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PATRONES DE SEDENTARISMO Y SU RELACIÓN CON LA INGESTA DE ALIMENTOS EN NIÑOS Y ADOLESCENTES EUROPEOS

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Sedentary patterns and their relationship with food intake in European children and adolescents

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Tesis Doctoral 2014

Facultad de Ciencias de la Salud
Departamento de Fisiatría y Enfermería
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Lista de publicaicones [List of publications]

La presente Tesis Doctoral es un compendio de trabajos científicos previamente publicados o sometidos a revisión. Las referencias de los artículos que componen este documento se detallan a continuación

I. **AM. Santaliestra-Pasías**, JP. Rey-López and LA. Moreno Aznar. Obesity and sedentarism in children and adolescents: What should be done?. *Nutr Hosp 2013;28(Supl. 5):99-104*

II. **AM. Santaliestra-Pasías**, T. Mouratidou, V. Verbestel, K. Bammann, D. Molnar, S. Sieri, A. Siani, T. Veidebaum, S. Märild, L. Lissner, C. Hadjigeorgiou, L. Reisch, I. Bourdeaudhuij and LA Moreno, on behalf of the IDEFICS Consortium. Physical activity and sedentary behaviour in European children: the IDEFICS study. *Public Health Nutr. 2013 Oct 8:1-12*

III. **AM. Santaliestra-Pasías**, T. Mouratidou, V. Verbestel, I. Huybrechts, F. Gottrand, C. Le Donne, M. Cuenca-García, LE. Díaz, A. Kafatos, Y. Manios, D. Molnar, M. Sjöström, K. Widhalm, I. De Bourdeaudhuij, LA. Moreno, for the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-sectional Study Group. Food Consumption and Screen-Based Sedentary Behaviors in European Adolescents. The HELENA Study. *Arch Pediatr Adolesc Med. 2012 Nov;166(11):1010-20*

IV. **AM. Santaliestra-Pasías**, T. Mouratidou, I. Huybrechts, L. Beghin, M. Cuenca-García, MJ. Castillo, M. Galfo, L. Hallstrom, A. Kafatos, Y. Manios, A. Marcos, D. Molnar, M. Plada, R. Pedrero-Chamizo, K. Widhalm, I. De Bourdeaudhuij, and LA. Moreno on behalf of the HELENA study group. Increased sedentary behaviour is associated with unhealthy dietary patterns in European adolescents participating in the HELENA study. *Eur J Clin Nutr 2014 Mar;68(3):300-8.*

V. **AM. Santaliestra-Pasías**, T. Mouratidou, L. Reisch, I. Pigeot, W. Ahrens, S. Mårild, D. Molnár, A. Siani, S. Sieri, M. Tornatiris, T. Veidebaum, V. Verbestel, I. De Bourdeaudhuij, LA. Moreno. Clustering of lifestyle behaviors and relation to body composition in European children. The IDEFICS study. *Eur J Clin Nutr (submitted)*

Contenidos

1. Proyectos de investigación [Research projects]

El trabajo que se desarrolla en la presente Tesis Doctoral, así como los artículos que forman parte de esta investigación, están basados en los siguientes proyectos de investigación:

1.- Estudio IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants). Proyecto financiado por la Unión Europea: European Union Sixth RTD Framework Programme (contract FOOD-CT-2006-016181-2.
Página web: www.idefics.eu
Coordinador: Wolfgang Ahrens

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

Así mismo, Alba Mª Santaliestra-Pasías ha recibido una beca destinada a la formación predoctoral concedida por la Fundación Cuenca Villoro, Zaragoza, desde enero de 2009 hasta diciembre de 2011.

2. Listado de abreviaturas [List of abbreviations*]

- AAP Academia Americana de Pediatria
- AF Actividad física
- ANOVA Análisis de varianza
- ANCOVA Análisis de covarianza
- CEHQ-FFQ Children's Eating Habits Questionnaire-food frequency section
- CEICA Comité Ético de Investigación Clínica de Aragón
- CFCA Cuestionario de frecuencia de consumo de alimentos
- Cols. Colaboradores
- DP Dietary patterns o patrones dietéticos
- DVD Digital Versatil Disk
- EPSGHAN European Society for Pediatric Gastroenterology
- FAS Family Affluence Scale
- HBSC Health Behaviour in School Age Chindren
- HELENA-CSS Healthy lifestyle in Europe by Nutrition in Adolescence-Cross- Sectional Study
- IDEFICS Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and InfantS
- IMC Índice de Masa Corporal
- Kcal Kilocalorías
- Min Minutes
- MSM Multiple source method
- PA Physical activity
- PASW Predictive Analytics Software
- TV Televisión

