [34,35] and even more so during the transition period from adolescence to adulthood [35,36]. Regarding ST, studies have observed an increase in ST during early childhood and also during the transition from primary to secondary school [37]. Both low PA and high ST have been associated with unfavorable body composition indicators such as BMI and waist circumference [38–40], both being determinants of obesity development in adulthood [33]. It has been suggested that ST, particularly TV, has an important role in the etiology of obesity due to its relationship with other unhealthy behaviors and its displacement of PA [41]. However, there is little evidence about the relationship between PA and ST on the one hand and food and beverage consumption on the other hand.

Previously, several cross-sectional studies analyzed the effects of PA or ST (alone) on food and beverage consumption. In European children (2–10 years old), boys and girls spending less time doing MVPA were more likely to consume fast food and less likely to consume vegetables and yogurt than those spending more time doing MVPA [13]. Similar associations were observed in European adolescents [42]: Those adolescents with the lowest PA levels consumed fewer fruits and dairy products compared to active adolescents. In a previous publication of the ToyBox study, those exceeding baseline ST recommendations had a higher consumption of energy-dense foods (sugar-based desserts, salty snacks, pastries, cakes, and biscuits) and beverages (fizzy drinks, sweet milk, and juices) than those complying with ST recommendations [12]. Another study reported that high TV viewing was related to less healthy food options (consumption of sweets and soft drinks) in children from different countries [43]. A study carried out in Brazil [44] in children less than two years old observed a positive association between time spent watching TV and the consumption of soft drinks. Santaliestra-Pasias et al. [45] reported that increased TV viewing and computer and internet use were associated with higher odds of sugar-sweetened beverage consumption and lower odds of fruit consumption in European adolescents. In an Australian adolescent sample, TV viewing was positively associated with energy-dense snack consumption and with higher availability of energy-dense snack foods at home [46].

There is consistent evidence to show that consumption of energy-dense foods is positively associated with low PA and high ST levels. However, research assessing the relationship between combinations of both PA and ST and food and beverage consumption is very scarce. Although high levels of both PA and ST have been observed in children [5], no studies have observed the combined effects of adherence to PA and ST recommendations on food and beverage consumption in preschool children.

This study had limitations. First, the generalizability of the findings is limited to the specific age group studied in the current study. The method used to assess PA was a pedometer, aside from Belgium. However, pedometers are not the gold standard in measuring preschool child PA, and therefore our results should be interpreted with caution. Nevertheless, the use of a pedometer provided objective information on PA, specifically in this age group. Information on food and beverage consumption and ST were collected via parental self-reported questionnaires, which are prone to over- or underreporting. However, the questionnaires used were developed/adapted and validated for the purposes of the study [22].

The main strengths of our study included the use of a large and culturally and socioeconomically diverse sample of preschool children from six different countries across Europe and its longitudinal design. Information through questionnaires was assessed via standardized and harmonized procedures [22].

5. Conclusions

This study examined the relationship between adherence to PA and ST recommendations and food and beverage consumption. In this sample of preschool children, we found that low PA levels and high ST were associated with an unhealthy food and beverage consumption profile. Preschool children and their parents should try to increase family time spent at activities promoting physical activity and to minimize the time they spend on screen time or being sedentary. In addition, public health interventions should focus on activities aimed at increasing movement in preschool children. Enabling healthier food and physical activity environments, together with the promotion of positive parental role modeling, should be prioritized to achieve higher rates of adherence to PA and ST recommendations.

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Paper V:

Parental perceptions, attitudes and knowledge on European preschool children's total screen time: The ToyBox-study. (accepted for publication)

Percepciones, actitudes y conocimientos de los padres sobre el tiempo de pantalla total de los niños europeos en edad preescolar: el estudio ToyBox (aceptado para publicación)

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Sincerely,
Dr. Peter Allebeck
Editor, European Journal of Public Health

Parental perceptions, attitudes and knowledge on European preschool children's total screen time: The ToyBox-study

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Abstract

Background. Preschool children spend a significant proportion of their waking hours being sedentary. Parents play a critical role in developing and shaping their children's lifestyle behaviours, particularly in the early years of life. This study aims to assess parental perceptions, attitudes and knowledge of their preschool children's sedentary behaviours and the association with children's TV/video/DVDs viewing and total screen time.

Methods. Data was obtained from a sample of 4836 children (3.5 to 5.5 years), participating in the multi-centre ToyBox-study at baseline (TO) and at one-year follow-up (T1) periods. Data on children's sedentary behaviours were collected via a standardized proxy-administered primary caregiver's questionnaire.

Results. Regarding total screen time, 66.6% of the children at T0 and 71.8% at T1 in the control group exceeded the recommendations, whereas the proportion in the intervention group varied from 69.7% at T0 to 72.5% at T1. The odds of exceeding total screen time recommendations were significantly higher when parental perceptions towards limiting the total screen time were negative ((both T0 and T1 and in the intervention and control groups ($p<0.05$)). Similarly, the odds of exceeding TV/video/DVDs viewing recommendations were significantly higher (both T0 and T1 is this observed in both groups) when parental knowledge of recommendation were absent.

Conclusion. Preschool children whose caregivers stated rules limiting their sedentary screen time were less likely to spent a high amount of time watching TV/video/DVDs. Interventions to increase parental practices may be a promising approach to decreasing total screen time of preschool children but studies are needed to confirm this.

Keywords:

● Total screen time ● Preschool children ● Parental perceptions and attitudes ● TV viewing ● Video viewing

Introduction

Childhood is a critical window of opportunity to influence lifestyle behaviours and health at early ages and their tracking into adulthood. Early childhood is a critical period to prevent obesity as key obesity-related behaviours like sedentary time develop during this stage. In fact, promoting a healthy diet and encouraging physical activity (PA) are some of the best options that can be made for personal well-being (1). Preschool children spent a significant proportion of their time being sedentary (2) which is shown to be increasing with age (3-5). Total screen time is the major contributor to the total sedentary screen time in children (6). Evidence shows that a high proportion of preschool children exceed recommendations for this specific age group i.e. maximum of one hour per day (7-9). Previous results of the ToyBox-study showed that 70% of preschool children from six European countries exceeded this recommendation (10, 11) with those with low parental education levels are at greater risk of exceeding the recommendations (12).

Given that most of the time spend on watching television (TV) is done in the home environment (13), parents have an important role in their children's screen-viewing habits. Hence, working with parents, as part of public health interventions, is essential to minimize their children's sedentary screen time as family rules seem to be effective in reducing screen time (14). Some European studies reported that children, from families with an authoritative parenting style of screen time, were more likely to comply with screen time recommendations (15, 16). Parental knowledge of screen time recommendations for preschool children could be important to establish rules at home. However, there is limited research in this matter. A study in children of two years of age and below reported that parents with knowledge of screen time recommendations influenced their children's habits i.e. children spent less time in front of a screen (17).

To the authors' knowledge, there are no studies in European preschool children that evaluated the longitudinal relationship between parental perceptions, attitudes and knowledge and its impact on children's TV/video/DVDs viewing or total screen time. So, the objectives were: 1) to examine the cross-sectional association of parental perceptions, attitudes and knowledge of screen-time recommendations with their children's total screen time both at baseline and follow-up; 2) to track parenting attitudes, perceptions and knowledge and children' total screen time recommendations between TO and T1and its association with children's TV/video/DVDs viewing and total screen time at follow-up.

Methods

Study design

The ToyBox-study (www.toybox-study.eu) is a multicomponent, kindergarten-based, family-involved intervention with a cluster-randomized design aiming to prevent obesity in preschool children. It was conducted in six European countries namely Belgium, Bulgaria, Germany, Greece, Poland and Spain. The detailed protocol is described elsewhere (18, 19). In total, 309 kindergartens and 7056 children aged 3.5–5.5 years were recruited at baseline (T0) and 5529 children continued at follow-up (T1) (20). The ToyBox-intervention aimed to promote preschool children's water consumption, healthy snacking, PA and limit/interrupt their sedentary screen time by improving the children's physical and social environment both at the kindergarten and at home. For the purposes of this study, 4836 (69% of the T0 sample) preschool children were included with complete information from the parental questionnaire (i.e. Primary Caregivers' Questionnaire) at T0 and T1. Data collection was carried out between May-June 2012 (T0) and May-June 2013 (T1). The selected kindergartens were randomly assigned as intervention or control at a 2:1 ratio. The ToyBox-study

adhered to the Declaration of Helsinki and the conventions of the Council of Europe on human rights and biomedicine. In all countries, ethical approval was obtained from their respective ethical committees and local authorities. Parents provided a consent form for their child or children to participate.

Socioeconomic variables

Maternal education level (years of education) was recorded in five categories (i) less than 7 years, ii) 7–12 years, iii) 13–14 years, iv) 15–16 years and v) more than 16 years of education). Re-categorized into the following categories for the purposes of this analysis: less than 7 years to 12 years, between 13 to 16 years, and more than 16 years of education. The selection of this indicator was based on evidence as the most suitable proxy indicator of socioeconomic status in children (21).

Anthropometric measures

Body weight was measured in underwear and without shoes using an electronic scale (Type SECA 861 or SECA 813), and body height was measured with a telescopic height instrument (Type SECA 225 or SECA 214) to the nearest 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by squared height (m^2). BMI z-scores (z-BMI) were computed and were used to classify children as having normal weight, overweight and obesity according to Cole et al. (22). The intra- and inter-observer reliability for weight and height was excellent (greater than 99% and 98%, respectively) in all participating countries (23).

Parental perceptions and attitudes

Parental perceptions and attitudes were collected via a standardized proxy-administered parental questionnaire. Parents/caregivers were asked to answer the following statements: “Q1. My child’s TV viewing levels are within the appropriate

recommendations", "Q2. I think it is necessary to limit the screen viewing activities for my child" and "Q3. My child is allowed to watch TV for as long as he/she wants". Original response categories can be found elsewhere (24) and re-categorized into the following three "Disagree", "Neither agree nor disagree" and "Agree" categories.

For the purposes of the analysis and considering possible changes in parental perceptions, attitudes and knowledge between T0 and T1, nine groups were established, reflecting differential combinations of the above questions (Q1, Q2 and Q3) stating in table 2.

Lastly, parental knowledge about TV viewing recommendations was assessed through the question "Q4. I think that the recommendation for TV viewing for 4-6 year old children is". Original response categories can be found elsewhere (24) and then were re-categorized into four categories; (1) "≤ 1 h/day"; (2) "> 1 h to ≤ 3 h/ day"; (3) "> 3 h/day"; and (4) "I don´t know". For the purpose of the longitudinal analysis, ten possible combinations of the above Q4 were established stating in table 2.

Sedentary behaviours

Data on children's sedentary behaviours were collected via the standardized proxy-administered parental questionnaire. Parents indicated the frequency that their children watched TV/videos/DVDs and played computer/video games on a scale of: 'never', 'less than 30 min/day', '30 min to 1 h/day', '1–2 h/day', '3–4 h/day', '5–6 h/day', '7–8 h/day', '8 h/day' and 'more than 8 h/day'. Average hours per day of TV/video/DVD viewing and personal computer/video games were computed separately for weekdays and weekend days. To obtain the daily TV/video/DVDs viewing and personal computer/video games separately, average minutes per day, both for week and weekend days were summed up and divided by 7 days. To obtain the total daily screen time, the average minutes per day both TV/video/DVDs viewing and personal computer/video

games were summed. Both variables (TV/video/DVDs viewing and total screen time) were further re-categorized into two groups including ≤1 h per day (if children followed the recommendations) and >1 h per day (if children did not follow the recommendations). These categories were based on the Australian, Canadian and recently from World Health Organization sedentary behaviour recommendations stating that preschool children should limit their screen time to maximum 1 h per day (8, 25, 26).

Statistical analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences (version 21.0; SPSS, Inc.) except for the multilevel logistic regression model that was conducted using Stata/SE 13 (Stata Corp LP, College Station, TX, USA). Analyses were done for the whole sample, as there were no differences by sex, tested using a t-test for continuous variables and a chi-squared test for categorical variables. Analysis was performed separately by control and intervention group.

For the longitudinal analysis, ANCOVA was used and marginal means and standard errors (SE) indicated differences in TV/video/DVDs viewing and total screen time by parental perceptions, attitudes and knowledge respective combinations indicated above. The analysis was adjusted for maternal education, z-BMI scores in T1, sex, age and centre. Finally, a multilevel logistic regression (level: centre) was performed. TV/video/DVD viewing or total screen time was considered as dependent variables and parental perceptions, attitudes and knowledge respective combinations as independent variables. Age, gender, z-BMI scores and maternal education at T1 were included as covariates into the analysis. All statistical tests and corresponding p-values lower than 0.05 were considered statistically significant.

Results

Table 1 provide information on age, gender, BMI categories, z-BMI scores, maternal education, country, TV/video/DVD viewing and total screen time both at T0 and T1 periods. According to BMI cut-offs, 8.9% of the total sample at T0 had obesity or overweight, while 9.4% of the total sample had obesity or overweight at T1. Regarding total screen time in the control group, 66.6 % exceeded the recommendations at T0 and 71.8% at T1.

Derived from the ANCOVA analysis, **Figure 1** presents marginal means and SE of TV/video/DVD viewing and total screen time (minutes/day) according to perceptions, attitudes and knowledge of the parents both at T0 and T1. In general, preschool children with positive parental perceptions towards the independent variables and knowledge on recommendations spent less time in front of any screen both at T0 and T1 as opposed to less strict parenting practices and limited or no knowledge of recommendations.

Table 2 presents mean time of TV/video/DVDs viewing and total screen time according to combinations of changes for parental perceptions, attitudes and knowledge between T0 to T1, in both control and intervention groups. Children whose parents agreed with the statement ((37.6% and 40.1 % (intervention and control group respectively)) that their children´s viewing levels were within the appropriate recommendations at both time points had significantly lower TV/video/DVDs viewing time was in comparison to children whose parents did not agree. When asked if they thought that it was necessary to limit their children's total screen time, only 8.2% and 11.4% (intervention and control group) of parents agreed. Those preschool children whose parents thought that it was not necessary to limit the total screen time at both T0 and T1, had significantly higher total screen time than those whose parents thought that it was necessary to limit it. The majority of the parents (80.90% intervention group and 83.87% control group) disagreed to allow their children watching TV for as long as they wish. Children with

parents not allowing them to watch TV for as long as they wish showed significantly lower TV/video/DVDs viewing time in comparison with those children whose parents had no rules about TV/video/DVDs viewing. Regarding to the parental knowledge about TV/video/DVDs viewing recommendations, 66.45% (intervention group) and 67.57% (control group) of parents knew about it at both T0 and T1. This knowledge resulted in significantly lower TV/video/DVDs viewing time of their children as compared with those children whose parents were not aware of the recommendations.

Results from multilevel logistic regression analysis are also shown in **table 2**. The odds of exceeding the TV/video/DVDs viewing recommendations were significantly higher when parents disagreed with the statement (Q1) at both time points, and both intervention and control groups. The highest probability was found when parents agreed at T0 and disagreed at T1 for both intervention and control group (Q.1.7).

When parents asked if it was necessary to limit the total screen time for the children (Q2), the odds of exceeding the total screen time recommendations in preschool children were significantly higher when parents disagreed at both T0 and T1 for both intervention and control group (Q.2.1). Only in the intervention group, the odds of exceeding the total screen time recommendations were less if the parents did not set limit in the total screen time at T0 and yes at T1 (Q.2.3), compared with those who agreed to limit the total screen time at both time points.

Regarding the question if parents allowed watching TV/video/DVDs for as long as their children wished (Q3), the preschool children had significantly higher probability to exceed the recommendations when parents disagrees at T0 and neither agrees nor disagrees at T1 (Q.3.2), both intervention and control group. Only in the intervention group, the odds of exceeding the TV/video/DVDs viewing recommendations were significantly higher when parents agreed at both T0 and T1 (Q.3.9).

Finally, parents were asked about their knowledge on recommendations for TV/video/DVDs viewing for 4-6 years old children (Q4). The odds of complying with the recommendations were higher in those preschool children whose parents thought that the recommendations were ≤ 1 h per day at T0 and >1 h to 3 h per day at T1 (Q.4.2), both in the intervention and control groups. However, the odds of exceeding the TV/video/DVDs viewing recommendations were significantly lower in those preschool children whose parents thought that the recommendations were >1 h to 3 h per day at T0 and ≤1 h per day at T1 (Q.4.4), both in the intervention and control group. Only in the control group, the odds of exceeding TV/video/DVDs viewing recommendations were significantly higher when parents thought that the recommendations were >3 h per day at both T0 and T1 (Q.4.9). Lastly, when parents did not know the recommendations, at both T0 and T1, preschool children were more likely to exceed the recommendations than those preschool children whose parents knew the recommendations.

Discussion

The novelty of this study includes examining the effect of paternal perceptions, attitudes and knowledge of TV/video/DVDs or total screen time on their children's adherence to screen time recommendations, across a period of one year of follow-up in a large sample of European preschool children using the same harmonized methodology. The current results suggest that parental attitudes could boost or not a nurturing environment for TV/video/DVDs viewing and subsequently influence their children's screen habits. For instance, more restricting rules or being conscious about screen time recommendations were associated with low TV/video/DVDs time in this sample of European preschool children.

Although TVs still appear to be the most common form of screen devices among children up to the age of six, playing computer/video games, tablets, and smartphones

have become widely available. The combination of total screen time is an essential tool to assess overall sedentary screen time. In our sample, a high proportion of children did not meet individual total screen time recommendations at T0 and T1. The current findings are consistent with research from other countries that have previously reported high exposure to TV, computer and videos at young ages. For example, a Canadian study reported that 25% of children aged 2–5 watched >2 hours of television daily (27). Another study observed that >80% of the Australian school children did not met their specific age- recommendation of spending < 2 hours per day using electronic media (28). In European children (2-9 years), approximately a third of the children failed to meet recommendations (29), and in European adolescents, the proportion of them that watched TV more than 2 h per day, was 58% in males and 53% in females (30).

Our study found strong and consistent associations between child's total screen time and parental rule setting practices. Parental limits and rules about TV or total screen time predicted less TV/video/DVDs viewing time in our sample. In preschool children from Netherlands, children from families with an authoritative parenting style had lower probability of exceeding screen time recommendations compared to families with a neglectful style indicating higher adherence to recommendations in children with established family screen time rules (15). Another study by Jago et al. (31) reported that a greater proportion of children with permissive parents watched TV > 4 h per day, compared with children with authoritarian parents. An Australian study of preschool children reported that children whose parents limited television viewing had significantly less time in total screen time (32). For all these reasons, improving parenting practices may be a promising approach to incorporate in health promotion strategies aiming to reduce or delay the screen time in very young children.

There is consistent evidence showing that parental rules are associated with lower levels of total screen time (33, 34). Jago et al. (35), in a systematic review, identified seven types of rules as part of the parenting practices: (1) limits on total time; (2) limits on time of day; (3) content restriction; (4) rules for no viewing during mealtimes; (5) rules for only allowing viewing when supervised by a parent; (6) contingent screen time in which TV can only occur when other tasks, such as homework or exercise, have been completed; and (7) a no TV policy. Moreover, parental knowledge of the recommendations may impact parental decisions to set screen time rules for their children. In this sense, it is important to note that research assessing the relationship between parental knowledge of screen viewing recommendations and total screen time in preschool children is scarce. Only a study carried out in Singapore (17) researched the association between parental knowledge of screen viewing recommendations and levels of screen viewing in young children. Findings showed that greater parental knowledge was associated with lower levels of screen viewing in children aged 2 years and below.

In our sample, significant differences between differential combinations of change in respect to parental perceptions, attitudes and knowledge between T0 and T1 and its effect on TV/video/DVDs and total screen time were observed. In this sense, conscious parental perceptions, attitudes and knowledge of recommendations and its effect on TV and total screen time can help to develop effective interventions for specific behaviours directly associated with non-communicable chronic diseases (34).

There are several limitations to our findings. First, generalizability of the findings is limited to the specific age group studied. Information on sedentary behaviours was collected via parental self-reported questionnaires, which are prone to over- or under-reporting. However, this questionnaire was developed/adapted and validated for the

purposes of the study (36). Nevertheless, this study has many strengths including the use of a large, culturally and socioeconomically diverse sample of preschool children from six different countries across Europe. The novelty of the results and the longitudinal design of the current analyses are also strengths, which increase the value of the results, especially at preschool ages.

Conflicts of interest

No conflict of interest was declared.

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Key points

- Preschool children whose parents have rules limiting sedentary screen time were less likely to spend high amount of time watching of TV/video/DVDs
- Family rules related to screen time and higher parent's knowledge about children's TV viewing times recommendations can decrease preschool children's total screen time.
- Improving parenting practices may be promising approaches in future interventions to decrease screen time.

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Table 1. Sample characteristics of included participants (n=4836).

		T0	T1	P value
		Mean (SD)	Mean (SD)	
Age		4.74 (0.4)	5.72 (0.4)	<0.001
		n (%)	n (%)	
Sex	**Boys**	3827 (51.8)	3827 (51.8)	0.361
	Girls	3562 (48.2)	3562 (48.2)	
		n (%)	n (%)	
BMI status*	**Normal weight**	4179 (56.5)	4136 (56.0)	
	Overweight	514 (7.0)	516 (7.0)	<0.001
	Obesity	143 (1.9)	181 (2.4)	
z-BMI scores		0.20 (1.0)	0.27 (1.0)	<0.001
		n (%)		
Maternal education (years)	**<7-12**	1383 (18.7)		
	13-16	3055 (41.3)		0.109
	>16	2607 (35.3)		
Country	**Belgium**	1263 (17.1)		
	Bulgaria	917 (12.4)		
	Germany	1276 (17.3)		
	Greece	1768 (23.9)		0.625
	Poland	1345 (18.2)		
	Spain	820 (11.1)		

		Intervention Group		Control Group		
		T0	T1	T0	T1	
		n (%)	n (%)	n (%)	n (%)	
TV/video/DVDs	**≤ 1hour/day**	1045 (32.4)	1009 (31.05)	628 (36.1)	558 (32.2)	0.035
viewing**	**>1 hour/day**	2178 (67.6)	2193 (68.5)	1110 (63.9)	1173 (46.9)	
Total screen time**	**≤ 1hour/day**	966 (30.3)	874 (27.5)	574 (33.4)	482 (28.2)	0.011
	>1 hour/day	2227 (69.7)	2301 (72.5)	1144 (66.6)	1229 (71.8)	

Abbreviations: BMI; Body Mass Index, z-BMI; Body Mass Index z-score
T0; baseline period, T1; follow-up period
* BMI status according to Cole´s cut-off (23)
** Recommendations on healthy eating and physical activity guidelines for early childhood settings in Australian, Canadian and World Health Organization (7,8,26).

Table 2. Analysis of covariance and multilevel logistic regression analysis by combinations of change for parental perceptions, attitudes and knowledge between at both time points (T0 and T1), in both intervention and control group, and its effects on TV viewing and screen time at T1.

			INTERVENTION GROUP			CONTROL GROUP		
Q1. My child's TV viewing levels are within the appropriate recommendations								
	T0	**T1**	**n (%)**	**Mean (CI)***	**OR (95% CI) †**	**n (%)**	**Mean (CI)***	**OR (95% CI) †**
Q.1.1	Disagree	Disagree	163 (5.6)	148.5 (139.68;157.44)	**6.85 (3.86;12.14)**	71 (4.5)	154.8 (141.01;168.66)	**8.52 (5.57;10.57)**
Q.1.2	Disagree	Neither agree nor disagree	133 (4.5)	119.0 (109.13;128.88)	**3.38 (2.01;5.67**	70 (4.4)	116.3 (102.51;130.11)	**5.27 (2.48;11.19)**
Q.1.3	Disagree	Agree	89 (3.1)	84.4 (72.17;96.65)	**1.83 (1.07;3.10)**	46 (2.9)	89.4 (72.32;106.39)	**2.03 (0.97;4.25)**
Q.1.4	Neither agree nor disagree	Disagree	127 (4.3)	140.9 (130.83;151.05)	**6.39 (3.33;12.24)**	58 (3.7)	132.1 (117.17;147.12)	**9.51 (3.59;25.18)**
Q.1.5	Neither agree nor disagree	Neither agree nor disagree	575 (19.6)	109.2 (104.51;113.95)	**3.11 (2.37;4.07)**	300 (19.1)	104.8 (98.07;111.53)	**3.11(2.14;4.50)**
Q.1.6	Neither agree nor disagree	Agree	330 (11.3)	81.7 (75.43;87.98)	**1.34 (1.01;1.79)**	175 (11.1)	85.8 (77.14;94.59)	**1.76 (1.18;2.63)**
Q.1.7	Agree	Disagree	80 (2.7)	122.8 (109.73;135.85)	**8.33 (3.66;18.95)**	48 (3.0)	123.9 (106.73;141.18)	**9.38 (3.15;27.93)**
Q.1.8	Agree	Neither agree nor disagree	329 (11.2)	110.1 (103.74;116.33)	**3.01 (2.16;4.19)**	174 (11.2)	100.1 (91.24;108.88)	**2.76 (1.79;4.27)**
Q.1.9	Agree	Agree	1102 (37.6)	69.0 (65.54;72.45)	*Ref*	631 (40.1)	70.5 (65.93;75.16)	*Ref*
Q2. I think it is necessary to limit the screen viewing activities for my child.								
			INTERVENTION GROUP			**CONTROL GROUP**		
	T0	**T1**	**n (%)**	**Mean (CI)***	**OR (95% CI) †**	**n (%)**	**Mean (CI)***	**OR (95% CI) †**
Q.2.1	Disagree	Disagree	1447 (46.3)	119.5 (115.27;123.74)	**2.44 (2.27;4.19)**	762 (44.8)	114.5 (108.55;120.42)	**4.41 (2.11;5.67)**
Q.2.2	Disagree	Neither agree nor disagree	140 (4.4)	123.0 (109.28;136.79)	0.85 (0.55;1.32)	88 (5.2)	107.1 (89.63;124.65)	0.83 (0.48;1.41)
Q.2.3	Disagree	Agree	217 (6.9)	111.3 (100.34;122.19)	**0.59 (0.41;0.83)**	113 (6.6)	120.1 (104.53;135.67)	0.95 (0.52;1.67)
Q.2.4	Neither agree nor disagree	Disagree	124 (3.2)	94.3 (79.66;108.89)	0.64 (0.41;1.01)	57 (3.4)	128.0 (105.87;150.67)	1.39 (0.66;2.87)
Q.2.5	Neither agree nor disagree	Neither agree nor disagree	230 (7.3)	132.4 (121.79;142.94)	0.95 (0.66;1.37)	135 (7.9)	128.3 (113.94;142.64)	1.30 (0.78;2.17)
Q.2.6	Neither agree nor disagree	Agree	240 (7.7)	131.3 (121.02;141.64)	1.12 (0.78;1.56)	111 (6.5)	140.9 (125.28;156.66)	1.20 (0.70;2.05)
Q.2.7	Agree	Disagree	215 (6.9)	98.4 (87.39;109.34)	1.65 (0.96;2.91)	110 (6.5)	95.3 (79.65;111.08)	0.67 (0.42;1.08)
Q.2.8	Agree	Neither agree nor disagree	254 (8.1)	139.5 (129.51;123.74)	1.10 (0.78;1.56)	130 (7.6)	123.2 (108.99;137.41)	0.77 (0.49;1.19)
Q.2.9	Agree	Agree	256 (8.3)	91.3 (81.19;101.43)	*Ref*	194 (11.4)	95.4 (82.19;100.03)	*Ref*

Q3. My child is allowed to watch TV for as long as he/she wants.								
			INTERVENTION GROUP			CONTROL GROUP		
	T0	T1	n (%)	Mean (CI)*	OR (95% CI) †	n (%)	Mean (CI)*	OR (95% CI) †
Q.3.1	Disagree	Disagree	2533 (80.9)	86.9 (84.57;89.37)	*Ref*	1430 (83.8)	83.9 (80.80;87.06)	*Ref*
Q.3.2	Disagree	Neither agree nor disagree	142 (4.5)	129.8 (119.51;140.23)	**1.38 (1.06;4.18)**	68 (3.9)	116.4 (102.31;130.47)	**1.50 (1.01;5.40)**
Q.3.3	Disagree	Agree	53 (1.6)	99.7 (82.74;116.78)	0.80 (0.41;1.55)	42 (2.4)	119.9 (101.19;138.61)	1.10 (0.51;2.38)
Q.3.4	Neither agree nor disagree	Disagree	142 (4.5)	107.1 (96.82;117.38)	1.26 (0.79;2.00)	57(3.3)	114.6 (98.60;130.65)	**6.98 (2.09;23.34)**
Q.3.5	Neither agree nor disagree	Neither agree nor disagree	89 (2.8)	120.2 (107.51;132.97)	1.49 (0.81;2.73)	34 (1.9)	146.3 (125.21;167.33)	4.61 (1.03;20.56)
Q.3.6	Neither agree nor disagree	Agree	21 (0.6)	118.7 (93.04;121.30)	2.13 (0.61;7.41)	10 (0.6)	90.4 (51.97;128.76)	1.41 (0.26;7.53)
Q.3.7	Agree	Disagree	78 (2.5)	107.5 (93.82;121.30)	1.40 (0.75;2.59)	36 (2.1)	109.5 (90.03;128.98)	1.51 (0.63;1.34)
Q.3.8	Agree	Neither agree nor disagree	39 (1.2)	137.5 (119.06;156.98)	1.83 (0.63;5.33)	15 (0.8)	125.2 (94.38;156.07)	0.41 (0.13;1.34)
Q.3.9	Agree	Agree	34 (1.1)	177.7 (156.21;199.26)	**4.85 (1.08;10.11)**	13 (0.7)	183.7 (151.79;215.67)	1.92 (0.98;4.51)
Q4. I think that the recommendation for TV viewing for pre-school children is:								
			INTERVENTION GROUP			CONTROL GROUP		
	T0	T1	n (%)	Mean (CI)*	OR (95% CI) †	n (%)	Mean (CI)*	OR (95% CI) †
Q.4.1	≤ 1h/day	≤ 1h/day	1989 (66.4)	76.0 (73.43;78.56)	*Ref*	1095 (67.4)	73.9 (70.51;77.29)	*Ref*
Q.4.2	≤ 1h/day	> 1h to 3 h/ day	328 (10.9)	123.0 (116.76;129.29)	**5.30 (3.51;8.01)**	184 (11.3)	114.3 (106.13;122.44)	**6.62 (3.78;11.61)**
Q.4.3	≤ 1h/day	> 3h/day	11 (0.4)	157.1 (123.98;190.32)	1.40 (0.36;5.37)	5 (0.3)	112.1 (63.79;160.53)	1.39 (0.85;5.45)
Q.4.4	> 1h to 3 h/ day	≤ 1h/day	267 (8.9)	110.5 (103.63;117.38)	**0.66 (0.51;0.89)**	114 (7.0)	111.2 (100.67;121.68)	**0.47 (0.38;0.91)**
Q.4.5	> 1h to 3 h/ day	> 1h to 3 h/ day	270 (9.0)	141.7 (134.71;148.66)	7.20 (0.19;12.39)	156 (9.6)	143.9 (134.68;153.14)	11.44 (0.90;26.68)
Q.4.6	> 1h to 3 h/ day	> 3h/day	17 (0.5)	260.3 (231.83;288.78)	1.98 (0.67;3.01)	14 (0.8)	214.5 (185.54;243.47)	1.49 (0.88;6.51)
Q.4.7	> 3h/day	≤ 1h/day	29 (0.9)	88.1 (66.88;109.26)	1.61 (0.66;3.95)	11 (0.6)	95.2 (61.01;129.37)	5.14 (0.63;41.68)
Q.4.8	> 3h/day	> 1h to 3 h/ day	35 (1.2)	144.8 (125.63;164.01)	4.27 (0.99;13.09)	17 (1.1)	128.5 (101.44;155.51)	3.31 (0.72;15.05)
Q.4.9	> 3h/day	> 3h/day	17 (0.5)	200.6 (171.20;230.10)	5.00 (0.63;22.87)	8 (0.4)	224.3 (186.05;262.53)	**1.83 (1.11;3.45)**
Q.4.10	I don't know	I don't know	30 (1.0)	93.5 (72.33;114.67)	**1.65 (1.10;4.01)**	19 (1.2)	112.7 (87.22;138.28)	**1.59 (1.03;2.33)**

Abbreviations: T0; at baseline period, T1; follow-up period; OR, odds ratio. CI, confidence intervals; Ref, Reference category, based on the healthiest option; h, hour
* Analysis of covariance (ANCOVA) was adjusted for maternal education, z-Body Mass Index in T1, sex, age and centre. Results are show in minutes per day of TV/video/DVDs (Q1, Q3 and Q4) or total screen time (Q2).
† Multilevel logistic regression was adjusted for z-BMI at both T0 and T1, sex, age, maternal education and center. All models of the multilevel logistic regression include random effects (country) to account for the study design.

8. Discusión [Discussion]

Los estilos de vida se han ido modificando a lo largo de los tiempos y en concreto el estilo de vida sedentario predomina ya en el mundo entero. Tanto es así, que la inactividad física constituye uno de los grandes factores de riesgo que explican las proporciones epidémicas actuales de las enfermedades no transmisibles. Dentro de los comportamientos sedentarios, el tiempo total de pantalla es el más prevalente, puesto que incluye todas las actividades realizadas en frente de una pantalla (televisión, ordenadores, vídeos y videoconsolas).

Elección del grupo de edad preescolar

La edad preescolar es un importante período para adoptar comportamientos de estilos de vida saludables, incluidos los hábitos de alimentación y de actividad física (71). En Europa, más del 95% de los niños en edad preescolar asisten a algún tipo de educación fuera del hogar (por ejemplo, escuelas infantiles) (72), las cuales son ideales para implementar intervenciones dirigidas a mejorar la salud de los niños.

La etapa preescolar es una etapa esencial desde el punto de vista del desarrollo de la obesidad, ya que si se produce el rebote de adiposidad de manera precoz, se asocia con el aumento posterior del índice de masa corporal (IMC) y la obesidad en la adolescencia (73). Es importante destacar que los niños que tienen sobrepeso a la edad de 5 años, presentan entre 4 y 5 veces mayor probabilidad de tener obesidad en la adolescencia en comparación con los otros niños con peso normal a la misma edad (74). Así mismo, la mayoría de los adolescentes que tienen obesidad en este periodo, la tendrán en la edad adulta (75).

Uso de podómetros en estudios epidemiológicos

El interés por conocer de forma objetiva los niveles de actividad física diaria utilizando métodos simples y económicos está en auge en las últimas décadas. Numerosos estudios descriptivos han implementado el uso de podómetros para

evaluar el nivel de actividad física tanto en niños como en adolescentes. A través de la revisión sistemática que se ha desarrollado en el marco de esta tesis doctoral (**artículo I**), se ha observado que existen asociaciones fuertes entre la obesidad y la actividad física o sedentarismo en niños y adolescentes, lo cual apoya el uso de podómetros en estudios epidemiológicos para evaluar dicha relación. Numerosos estudios han evaluado la AF mediante el uso de podómetros (76) o acelerómetros (77-79), encontrando asociaciones entre la falta de AF y el aumento de adiposidad en niños en cuanto a IMC, pliegues cutáneos y porcentaje de grasa corporal.

Se debe considerar que existen recursos adicionales que permiten medir y evaluar la actividad física de forma objetiva como es el caso de la acelerometría. No obstante, se debe tener en cuenta el mayor coste de la misma. Los resultados de la presente revisión, apoyan la hipótesis de que altos niveles de actividad física, medidos igualmente mediante podómetros, son protectores contra el aumento de la adiposidad tanto en niños como en adolescentes. En ese sentido es importante recalcar que el hábito de caminar es una estrategia de salud pública para la prevención de la obesidad.

Nivel educativo de los padres y su relación con el estilo de vida de los niños

Los padres tienen un papel crucial en la vida de los niños, especialmente en la edad preescolar, debido al control que ejercen sobre la disponibilidad de alimentos, determinando su ingesta y los patrones de actividad física; además, son los modelos a seguir por los más pequeños y las personas que más influyen en el estilo de vida de los niños en edad preescolar (80). En diversos estudios se ha observado que existe una relación directa entre el nivel de educación de los padres y diferentes parámetros relacionados con los estilos de vida. De forma concreta, el bajo nivel de educación de los padres, parece estar asociado con estilos de vida poco saludables, caracterizados por un aumento de alimentos con elevada densidad energética (81, 82) y elevada exposición a pantallas en niños en edad preescolar (83).

El nivel educativo de los padres es un indicador importante del nivel socioeconómico familiar, que permite explicar en gran medida las diferencias observadas en los factores del entorno físico y social de la familia (84). En ese sentido, la educación superior generalmente se asocia con una mayor comprensión, capacidades y habilidades para adoptar estilos de vida saludables en comparación con niveles educativos inferiores (85).

Para valorar de forma combinada los estilos de vida de los niños en edad prescolar se realizó un análisis de agrupamiento basado en la combinación de 6 comportamientos: consumo de agua, frutas y verduras (F&V) y refrescos, el tiempo que dedicaban a la realización de actividad física y sedentarismo y la duración del sueño. A partir de los comportamientos el análisis permitió agrupar a los participantes del estudio en 6 agrupaciones diferentes, tal como se recoge en el **artículo 3,** que en términos generales se caracterizaban por: 1.- "dieta saludable pero poca actividad", aquellos que destacaban por un elevado consumo de agua y F&V, bajo consumo de refrescos, y bajos niveles de AF; 2.- "activo", aquellos que destacaban principalmente por los elevados niveles de AF; 3.- "estilo de vida saludable", aquellos que consumían alto consumo de agua, F&V y bajo consumo de refrescos además de altos niveles de AF y poco sedentarios; el 4 caracterizado por alto consumo de agua y tiempo de pantalla, bajo consumo de F&V y poca actividad física"; 5.- "estilo de vida poco saludable" aquellos que tenían un bajo consumo de agua, F&V y alto consumo de refrescos además de bajos niveles de AF y más sedentarios y por último el 6.- caracterizado por un alto consumo de frutas y verduras**.** Se observó que los niños en edad preescolar cuyos padres tenían un menor nivel de educación tenían mayor probabilidad de pertenecer al grupo de "Estilo de vida poco saludable" caracterizado por pasar mayor tiempo frente a la pantalla y poco tiempo realizando ejercicio físico, así como tener un bajo consumo de frutas y verduras.

Se pueden observar algunas similitudes entre nuestros resultados y los hallazgos de otros estudios. Lioret y cols. (86) identificaron varios patrones dietéticos,

observando que aquellos niños cuya madre tenía un bajo nivel de educación tenían más probabilidades de seguir un patrón dietético rico en dulces y refrescos. Aranceta y cols. (87) y Northstone y cols. (82) también observaron que un mayor consumo de frutas y verduras se asoció positivamente con el nivel de educación de la madre.

En relación con los comportamientos sedentarios, existe evidencia de que los niños cuyos padres presentan bajo nivel socioeconómico, tienden a tener más riesgo de exceder las recomendaciones de tiempo de pantalla, en comparación con los niños cuyos padres tienen ingresos elevados (88, 89). Del mismo modo, se ha observado que los niños en edad escolar con mayor nivel socioeconómico tienen a disposición más herramientas para realizar AF en el hogar (90) mientras que los niños en edad escolar con menos recursos económicos tienen en el hogar más dispositivos relacionados con la pantalla (91).

Por todo ello, se puede considerar que los resultados obtenidos combinando diversos comportamientos relacionados con los estilos de vida, están en concordancia con la literatura previa.

Cumplimiento de las recomendaciones de actividad física

En el **artículo IV** se ha valorado el recuento de pasos por día mediante el uso de podómetros y la proporción de niños y niñas en edad preescolar que cumplían con las recomendaciones de actividad física. Para ello, era necesario elegir un punto de corte para establecer un objetivo de recuento de pasos. Este objetivo de recuento de pasos debe ser lo suficientemente alto para que no todos los niños en edad preescolar se clasifiquen como suficientemente activos, porque la literatura muestra un aumento en la prevalencia de sobrepeso y obesidad y niveles bajos de AF en preescolares. De Craemer y cols. (70) mostró que la función de conteo de pasos de los acelerómetros ActiGraph era comparable a nivel de grupo con los conteos de

pasos del podómetro Omron Walking Style Pro, que también se ha validado en niños en edad preescolar (70). Por ello, se puede concluir que el uso de podómetros podría ser una alternativa para medir la AF en niños preescolares, ya que tienen un menor coste en comparación con los acelerómetros, así como que se pueden distribuir de forma más asequible a la población, como estrategia de salud pública. La OMS estableció las pautas de AF para niños en edad preescolar en 180 min de AF al día (50) y, en consecuencia, junto con la validación previa realizada por De Craemer en el mismo grupo poblacional, se optó por utilizar el punto del corte de 11,500 pasos al día (69, 70) ya que este objetivo se consideraba alcanzable, realista y útil para promover la actividad física entre los niños en edad preescolar.

En nuestra muestra se encontró que solo el 12,4% de los niños al inicio del estudio y el 8,8% al final del estudio cumplieron con las recomendaciones de AF, considerando el punto de corte de 11,500 pasos al día. Los presentes resultados son comparables con los de otros estudios, Un estudio reciente que evaluó a más de 1000 niños en edad preescolar procedentes de Reino Unido, Bélgica, Suiza y Estados Unidos, países de altos ingresos, observaron que los niños de tres a cuatro años fueron sedentarios por un promedio de más de 8 horas por día. El 30% de los niños en edad preescolar no participaban en los ≥180 minutos recomendados de AF y el 21.2% no reunía ≥60 minutos de AF moderada-vigorosa por día (92). Un estudio longitudinal realizado en Nueva Zelanda, que evaluó anualmente la actividad física mediante acelerometría, a los 3, 4 y 5 años, concluyó que la AF disminuía conforme los niños aumentaban la edad (93).

Numerosos estudios (79, 94, 95) ponen de manifiesto la importancia de la práctica de la AF en la población infantil, pero también la falta de compromiso por parte de los más pequeños. Se sabe que hay una disminución de la AF en la primera infancia (1-6 años) y todavía disminuye más en la transición de la infancia a la adolescencia (94). En una revisión sistemática se pudo concluir que la práctica de AF disminuye conforme aumenta la edad, especialmente en la adolescencia. Concretamente, se observó que la disminución media era del 7% por año en el

nivel de AF, sugiriendo que el cambio global de AF durante la adolescencia podría ser del 60–70% (95).

Relación entre comportamientos sedentarios y riesgo de obesidad.

El sedentarismo se considera uno de los factores de riesgo con mayor probabilidad de ser modificado, siendo un factor esencial dado su relación directa con la obesidad en la edad infantil (96). La asociación entre el uso y tiempo de pantallas, como uno de los principales indicadores de los comportamientos sedentarios, y la obesidad ha sido ampliamente estudiada. Desde que se comenzaron los primeros estudios a partir de la década de los 80 (97), muchos estudios observacionales han encontrado relaciones entre la exposición a los medios de pantalla y el aumento de riesgo de obesidad (98, 99). Concretamente, una cohorte británica que evaluó a más de 16.000 niños a los 5, 10 y 30 años encontró que cada hora adicional de exposición a la televisión durante los fines de semana aumentaba el riesgo de obesidad en adultos en un 7% (100). En la misma línea, un estudio longitudinal realizado en una cohorte de más de 1000 niños en Nueva Zelanda, evaluados desde el nacimiento hasta los 26 años de edad, identificó que exceder las recomendaciones del tiempo sedentario durante la infancia podría ser responsable del 17% del sobrepeso, el 15% de la mala condición física, el 15% de los casos de colesterol elevado en suero y el 17% de los casos de fumadores a los 26 años (43).

Varios son los mecanismos que explican los efectos de la exposición a los medios de pantalla y su influencia en la obesidad (101) entre los que destaca entre otros (i) el desplazamiento de la actividad física, (ii) el aumento de la ingesta de energía durante la visualización de las pantallas, (iii) los efectos de la publicidad sobre el consumo de alimentos de elevada densidad energética y (iv) la reducción de las horas de sueño. En la actualidad, los estudios sugieren la necesidad de centrarse en el uso de pantalla total, ya que la televisión ha dejado de ser la principal fuente de exposición a la pantalla en la mayoría de los niños, como lo era en las últimas décadas. Los datos recientes sugieren que los niños pasan cada vez más tiempo usando ordenadores, videojuegos, tabletas y teléfonos inteligentes, y el tiempo que

pasan con los teléfonos inteligentes incluso ha superado a la televisión entre los adolescentes.

Así como los nuevos medios se asocian potencialmente al desarrollo de obesidad, pueden resultar también herramientas efectivas que permitan prevenir y reducir la obesidad. En ese sentido, su uso en nuevos estudios epidemiológicos de intervención está en auge. Algunas evidencias sugieren que pueden resultar una alternativa a corto plazo para ayudar a modificar la alimentación, así como a aumentar la actividad física en los niños (102). Por ejemplo, varios estudios han mostrado el potencial de los video juegos activos para aumentar la actividad física y/o reducir la obesidad (103), especialmente cuando se usan como parte de un programa de control de peso integral para niños con sobrepeso y/u obesidad (104).

El uso de pantallas y su relación con el estilo de vida de los niños

Hoy en día, las nuevas tecnologías, incluidos los medios de pantalla interactivos y móviles, están en la vida diaria de los niños desde edades cada vez más tempranas. Desde 1970, la edad en que los niños comienzan a interactuar regularmente con los medios de comunicación ha cambiado de 4 años a 4 meses, lo que significa que los niños de hoy en día son "nativos digitales", han nacido en un ecosistema digital en constante evolución (105). Los niños utilizan cada vez más los medios digitales durante los primeros años de desarrollo cerebral. Es importante tener en cuenta que las pantallas tienden a ser altamente atractivas para los niños, y de forma paralela pueden distraer de los objetivos de aprendizaje. En niños de 3 a 5 años, el uso excesivo de pantallas se ha relacionado con una disminución de la cualidad creativa de los niños, de la capacidad de atención y con una menor tolerancia al aburrimiento (106) así como con habilidades cognitivas y sociales más deficientes y menor bienestar psicosocial (107). Por otro lado los estudios observacionales también han revelado que un mayor tiempo de dedicación a diversas actividades de pantalla se asocia con la presencia de factores de riesgo cardio-metabólicos como hipertensión, concentraciones elevadas de colesterol, resistencia a la insulina, inflamación y síndrome metabólico (98).

El sueño inadecuado es otro mecanismo probable que vincula la exposición a los medios de pantalla con el consumo excesivo de energía, así como con la obesidad. Una reciente revisión sistemática observó que más del 90% de los estudios demostraron asociaciones positivas entre el tiempo de pantalla y la hora de acostarse más tarde y un menor tiempo total de sueño (108).

Otro de los posibles mecanismos que explica la asociación entre los comportamientos sedentarios y peor indicador en el estilo de vida de los niños es la relación que existe entre mayor ingesta de energía, nutrientes y alimentos y el comportamiento sedentario. El **artículo II** de la presente Tesis Doctoral fue el primer estudio en examinar las asociaciones entre diversos comportamientos sedentarios y el consumo de alimentos y bebidas en niños en edad preescolar, encontrando una asociación positiva entre el uso de pantallas y el consumo de alimentos con alta densidad energética como serían los snacks y las bebidas azucaradas. Esta asociación ya se había estudiado en niños en edad escolar (109-111) y adolescentes (111-113), confirmando la tendencia en el caso de los niños de edad preescolar.

Además, en el **artículo IV** se estudió las asociaciones de forma conjunta entre los comportamientos relacionados con el balance energético, como son la actividad física y los comportamientos sedentarios, en relación con el consumo de alimentos y bebidas en el mismo grupo poblacional. Para ello, se examinó la adherencia a cumplir las recomendaciones tanto de AF como de los comportamientos sedentarios en el momento basal y tras el seguimiento en los participantes del estudio Toy-Boy. Se observó que aquellos niños que la adherencia a las recomendaciones de AF y tiempo de pantalla en ambos momentos se asociaba con un mayor consumo de alimentos considerados saludables (frutas, verduras y agua) y un menor consumo de productos con gran densidad energética, como bebidas azucaradas, dulces, postres, y aperitivos salados ($p<0.05$). A pesar de que existe evidencia consistente de que el consumo de alimentos de elevada densidad energética está asociado positivamente con niveles bajos de AF y excesivo tiempo

dedicado a comportamientos sedentarios, ningún estudio previo había analizado los efectos combinados de la adherencia a recomendaciones de AF y sedentarismo, sobre el consumo de alimentos y bebidas en niños en edad preescolar. Es por ello esencial atender de forma conjunta a todos los comportamientos que están relacionados con el balance energético en aras a poder establecer políticas de salud pública comunes en las que se pueda orientar a las familias sobre la mejora de sus estilos de vida de forma global.

El uso de pantallas y la influencia de los padres.

La influencia del ambiente familiar en los hábitos de los niños es un hecho de especial relevancia, y en ese sentido, que los padres conozcan las recomendaciones existentes para la visualización de pantallas en edad preescolar puede afectar a las decisiones y normas que se establezcan a la hora de limitar o no el tiempo de pantalla para sus hijos. En ese sentido, en el **artículo V** se valoró cómo influía el conocimiento de los padres acerca de las recomendaciones sobre el tiempo de pantalla para niños en edad preescolar, así como si habían modificado el conocimiento de las mismas durante el proyecto gracias a la intervención realizada en el estudio. En ambos momentos, se observó que un 66.4% de los padres en el grupo intervención y 67.4% en el grupo control conocían que, en niños en edad preescolar, estas recomendaciones consistían en no usar pantallas más de una hora al día. De forma adicional, se evaluó la relación existente entre los conocimientos sobre las recomendaciones del tiempo de pantalla y el tiempo reportado que utilizaban sus hijos/as las pantallas, que indicó que los niños/as de familias en las que los padres no conocían las recomendaciones existentes o pensaban que las recomendaciones eran más de 1 hora al día, tenían una mayor probabilidad de exceder las recomendaciones que aquellos que conocían las recomendaciones actuales. Estos resultados van en la línea de otros estudios previos, aunque su investigación, especialmente en población preescolar es escasa. Un estudio

realizado en Singapur (114) valoró la asociación entre el conocimiento de los padres sobre las recomendaciones de visualización de pantalla y los niveles de visualización de pantalla en niños pequeños. Los hallazgos mostraron que un mayor conocimiento de los padres se asoció con niveles más bajos de visualización de pantalla en niños de 2 años o menos.

Los resultados actuales sugieren que las actitudes y conocimientos de los padres influyen directamente en las actividades de sus hijos, y por ello podrían ser una herramienta para poder mejorar o no un entorno propicio para la visualización de pantallas y, como consecuencia, influir en los hábitos de pantalla de sus hijos. Se ha observado que una mayor autoeficacia de los padres para limitar el tiempo de pantalla se asocia con menor tiempo de pantalla de los niños (115). El presente estudio encontró asociaciones sólidas y consistentes entre el tiempo total de pantalla de los niños y el establecimiento de reglas por parte de los padres. Una mayor presencia de límites y reglas de los padres sobre la televisión o el tiempo total de pantalla se asociaron con un menor tiempo de visualización de pantallas por parte de los niños. Son pocos los estudios que hayan evaluado la relación entre las normas y/o reglas sobre el tiempo de pantalla y su influencia en el tiempo dedicado por los niños a estas actividades. En los niños en edad preescolar de los Países Bajos, aquellos procedentes de familias con un estilo de crianza autoritario tenían una menor probabilidad de exceder las recomendaciones de tiempo frente a la pantalla en comparación con las familias con un estilo menos autoritario (116). Por ello empoderar a los padres a través de la mejora de sus conocimientos y actitudes, son aspectos esenciales que se deberán tener en cuenta en futuras políticas de salud pública.

Implicaciones para la salud pública

En el año 2010, la Organización Mundial de la Salud identificó la inactividad física como el cuarto factor de riesgo principal para la mortalidad global (6% de las

muertes a nivel mundial). Los comportamientos sedentarios y en concreto el creciente uso de pantallas en poblaciones cada vez de menor edad están contribuyendo a esa creciente inactividad física. Los resultados obtenidos en la presente Tesis Doctoral ponen de manifiesto la importancia de conocer y describir las actividades sedentarias que realizan los niños europeos en edad prescolar. La falta de adherencia a las recomendaciones de actividad física, además del aumento de dichos comportamientos sedentarios, se ha asociado a un consumo de alimentos menos saludable; por ello se deberían desarrollar estrategias de prevención efectivas que se focalicen en mejorar la combinación de estos estilos de vida desde edades más tempranas.

El nivel educativo de los padres es uno de los factores que más influye en la presencia de estilos de vida menos favorables para la salud. Por tanto, los resultados obtenidos sugieres la importancia de promover hábitos saludables dirigidos a los grupos socioeconómicamente más vulnerables, ya que además acumulan mayor prevalencia de sobrepeso/obesidad. En este sentido, los centros escolares se consideran un entorno idóneo para la implementación de estrategias de promoción de la salud, ya que presentan el potencial de llegar a todos los alumnos, independientemente de su estatus socioeconómico. Puesto que el principal indicador del nivel socioeconómico es el nivel educativo, se debería tener en cuenta a la hora de establecer las estrategias de promoción de salud haciendo que los mensajes fueran entendibles, concretos y dirigidos a dichas poblaciones más desfavorables.

Todo ello con el objetivo principal que es la prevención de la obesidad infantil. Como dijo Margaret Chan, exdirectora de la Organización Mundial de la Salud, “los niños que hoy tienen obesidad, la mayoría de ellos la tendrán en la edad adulta y estos niños tan solo son víctimas de una infancia con un ambiente obesogénico”. Las medidas de Salud Pública no han conseguido frenar el progreso de la epidemia de obesidad en las últimas 3 décadas, por ello, consideramos imprescindible la inclusión de personal cualificado en materia de salud y prevención de obesidad

dentro de los entornos escolares, integrando un equipo multidisciplinar que debería ser el responsable de trazar las líneas maestras para prevenir y frenar la epidemia de la obesidad de forma efectiva.

Futuras líneas de investigación

Hasta la actualidad, se ha estudiado en profundidad el uso de pantallas y el consumo de alimentos en edad prescolar, escolar y adolescente. Estos estilos de vida están directamente relacionadas con las enfermedades no transmisibles como la obesidad, diabetes tipo 2 y enfermedades cardiovasculares. Todavía no se ha estudiado la relación entre el uso de pantallas en niños menores de 3 años y la ingesta de alimentos. Cada vez es más frecuente ver como los niños de esa edad hacen uso de pantallas táctiles o móviles con el consentimiento de sus padres y mientras comen, a modo de entretenimiento. La hipótesis que se plantearía es que los niños menores de 3 años que comen frente a una pantalla tienden a comer más cantidad y alimentos con una densidad energética mayor que aquellos niños que no lo hacen, pudiendo presentar una mayor probabilidad de padecer obesidad en el futuro.

Para ello se podría realizar un estudio epidemiológico mediante el uso de cuestionarios y también experimentos en los cuales se cuantificaría el consumo de alimentos en los mismos niños, valorados en distintas ocasiones expuestos o no a una pantalla.

Se necesitas estudios longitudinales con seguimiento a largo plazo, para intentar valorar si existe asociación entre la combinación de estos estilos de vida con el desarrollo posterior de obesidad, diabetes tipo 2 y otras enfermedades crónicas relacionadas con la nutrición.

9. Conclusiones

Artículo I: La revisión sistemática de la evidencia científica indica que mayores niveles de actividad física, medidos mediante podómetros, se asocian negativamente con la adiposidad en niños y adolescentes. Esta asociación sugiere favorecer la monitorización del tiempo dedicado a caminar, que podría ser utilizada como herramienta para promover mejores patrones de actividad física teniendo en cuenta aspectos motivacionales.

Artículo II: En una muestra de niños europeos en edad preescolar, los comportamientos sedentarios se asociaron con un mayor consumo de alimentos y bebidas con elevada densidad energética como snacks, pasteles, refrescos, zumos y un menor consumo de frutas, verduras y agua. Por ello, es esencial limitar la exposición de los niños a actividades de pantalla.

Artículo III: El nivel de educación de los padres se asocia con los principales comportamientos relacionados con el balance energético (alimentación, actividad física y comportamientos sedentarios), valorados de forma combinada. Aquellos niños con al menos un padre que presenta niveles de educación media o superior pertenecen al grupo caracterizado por las opciones más saludable (elevado consumo de agua, frutas y verduras, y práctica de actividad física). Aquellos participantes con un estilo de vida poco saludable, caracterizado por elevado tiempo de pantalla, elevado consumo de refrescos azucarados y bajo consumo de agua, F&V y actividad física, se presentó con una mayor frecuencia entre los niños cuyos padres (padre, madre o ambos) presentaban menores niveles de educación.

Artículo IV: En esta muestra de niños en edad preescolar, la proporción de niños que se adhirieron tanto a las recomendaciones de actividad física y de tiempo de

pantalla fue muy baja y se asoció con un perfil de consumo de alimentos y bebidas poco saludables. Los niños en edad preescolar y sus padres deben tratar de aumentar el tiempo que la familia pasa en actividades que promueven la actividad física y minimizar el tiempo que pasan utilizando diversos tipos de pantalla o en cualquier tipo de actividades sedentarias. Además, las intervenciones de salud pública deben centrarse en actividades dirigidas a aumentar el movimiento y la actividad en niños preescolares. Habilitar entornos alimentarios y de actividad física más saludables, junto con la promoción del modelado positivo del rol de los padres, debe priorizarse para lograr tasas más altas de cumplimiento de las recomendaciones de actividad física y comportamientos sedentarios, y por ende de su asociación con un consumo de alimentos y bebidas más saludables.

Artículo V: Los niños en edad preescolar cuyos padres tienen reglas que limitan el comportamiento sedentario eran menos propensos a exceder el tiempo recomendado viendo TV / video / DVD, en lugar de aquellos niños con padres más permisivos. Los hallazgos sugieren que las reglas familiares relacionadas con el tiempo de pantalla y el mayor conocimiento de los padres sobre los horarios de visualización de la televisión por parte de los niños, pueden disminuir el tiempo de pantalla total o específico de los niños en edad preescolar. Mejorar las prácticas de crianza de los hijos puede ser un enfoque prometedor en futuras intervenciones para reducir el tiempo de pantalla, especialmente en edades tempranas, debido a su impacto en el desarrollo, a la promoción de conductas relacionadas con el equilibrio energético saludable, así como a su persistencia en el tiempo.

9. Conclusions

Paper I: The evidence sure that higher level of walking behaviour are against higher levels of child and adolescent adiposity. This association using pedometers not only implies its utility in monitoring walking levels but also could help us as a tool in promoting physical activity patterns by means of motivational aspects.

Paper II: In European preschoolers, sedentary behaviours were associated with consumption of energy-dense foods and fizzy drinks. Our results support evidence calling for limiting children's exposure to screen-based activities associated with energy-dense food consumption.

Paper III: The healthiest group characterised by high water and F&V consumption and high PA z scores ('healthy lifestyle') was more prevalent among preschool children with at least one medium- or higher-educated parent and showed markedly healthier trends for all the included EBRB. In the opposite, the 'unhealthy lifestyle' cluster (characterised by high soft drinks and screen time z scores, and low water, F&V and PA z scores) was more prevalent among children with lower parental, paternal and maternal education levels. It identified those children with lower maternal, paternal and parental education levels were less likely to be allocated in the 'healthy lifestyle' cluster and more likely to be allocated in the 'unhealthy lifestyle' cluster. Therefore, parental educational level is one of the key factors that should be considered when developing childhood obesity prevention interventions.

Paper IV: In this sample of preschool children, the proportion of children adhering to both physical activity and screen time recommendations was very low and were associated with an unhealthy food and beverage consumption profile. Preschool children and their parents should try to increase family time spent at activities

promoting physical activity and to minimize the time they spend on screen time or being sedentary.

Paper V: Preschool children whose parents have rules limiting sedentary time were less likely to spend high amount of time watching of TV/video/DVDs as opposed to children with permissive parents that had high levels of TV/video/DVDs viewing. Findings suggest that family rules related to screen time and higher parent's knowledge about children's TV viewing times recommendations can decrease preschool children's total or specific screen time. Improving parenting practices may be promising approaches in future interventions to decrease screen time, especially at young ages due to its impact on development and promotion of healthy energy balance-related behaviours.

In addition, public health interventions should focus on activities aimed at increasing movement in preschool children. Enabling healthier food and physical activity environments, together with the promotion of positive parental role modeling, should be prioritized to achieve higher rates of adherence to PA and ST recommendations.

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11. 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	**Impact factor**	**Quartile**
Artículo I: Clinical Journal of Sport Medicine	2.224	Q2
Ranking in 2017 ISI JCR: 33/81 (Orthopaedics and Sports Medicine)		
Artículo II: European Journal of Nutrition	4.370	Q1
Ranking in 2016 ISI JCR: 14/81 (Nutrition and Dietetics)		
Artículo III British Journal of Nutrition	3.657	Q2
Ranking in 2017 ISI JCR: 23/83 (Nutrition and Dietetics)		
Artículo IV Nutrients	4.171	Q1
Ranking in 2018 ISI JCR: 16/83 (Nutrition and Dietetics)		
Artículo V European Journal of Public Health	2.782	Q2
Ranking in 2017 ISI JCR: 47/181 (Public Health, Environmental and Occupational Health). Accepted.		

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Existe un proverbio africano que dice “Sí quieres ir rápido camina solo, pero si quieres llegar lejos camina en grupo”. Pues bien, el grupo Genud es el ejemplo de un caminar acompañado, con compañeros excepcionales, donde se disfruta cada día del trabajo, donde se te quiere como eres y con lo que haces y como no, Luis Moreno capitaneando el grupo trata de hacer la vida más fácil a cada uno de nosotros.
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13. Cuestionarios utilizados

A continuación se presentan los cuestionarios utilizados en el estudio en el cual se ha basado la presente Tesis Doctoral.

Cuestionario sobre actividad física, comportamientos sedentarios, percepciones, reglas y conocimiento de los padres a cerca de los comportamientos sedentarios

D. Actividad física

En la siguiente sección del cuestionario te preguntaremos por tus hábitos de actividad física y de tu hijo/a. Es importante recordar que no hay respuestas correctas o incorrectas. Contesta lo que se corresponda a tu situación.

En las siguientes preguntas, cuando decimos ACTIVIDAD FÍSICA, incluyendo el practicar un deporte o hacer ejercicio nos referimos a:

Actividades que hacen al individuo respirar con más intensidad o sudar, por ejemplo, andar, ir en bicicleta, deportes de equipo como el fútbol y actividades organizadas como la natación.

En las siguientes preguntas, cuando decimos ACTIVIDAD FÍSICA **, incluyendo el practicar un deporte o ejercicio**, nos referimos a:
Actividades que realiza tu hijo/a antes o después del colegio y que le hacen respirar de forma más intensa de lo normal o sudar.

Ejemplos de actividad física son: andar, ir en bicicleta, jugar en el parque, deportes de equipo como fútbol y actividades organizadas como nadar o clases de baile

PREGUNTAS ACERCA DE TU HIJO/A

D8. ¿Pertenece tu hijo/a a un club deportivo?

❑1 Sí

❑2 No ➔➔➔ por favor, continúa con la pregunta D11

D9. ¿Cuánto tiempo está tu hijo/a practicando deporte en el club deportivo a la semana?

|___|___| horas |___|___| minutos

D10. ¿Qué tipo de deporte practica tu hijo/a en el club deportivo?

Por favor, señala todas las que correspondan

❑1 Fútbol

❑2 Artes marciales (por ejemplo, judo)

❑3 Natación

❑4 Gimnasia rítmica

❑5 Otras, por favor, especificar:

_____

D. Actividades sedentarias

En la siguiente sección del cuestionario te preguntaremos por tus hábitos en actividades sedentarias y los de tu hijo/a. Es importante recordar que no hay respuestas correctas o incorrectas. Contesta lo que se corresponda a tu situación.

Cuando decimos actividades SEDENTARIAS, nos referimos a todas las actividades en las que estás sentado o tumbado, como ver la TV y/o DVD, utilizar el ordenador, dibujar o leer libros. Respecto a las actividades frente a las pantallas, nos referimos al tiempo que inviertes en actividades como ver la TV/DVD/Video, juegos electrónicos y uso del ordenador con fines de ocio, etc.

- PREGUNTAS ACERCA DE TU HIJO/A

Cuando decimos actividades SEDENTARIAS, nos referimos a todas las actividades en las que estás sentado o tumbado, como ver la TV y/o DVD, utilizar el ordenador, dibujar o leer libros.
Respecto a las actividades frente a las pantallas, nos referimos al tiempo que inviertes en actividades como ver la TV/DVD/Video, juegos electrónicos y uso del ordenador con fines de ocio, etc.

¿Cuántas horas al día VE TU HIJO/A habitualmente la TV (incluyendo DVD y videos) in Su tiempo libre? (por favor, marca una casilla para los días entre semana y una casilla para los días de fin de semana)

E1. Entre semana (media de los días)	**E2.** Fines de semana (media de los días)
❑1 Nunca	❑1 Nunca
❑2 Menos de 30 minutos/día	❑2 Menos de 30 minutos/día
❑3 30 minutos a <1 hr/día	❑3 30 minutos a <1 hr/día
❑4 1- 2 hrs/ día	❑4 1- 2 hrs/ día
❑5 3-4 hrs/ día	❑5 3-4 hrs/ día
❑6 5-6 hrs/ día	❑6 5-6 hrs/ día
❑7 7-8 hrs/ día	❑7 7-8 hrs/ día
❑8 8 hrs/ día	❑8 8 hrs/ día

❑9 Más de 8 hrs/ día	❑9 Más de 8 hrs/ día
❑10 No lo sé	❑10 No lo sé

¿Cuántas horas al día está tu hijo/a habitualmente utilizando el ordenador para jugar, también con consolas (por ejemplo, Playstation, Xbox, GameCube) durante su tiempo de ocio?

E3. Entre semana (media de los días)	**E4.** Fines de semana (media de los días)
❑1 Nunca	❑1 Nunca
❑2 Menos de 30 minutos/día	❑2 Menos de 30 minutos/día
❑3 30 minutos a <1 hr/día	❑3 30 minutos a <1 hr/día
❑4 1- 2 hrs/ día	❑4 1- 2 hrs/ día
❑5 3-4 hrs/ día	❑5 3-4 hrs/ día
❑6 5-6 hrs/ día	❑6 5-6 hrs/ día
❑7 7-8 hrs/ día	❑7 7-8 hrs/ día
❑8 8 hrs/ día	❑8 8 hrs/ día
❑9 Más de 8 hrs/ día	❑9 Más de 8 hrs/ día
❑10 No lo sé	❑10 No lo sé

¿Cuántas horas al día juega tu hijo/a de manera pasiva (mirando, leyendo libros, jugando con muñecas, a coches, pintando, construcción) durante su tiempo de ocio?

E5. Entre semana (media de los días)	**E6.** Fines de semana (media de los días)

❑$_1$ Nunca	❑$_1$ Nunca
❑$_2$ Menos de 30 minutos/día	❑$_2$ Menos de 30 minutos/día
❑$_3$ 30 minutos a <1 hr/día	❑$_3$ 30 minutos a <1 hr/día
❑$_4$ 1- 2 hrs/ día	❑$_4$ 1- 2 hrs/ día
❑$_5$ 3-4 hrs/ día	❑$_5$ 3-4 hrs/ día
❑$_6$ 5-6 hrs/ día	❑$_6$ 5-6 hrs/ día
❑$_7$ 7-8 hrs/ día	❑$_7$ 7-8 hrs/ día
❑$_8$ 8 hrs/ día	❑$_8$ 8 hrs/ día
❑$_9$ Más de 8 hrs/ día	❑$_9$ Más de 8 hrs/ día
❑$_{10}$ No lo sé	❑$_{10}$ No lo sé

Por favor, lee los siguientes enunciados y marca la opción que te parezca más apropiada:

	Muy en desacuerdo	En desacuerdo	Ni de acuerdo ni en desacuerdo	De acuerdo	Muy de acuerdo
E7. Creo que realizar actividades de pantalla son beneficiosas y educativas para mi hijo/a	❑1	❑2	❑3	❑4	❑5
E8. A mi hijo/a le gusta ver TV/DVD/video	❑1	❑2	❑3	❑4	❑5
E9. Mi hijo/a prefiere ver TV mucho tiempo antes que hacer otras actividades	❑1	❑2	❑3	❑4	❑5
E10. Encuentro difícil limitar a mi hijo/a las actividades de pantalla si no quiere y empieza a quejarse	❑1	❑2	❑3	❑4	❑5
E11. Me gusta ver TV/DVD/video junto a mi hijo/a	❑1	❑2	❑3	❑4	❑5
E12. Me aseguro que haya disponibles otras actividades a mi hijo/a en vez de actividades de pantalla	❑1	❑2	❑3	❑4	❑5
E13. A mi hijo/a no le gusta realizar actividades estando de pie	❑1	❑2	❑3	❑4	❑5
E14. Creo que es necesario limitar las actividades de pantalla de mi hijo/a	❑1	❑2	❑3	❑4	❑5
E15. Animo a mi hijo/a a hacer cosas diferentes en vez de ver TV/DVD/video	❑1	❑2	❑3	❑4	❑5
E16. Es un hábito organizar para mi familia el ver programas	❑1	❑2	❑3	❑4	❑5

en la tele que nos gusten a todos					
E17. Intento restringirme a mí mismo/a el ver TV/DVD/video si mi hijo/a está presente	❑1	❑2	❑3	❑4	❑5
E18. A mi hijo/a se le permite ver TV todo el tiempo que quiera	❑1	❑2	❑3	❑4	❑5
E19. Castigo a mi hijo/a prohibiéndole ver TV	❑1	❑2	❑3	❑4	❑5
E20. No creo necesario limitar el ver la TV a mi hijo/a si está viendo programas adecuados para niños/as	❑1	❑2	❑3	❑4	❑5
E21. Los hábitos de mi hijo/a respecto a las actividades de pantalla son saludables	❑1	❑2	❑3	❑4	❑5

E22. Creo que las recomendaciones para los niños/as en edad preescolar respecto a ver la TV son:

❑1 No ver la TV nunca

❑2 Ver TV no más de unas pocas veces por semana

❑3 Ver TV 1-2 horas al día

❑4 Ver TV 3- 4 horas al día

❑5 Ver TV 5- 6 horas al día

❑6 Ver TV 7 -8 horas al día

❑7 Ver TV más de 8 horas al día

❑8 Ver TV tanto como quiera

❑9 No lo sé

Cuestionario de frecuencia de consumo de alimentos semi-cuantitativo

Grupos de alimentos	¿Con qué frecuencia consume su hijo los siguientes productos?	Y ¿cúal es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Zumo y otras bebidas				
Agua natural	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza = 225 ml 1 botella pequeña de plástico= 500ml Para tamaños de vasos y tazas, por favor, vea el apéndice	
Bebidas azúcaradas (Coca Cola, Pepsi, Fanta, Sprite, Nestea)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza = 225 ml 1 lata= 330ml 1 botella pequeña de plástico= 500ml Para tamaños de vasos y tazas, por favor, vea el apéndice	
Bebidas light (Cola light, Coca cola	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml	1 taza = 225 ml 1 lata= 330ml 1 botella = 500ml	

zero, Pepsi max, Fanta zero)	○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	Para tamaños de vasos y tazas, por favor, vea el apéndice	
Grupos de alimentos	¿Con qué frecuencia consume su hijo los siguientes productos?	Y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Zumo de frutas natural recién exprimido	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza= 225 ml Para tamaños de vasos y tazas, por favor, vea el apéndice	
Zumo de fruta industrial de brick/embotellado. (Don Simon, Juver/Disfruta, marcas blancas, etc)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml	1 taza = 225 ml 1 botella pequeña de plástico= 500ml 1 carton= 1l Para tamaños de	

		○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	vasos y tazas, por favor, vea el apéndice	
Té (infusión, té negro, té verde, manzanilla, etc)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza = 225 ml Para tamaños de vasos y tazas, por favor, vea el apéndice	○ con azúcar ○ sin azúcar
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	y ¿cuál es la cantidad media por día?	Ejemplos de tamaños de porciones	Elija la opción más frecuente
Batidos (todos los tipos) (Solo Fruta (Hero), FruitSimply (Sunnydelight)), etc	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza = 225 ml 1 lata= 330ml 1 carton= 1 botella de plástico pequeña= 500ml Para tamaños de vasos y tazas,	

			por favor, vea el apéndice	
Leche, yogur y queso				
Leche	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza = 225 ml 1 botella de plástico pequeña= 500ml Para tamaños de vasos y tazas, por favor, vea el apéndice	○ Leche entera ○ Semidesnatada ○ Desnatada ○ Fortificada/enriquecida (por ejemplo, con calcio, hierro, vitaminas)
Leche chocolateada o azucarada (Puleva, Central Lechera Asturiana, marcas blancas)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 100 ml o menos ○ entre 100 y 200 ml ○ entre 200 y 300 ml ○ entre 300 y 400 ml ○ entre 400 y 500 ml ○ entre 500 y 600 ml ○ entre 600 y 700 ml ○ entre 700 y 800 ml ○ entre 800 y 900 ml ○ entre 900 y 1000 ml ○ 1000 ml o más	1 taza = 225 ml 1 lata= 200ml 1 botella pequeña de plástico= 300ml 1 botella grande de plástico= 500ml Para tamaños de vasos y tazas, por favor, vea el	

			apéndice	
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	Y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Yogurt natural (sin azúcar añadido, yogur con edulcorante artificial) (Danone, Danonino, Petit-suisse, marcas blancas)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 65 g o menos ○ entre 65 y 195 g ○ 195 g o más	1 taza=125 mg 1 petit-suisse= 50 g Para tamaños de vasos y tazas, por favor, vea el apéndice	○ Yogurt griego ○Entero ○Semidesnatado ○Desnatado ○Fortificado /enriquecido (por ejemplo, con vitaminas calcio, hierro, vitaminas) ○ Yogurt para niños
Yogurt de frutas aromatizado o azucarado (yogurt de frutas, yogurt con azúcar añadido por el consumidor…)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 65 g o menos ○ entre 65 y 195 g ○ 195 g o más	1 taza=125 mg 1 petit-suisse= 50 g Para tamaños de vasos y tazas, por favor, vea el apéndice	○Entera ○Semidesnatada ○Desnatada ○Fortificada/ enriquecida (por ejemplo, con vitaminas, calcio, hierro)

(Danone, Danonino, Petit-suisse, marcas blancas)				○ Yogurt para niños
Queso [queso de untar/ queso derretido (fondue de queso, lonchas de queso), Gouda, Emmental, Gruyère, requesón, queso feta.]	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 10 g o menos ○ entre 10 y 20 g ○ entre 20 y 30 g ○ entre 30 y 40 g ○ entre 40 y 50 g ○ 50 g o más	1 triángulo de queso = 20 g 1 loncha de queso (10cm por 10 cm) = 25 g 1 cucharada de queso rallado = 10g	
Frutas y verduras/hortalizas				
Fruta deshidratada	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ Menos de 1 cucharada ○ 1 - 3 cucharadas ○ Más de 3 cucharadas	1 cucharada de fruta deshidratada (~20gr) -2 higos secos -40 pasas -2 ciruelas pasas	
Fruta enlatada	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana	○ 35 g o menos ○ entre 35 and 70 g ○ entre 70 y 105 g ○ entre 105 y 140 g ○ entre 140 y 175 g	1 rodaja de piña en conserva= 35g 10 cerezas negras	

	○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 175 g o más	enlatadas= 90g Medio albaricoque en conserva con almibar= 17g	
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Fruta fresca	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 30 g o menos ○ entre 30 y 60 g ○ entre 60 y 90 g ○ entre 90 y 120 g ○ entre 120 y 150 g ○ entre 150 y 180 g ○ entre 180 y 210 g ○ entre 210 y 240 g ○ entre 240 y 270 g ○ 270 g o más	1 kiwi = 75 g 1 naranja = 140 g 1 mandarina= 60 g 1 manzana pequeña = 125g Otra fruta = 130 g 1 banana mediana= 90gr 10 uvas= 20g 1 bol de melon/sandía= 150g 5 fresas= 50g Para ejemplos de los distintos tipos de fruta fresca vea apéndice	
Verduras	○ nunca o menos de	○ 30 g o menos	1 cucharada de	

crudas	una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ entre 30 y 60 g ○ entre 60 y 90 g ○ entre 90 y 120 g ○ entre 120 y 150 g ○ entre 150 y 180 g ○ entre 180 y 210 g ○ entre 210 y 240 g ○ entre 240 y 270 g ○ 270 g o menos	zanahoria = 20 g 1 tomate = 150 g 1 cucharada de hojas cortadas de lechuga o repollo= 10g Para ejemplo de los diferentes tipos de verduras crudas , por favor ver apéndice	
Verduras cocidas (al vapor, cocida, a la parrila, estofado)	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 30 g o menos ○ entre 30 y 60 g ○ entre 60 y 90 g ○ entre 90 y 120 g ○ entre 120 y 150 g ○ entre 150 y 180 g ○ entre 180 y 210 g ○ entre 210 y 240 g ○ entre 240 y 270 g ○ 270 g o más	1 cucharada de verduras preparadas= 30 g Para ejemplos de los diferentes tipos de verduras cocidas, por favor, ver el apéndice	
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	Y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Chocolate				

Chocolate (tableta de chocolate negro, tableta de chocolate con almendras, avellanas o nueces, chocolatinas como Mars Twix, Bounty, Snickers, Milky Way, *Huevo Kinder, Kinder Bueno*	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 25 g o menos ○ entre 25 y 50 g ○ entre 50 y 75 g ○ entre 75 y 100 g ○ entre 100 y 125 g ○ 125 g o más	1 tableta grande de chocolate= 100g 1 tableta mediana de chocolate=50gr 1 tableta pequeña de chocolate=25-30gr 1 porción/onza de chocolate= 10g 1chocolatina (e.g. Mars, Twix)=60g 1 huevo kinder sorpresa= 22g	
Postre				
Postres lácteos (mousse de chocolate (por ejemplo, Danone), helado (por ejemplo, Magnum Frigo)/ barra de helado, pudin, arroz	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 50 g o menos ○ entre 50 y 100 g ○ entre 100 y 150 g ○ entre 150 y 200 g ○ 200 g o más	1 bola de helado = 50 g Para los tamaños de tazas, boles y tarrinas, por favor, vea el apéndice	

con leche, natillas)				
Galletas, pasteles y pastas				
Tarta (pastel de vainilla, pastel de fruta, pastel de mermelada, pastel de chocolate, etc) Por ejemplo Kinder delice, Bollycao, Donut, Phoskitos/Tigretón)	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 35 g o menos ○ entre 35 y 70 g ○ entre 70 y 105 g ○ entre 105 y 140 g ○ entre 140 y 175 g ○ entre 175 y 210 g ○ entre 210 y 245 g ○ 245 g o más	Para ejemplos de los diferentes tipos de pasteles y tamaños de pasteles, por favor, vea el apéndice	
Galletas (galletas de mantequilla, sandwich crème biscuits, galletas integrales , Digestive, mantecosas, etc, e.g. galletas	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 15 g o menos ○ entre 15 g y 30 g ○ entre 30 g y 45 g ○ entre 45 g y 60 g ○ 60 g o más	1 galleta = 7 g 1 galleta de chocolate (tipo galletas príncipe)= 20 g	

María, Chiquilín, Principe)				
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Pastas (croissants, tarta de fruta, gofres, crepes, tarta de crema, etc, e.g. magdalenas, napolitanas, croissants)	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 35 g o menos ○ entre 35 y 70 g ○ entre 70 y 105 g ○ entre 105 y 140 g ○ entre 140 y 175 g ○ entre 175 y 210 g ○ entre 210 y 245 g ○ 245 g o más	1 gofres belgas= 50 g 1 croissant de chocolate= 95g 1 porción de tarta de manzana= 150g 1 porción de tarta de crema= 200g	
Postres a base de azúcar (gelatina, piruletas, chicles, caramelos duros, delicias turcas (lokum))	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 5 g o menos ○ entre 5 y 10 g ○ entre 10 y 15 g ○ entre 15 y 20 g ○ entre 20 y 25 g ○ entre 25 y 30 g ○ entre 30 y 35 g ○35 g o más	1 judía jelly=1g 1 piruleta =6g 1 caramelo duro=6g 1 lokum prequeño (delicia turca)=15g	
Cereales del desayuno				
Cereales del desayuno no azucarados	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes	○ 15 g o menos ○ entre 15 y 45 g ○ 45 g o más	1 bol de cereales = 30 g 1 caja	○ con azúcar añadido ○ sin azúcar

(Corn Flakes, Weetabix, Muesli Krispies)	○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días		individual= 30 g 1 cucharada= 10g Para ejemplos de diferentes tamaños de porciones, por favor ver el apéndice	añadido
Cereales de desayuno azucarados (Frosties, Pops, Cruesli, ChocoKrispies)	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 15 g o menos ○ entre 15 y 45 g ○ 45 g o más	1 bol de cereales= 30 g 1 caja individual= 30 g 1 cucharada= 10g 1 tableta de cereales=24g Para ejemplos de los diferentes tamaños de porciones, por favor, ver el apéndice	
Pan (incluyendo sandwiches y tostadas)				
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	Y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Pan blanco y otros productos de panadería	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana	○ 30 g o menos ○ entre 30 y 60 g ○ entre 60 y 90 g ○ entre 90 y 120 g	1rebanada grande de pan= 30 g 1 rebanada	

(pan, biscote , panecillo crujiente alargado, baguette, torta de arroz, pan de sandwich, tostada)	○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ entre 120 g y 150 g ○ 150 g y más	pequeña de pan= 20-25 g 1 biscote = 10 g 1 panecillo crujiente alargado= 40 g Para ejemplo de los diferentes tamaños de pan, por favor, vea el apéndice	
Pan integral y otros productos de panadería (pan, biscote , panecillo crujiente alargado,, baguette , torta de arroz, pan de molde, tostada)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 30 g o menos ○ entre 30 y 60 g ○ entre 60 y 90 g ○ entre 90 y 120 g ○ 120 g o más	1 rebanada grande de pan= 30 g 1 rebanada pequeña de pan= 20-25 g 1 biscote = 10 g 1 panecillo crujiente alargado= 40 g Para ejempos de diferentes tamaños de porciones, vea el apéndice	
Aperitivos de sabores				
Aperitivos salados (Lays,	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana	○ 25 g o menos ○ entre 25 y 75 g ○ 75 g o más	1 bolsa pequeña de patatas= 30 g 1 galleta salada= 3 g	

Doritos, Ruffles, Pringles, Cheetos)	○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días		(1 paquete de galletas saladas = 100 g)	
Carnes, aves de corral y productos pesqueros				
Carne y aves de corral (chuletas, filete, bovino, carne, aves de corral, hamburguesa,	○ nunca o menos de una vez al mes mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 25 g o menos ○ entre 25 y 50 g ○ entre 50 y 75 g ○ entre 75 y 90 g ○ entre 90 y 115 g ○ 115 g o más	1 filete de pollo = 150 g 1 nugget de pollo = 25 g 1 chuleta de cerdo or 1 salchicha asada (20 cm) or 1 chuleta grande = 130 g 1 filete = 175 g	○ Asado a la pariila, hervido, etc ○ Frito
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	Y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de porciones	Elija la opción más frecuente
Pescado y productos derivados de la pesca (Pescado fresco o congelado, barritas de pescado, marisco)	○nunca o menos de una vez al mes ○ 1-3 días a la mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 25 g o menos ○ entre 25 y 50 g ○ entre 50 y 75 g ○ entre 75 y 90 g ○ entre 90 y 115 g ○ 115 g o más	1 arenque joven = 80 g 4 cucharadas de gambas = 80 g 1 filete de bacalao fresco = 200 g 1 barritas de pescado = 30 g	○ Asado a la parrilla, cocido ○ Frito

Productos cárnicos (jamón, salami, paté, etc) (SÓLO con comidas frías y con pescado)	○ nunca o menos de una vez al mes ○ 1-3 días a la mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 15 g o menos ○ entre 15 y 30 g ○ entre 30 y 45 g ○ entre 45 y 60 g ○ 60 g o más	15 g loncha en una rebanada de pan 1 rebanada= 20g	
Patatas, arroz y pasta				
Pasta (espaguetis, macarrones, lasaña, macarrones, etc)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 75 g cocidos o menos ○ entre 75 y 225g cocido ○ 225 g cocido o más	50 g pasta sin cocer da 125 g= 1 taza de pasta cocida 1 cucharada de pasta cocida = 25 g Para los ejemplos de los diferencias tamaños de porciones, por favor, ver el apéndice	○ Pasta Blanca ○ Pasta Integral ¿Cuáles de los siguientes tipos de salsa y cuántas cucharadas consume el niño por una taza de pasta? ○ con salsa de tomate

				○ con salsa de carne ○ con salsa de crema ○ con queso gratinado ○ nada …….. cucharadas
Grupos de alimentos	¿Con qué frecuencia consume tu hijo los siguientes productos?	Y ¿cuál es la cantidad media por día?	Ejemplo de tamaño de las porciones	Elija la opción más frecuente
Arroz	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 75 g cocido o menos ○ entre 75 y 225g cocido ○ 225 g cocido o más	40 g arroz no cocido dan 100g = 1 taza de arroz cocido 1 cucharada de arroz cocido =25g Para los ejemplos de los diferentes tamaños de porciones, por favor, ver el apéndice	○Arroz blanco ○Arroz negro
Alimentos	○ nunca o menos de	○ 50 g o menos	2 patatas	

fritos (patatas, croquetas..)	una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ menos 50 y 150 g ○ 150 g o más	cortadas en rodajas o 3-4 croquetas o 20 fritas =100g	
Patatas (cocidas,al vapor, asadas al horno, en puré, etc)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 50 g cocido o menos ○ entre 50 y 100g cocido ○ entre 100 y 150g cocido ○ entre 150 y 200g cocido ○ 200 g cocido o más	1 patatas cocidas (tamaño de un huevo)= 50g 1 cucharada de puré de patata = 50 g Para los ejemplos de los diferentes tamaños de las porciones, por favor, ver el apéndice	
Azúcar, mermelada y otras cremas derivadas				
Crema de cacao / otras cremas dulces de untar (crema de cacao, chocolate sprinkles, miel,	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 10 g or menos ○ entre 10 y 20 g ○ entre 20 y 30 g ○ entre 30 y 40 g ○ entre 40 y 50 g ○ 50 g o más	1 cucharilla= 5g 15 g para 1 rebanada grande 10 g para una rebanada pequeña	

mermelada, confituras, sirope, etc, ej. Nocilla, Nutella)				
Platos con legumbres				
Legumbres (judías blancas/rojas, garbanzos, lentejas)	○ nunca o menos de una vez al mes ○ 1-3 días al mes ○ 1 día a la semana ○ 2-4 días a la semana ○ 5-6 días a la semana ○ todos los días	○ 30 g o menos ○ entre 30 y 60 g ○ entre 60 y 120 g ○ entre 120 y 150 g ○ entre 150 y 180 g ○ 180 g o más	1 cucharada de legumbres cocidas = 30 g	

About the author

FORMACIÓN ACADÉMICA:

- Cursando. Doctorado en departamento de Fisiatría y Enfermería bajo tutela de Luis A Moreno Aznar. Universidad de Zaragoza.
- 2016. Graduada en Nutrición Humana y Dietética. Facultad de Ciencias de la Salud y del Deporte. Universidad de Zaragoza.
- 2012-2013. Máster en condicionantes genéticos, nutricionales y ambientales del crecimiento y desarrollo. Universidad de Zaragoza.
- 2012. Naturópata. Experta en Fitoterapia. Instituto Aragonés de Osteopatía
- 2008-2011. Diplomada en Nutrición Humana y Dietética. Facultad de Ciencias de la Salud y del Deporte. Universidad de Zaragoza.
- 2010-2011. Auxiliar de Farmacia. Centro de formación Columbus.
- 2006-2008. Técnico en Dietética. IES Miguel Catalán. Zaragoza.

FORMACION COMPLEMENTARIA:

- 2019. Controversias y certezas en evidencia científica en Nutrición.
- 2019. Técnicas en expresión oral. 32 horas.
- 2019. Tratamiento de datos mediante programa excel. 24 horas
- Conducta Alimentaria, Medicamentos, Productos de Parafarmacia y Riesgos en la Red. Zaragoza. Facultad de Medicina. Universidad de Zaragoza. Zaragoza. 14 y 15 de noviembre de 2018.
- 2018. ¿Cómo divulgar mis resultados de investigación? 16 horas
- 2018. Curso Abordaje dietético en pacientes con cáncer. Zaragoza

- 2016. Curso de meta-análisis. Universidad de Zaragoza.
- 2016. Curso de Coaching Nutricional. Universidad de Santiago.
- 2015 y 2016. Curso de revisiones sistemáticas y meta-análisis: bases para su realización e interpretación. Universidad de Zaragoza.
- 6 y 7 Julio 2015. XVI Escuela de Nutrición Francisco Grande Covian. Microbiota y enfermedades crónicas relacionadas con la nutrición. Santander.
- 2014. Asistencia a curso "Acciones Estratégicas de formación en vida saludable y diabetes". Zaragoza.
- 2014. Estudios epidemiológicos multicéntricos en enfermedades no transmisibles y estilos de vida por la Facultad de Medicina de la Universidad de Sao Paulo.
- 2014. Taller de medicina basada en la evidencia. Búsqueda y lectura crítica de una revisión sistemática. (8 horas)
- 2014. Taller de medicina basada en la evidencia. Lectura crítica de un ensayo clínico aleatorizado. (4 horas)
- 2014. Asistencia VII Foro de innovación en biomedicina. Cesta de productos cardiosaludables de Aragón.
- 2013. Curso de operadores de comunicaciones por Cruz Roja Española. 40 horas lectivas.
- 2012. Curso de especialización en investigación documental. 10 horas.
- 2012. Naturópata. Experta en Fitoterapia. Instituto Aragonés de Osteopatía. 350 h.
- Curso "aspectos psicológicos y motivacionales en la pérdida de peso" Colegio Profesional de Dietistas-Nutricionistas de Aragón. 2013 (4,5 horas lectivas).
- 2011. Curso en técnicas de análisis microbiológicas e higiene en manipulación de alimentos. INAEM (300 horas).

EXPERIENCIA PROFESIONAL:

- Enero 2013-Actualmente; Personal de investigación en grupo GENUD. Universidad de Zaragoza. Participando en proyectos como Ifamily, ToyBox, PUBMEP, CALINA, BELINDA ect.
- 2017-2018. Colaboración como docente en Grado de Enfermería en la asignatura metodología de la investigación. Universidad de Zaragoza.
- Julio 2018- Actualmente. Docente en curso de manipulador de alimentos en centro Ymca. Zaragoza.
- Junio-Julio 2017. Docente en curso de manipulador de alimentos en academia DAYDA. Utebo.
- Septiembre-Diciembre 2015. Estancia en Chile como coordinadora de proyecto multicéntrico latino Saycare.
- Febrero-Abril 2015. Estancia en Reino Unido. Convenio de colaboración con el grupo de investigación de Ciencias del Ejercicio, Nutrición y Salud. Universidad de Bristol.
- Verano 2014. Estancia en Colombia. Cooperación como dietista-nutricionista.
- 2012 Dietista-nutricionista en farmacias. Alfajarin y Villafranca de Ebro.
- 2011-2012. Trabajo en restauración colectiva en residencia de mayores; valoración de menús y pinche de cocina.
- Junio 2012. Asesora dietética de BIMANAN en farmacias.
- Trabajo en farmacia de Inmaculada de la Cruz como auxiliar de farmacia.
- Verano 2011. Estancia en Perú. Cooperación como dietista- nutricionista en Hospital de Piura. Formación y prevención de la desnutrición.
- Marzo- Junio 2011. Hospital Perpetuo Socorro desempeñando consejo dietético y participando en el proyecto CEREA junto a la matrona. Prácticas.

- Julio- Sept 2010. Centro de Salud de Fuentes de Ebro desempeñando consejo dietético y valoraciones nutricionales a niños de 6 a 12 años. Prácticas.

VOLUNTARIADO:

- Voluntaria en Cruz Roja los fines de semana en centro de coordinación de ambulancias, ropero y banco de alimentos. Desde Septiembre 2011.
- Voluntaria en servicio de UES (Unidad de Emergencia Social) dos noches al mes. Desde Enero 2014.
- Nutricionista colaboradora en Colombia. Sierra Nevada de Santa Marta. Empresa indígena Wintwkua realizando las siguientes funciones: capacitación nutricional a médicos y enfermeros que trabajan en la zona, capacitación a profesores de niños indígenas, valoración nutricional y programación nutricional en el centro de recuperación nutricional de la comunidad. Agosto 2014.
- Nutricionista colaboradora en Piura (Perú) con el Dr. Gerardo Castillo en el programa de cooperación con países desfavorecidos de la Universidad de Zaragoza. Programa médico-social de voluntariado de la Universidad de Zaragoza en poblaciones rurales desfavorecidas y marginales peruanas. Centro Universitario de Medicina Preventiva (CUM) de la Universidad de Piura. Julio 2011 – Septiembre 2011

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- María L. Miguel-Berges, Alba M. Santaliestra-Pasias, Theodora Mouratidou, Pilar De Miguel-Etayo, Odysseas Androutsos, Marieke De Craemer, Sonya Galcheva, Berthold Koletzko, Zbigniew Kulaga, Yannis Manios, Luis A. Moreno and on behalf of the ToyBox-study group. Combined Longitudinal Effect of Physical Activity and Screen Time on Food and Beverage Consumption in European Preschool Children: The ToyBox-Study. Nutrients 2019, 11, 1048.
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vegetarianism, bone mineral density, and fracture risk: a systematic review and meta-analysis. Nutr Rev. 2019 Jan 1;77(1):1-18.

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- María L. Miguel-Berges, Alba M. Santaliestra-Pasias, Theodora Mouratidou, Odysseas Androutsos, Marieke de Craemer, An-Sofie Pinket, Julia Birnbaum, Berthold Koletzko, Violeta Iotova, Natalia Usheva, Zbigniew Kulaga, Magdalena Gozdz, Yannis Manios and Luis A. Moreno on behalf of the ToyBox-study group. Associations between food and beverage consumption and different types of sedentary behaviours in European preschoolers: the ToyBox-study. ISSN 1436-6207 2016 Published: Eur J Nutr DOI 10.1007/s00394-016-1236-7
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- Iglesia I, Santaliestra-Pasías AM, Bel-Serrat S, Sadalla-Collese T, Miguel-Berges ML, Moreno LA. Fluid consumption, total water intake and first morning urine osmolality in Spanish adolescents from Zaragoza: data from the HELENA study. Eur J Clin Nutr. 2016 May;70(5):541-7. Doi: 10.1038/ejcn.2015.203. Epub 2015 Dec 16.
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- Clusters of lifestyle behaviours and changes in body composition in European prescholers. The Toybox-study. María L Miguel-Berges, Alba M Santaliestra-Pasias1, Odysseas Androutsos, Ilse De Bourdeaudhuij, Greet Gardon, Zbigniew Kulaga, Piotr Socha, Sonya Galcheva, Violeta Iotova, Theodora Mouratidou1 Yannis Manios and Luis A Moreno on behalf of the ToyBox-study group. XVII Reunión de la Sociedad Española de Nutrición. 3-5 Noviembre 2016. Santiago de Compostela.
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- Factores perinatales relacionados con la tensión arterial en niños de 3 y 6 años. Estudio calina. L. Tomaino, I. Iglesia Altaba, M.L. Miguel Berges, P. Flores Barrantes, P. Samper Villagrasa, G. Rodriguez Martinez. XXVI Congreso de Neonatología y Medicina Perinatal. Póster.
- Associations between pedometer-determined physical activity and adiposity in children and adolescents: Systematic review. Miguel-Berges ML, Jiménez-Pavón D, Moreno LA. Poster Symposium Exernet. 7-8 Noviembre de 2014.
- Agrupaciones de los hábitos de vida y cambios en la composición corporal en niños europeos en edad preescolar. Estudio Toybox. Poster científico. XVII Reunión de la sociedad española de nutrición. Santiago de Compostela.
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- "Veganismo, vegetarianismo y densidad mineral ósea. Revisión sistemática y meta-análisis". Comunicación oral. I Congreso de alimentación, nutrición y dietética. Academia Española de Nutrición y Dietética. 10-11 Noviembre 2017
- Total fluid intake, and first morning urine osmolality in Spanish adolescents from Zaragoza: data from the HELENA study. Iglesia I, Santaliestra-Pasías AM, Bel-Serrat S, Sadalla-Collese T, Miguel-Berges ML, Moreno LA. Poster 17th ICDA Granada 2016.
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2014.

- Beneficios de la actividad física según las recomendaciones de la organización mundial de la salud sobre la composición corporal y la adiposidad en escolares. Pilar Ferrer Santos, Pilar Samper Villagrasa, Iris Iglesia Altaba, María Luisa Miguel Berges, Luis A. Moreno Aznar, Gerardo Rodríguez Martínez. Póster: 66 Congreso AEP Zaragoza 8 de junio 2018.
- Trends in obesity development and its relationship with screen time in children from Aragón. The calina study. María L Miguel-Berges; Alba Santaliestra-Pasias; Paloma Flores-Barrantes; Iris Iglesia-Altaba; María Luisa Álvarez; Luis Moreno y Gerardo Rodriguez. XVII Congreso de la Sociedad Española de Nutrición (SEÑ). Poster.

CONGRESOS Y JORNADAS:

- Congreso Nacional de la Sociedad Española del Estudio de la Obesidad. Póster: Efecto de la combinación de actividad física y tiempo de pantalla sobre el consumo de alimentos y bebidas en niños europeos en edad prescolar. Estudio longitudinal Toybox. XVII Congreso de la Sociedad Española de Nutrición, Junio del 2018, Barcelona - España.
- Presentación de póster: Trends in obesity development and its relationship with screen time in children from Aragón. The calina study. V Jornadas Doctorales de Campus Iberus. Jornadas de divulgación investigadora. 1 y 2 de Julio. Jaca.
- II Congreso de alimentación, nutrición y dietética. Academia Española de Nutrición y Dietética. 5-6 Octubre 2018. Madrid. Presentación de póster.
- II Encuentro de Grupos de Investigación del IA2. Noviembre del 2018, Zaragoza - España. Presentación de Póster.
- II Congreso Internacional de Ciencias de la Salud y del Deporte. Mayo 2019.

Presentación de póster.

- 5-6 Octubre 2018. II Congreso de alimentación, nutrición y dietética. Academia Española de Nutrición y Dietética. Presentación de poster
- 28 y 29 de junio de 2018. XVII Congreso de la Sociedad Española de Nutrición (SEÑ). Presentación de poster
- 10-11 Noviembre 2017. I Congreso de alimentación, nutrición y dietética. Academia Española de Nutrición y Dietética. Moderadora y presentación poster.
- Marzo 2017. Congreso de Obesidad. SEEDO. Comunicación oral.
- 2-5 Noviembre 2016. XVII Reunión de la sociedad española de nutrición. Santiago de Compostela.
- 18-20 Junio 2015. Symposium Early Nutrition, Physical Activity and Health. Escuela de medicina. Universidad de Zaragoza.
- Poster científico en Symposium Exernet. Granada 7-8 Noviembre de 2014.
- 5-6 Agosto 2014. Ponente en la I Jornada de Nutrición y Educación en la Universidad de la Sabana. Colombia.
- Comunicación científica en XVI Reunión de la Sociedad Española de Nutrición. Pamplona 3-5 Julio 2014.
- Poster científico en XVI Reunión de la Sociedad Española de Nutrición. Pamplona 3-5 Julio 2014.
- Asistencia a I Cátedra Ordesa en Zaragoza el 19 de noviembre de 2013.
- IUNS 20th International Congress of Nutrition. Sep 2013. Granada.