*Abbreviation in English language are shown in the scientific papers included in the present Doctoral Thesis

3. Resumen general

La infancia y la adolescencia son periodos cruciales en el desarrollo de estilos de vida saludables y en la adquisición de hábitos alimentarios y de actividad física. Los comportamiendo se establecen durante la niñez y se mantienen hasta la edad adulta. Además, se caracterizan por ser etapas de crecimiento y desarrollo rápido. En las últimas décadas se está analizando con detalle el impacto de los comportamientos sedentarios en diversos grupos poblacionales, debido a la estrecha relación de los mismos con diferentes enfermedades crónicas como es el caso de la obesidad, diabetes tipo 2 o las enfermedades cardiovasculares.

A nivel general, los objetivos de la presente Tesis Doctoral son: 1) describir la situación actual de los comportamientos sedentarios en la infancia y adolescencia, 2) valorar las asociación de los comportamientos alimentarios con los patrones de alimentación en este grupo de población y 3) ampliar el conocimiento científico actual sobre la relación entre los estilos de vida definidos por los comportamientos sedentarios, la actividad física (AF) y la alimentación y su relación con la composición corporal en jóvenes europeos.

Para analizar la situación actual de los comportamientos sedentarios se realizó una revisión de la bibliografía existente, así como se obtuvieron medidas en 15.330 niños participantes en el estudio IDEFICS (Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and InfantS), procedentes de ocho países europeos (Italia, Estonia, Chipre, Bélgica, Suecia, Alemania, Hungría y España), con edades comprendidas entre los 2 y 8 años. Para la consecución del segundo objetivo se obtuvieron medidas en 2.202 adolescentes procedentes del estudio HELENA-CSS (Healthy lifestyle in Europe by Nutrition in Adolescence-Cross Sectional Study), procedentes de 8 ciudades europeas (Atenas en Grecia, Dortmund en alemania, Gante en Bélgica, Lille en Francia, Roma en Italia, Estocolmo en Suecia, Viena en Austria y Zaragoza en España), con edades comprendidas entre los 12.5 y 17.5 años. En cuanto al tercer objetivo, se obtuvieron medidas del estudio IDEFICS (n=11.674), en niños procedentes de los ocho países europeos y con los mismos rangos de edad.

Los resultados de la revisión de la literatura permiten establecer unas recomendaciones para disminuir los comportamientos sedentarios en niños y adolescentes que se basa en los siguientes puntos clave: (1) los padres deben ser conscientes del impacto de los diferentes estilos de vida en la salud de los niños y promover hábitos saludables; (2) retirar los aparatos electrónicos del espacio personal de los niños y adolescentes, principalmente la televisión; (3) los niños no deberían comer mientras estén viendo la televisión; (4) las familias deberían disminuir el tiempo de exposición a los anuncios de comida; (5) las autoridades y las comunidades no deberían incentivar los entretenimientos electrónicos pasivos; y (6) tener en cuenta

todos los factores vinculados a la obesidad en el desarrollo de intervenciones para prevenir la obesidad infantil y lograr un éxito a largo plazo.

En cuanto a la descripción de los comportamietnos sedentarios, se ha observado que aproximadamente un tercio de los niños europeos no cumplen las recomendaciones para el tiempo total de pantalla (<2horas/día). Además, disponer de televisión en el espacio personal de los niños aumenta el riesgo de exceder las recomendaciones del tiempo total de pantalla (>2horas/día). Respecto al tercer objetivo, nuestros resultados ponen de manifiesto que durante la adolescencia dedicar más tiempo a realizar actividades sedentarias como ver la televisión, jugar a los ordenadores o utilizar internet está asociado con un mayor consumo de bebidas azucaradas y un menor consumo de fruta. Por otro lado, al evaluar la alimentación de los adolescentes en su conjunto, se ha observado que los patrones alimentarios de los adolescentes están relacionados con el tiempo invertido en diferentes conductas sedentarias. En chicos, un mayor consumo de tiempo viendo la televisión, jugando a juegos de ordenador y utilizando internet en su tiempo libre está asociado con una menor adherencia a los patrones saludables ("DP alimentos vegetales", "DP basado en alimentos típicos del desayuno" y "DP basado en alimetos saludables"), y con una mayor adherencia a los patrones menos saludables ("DP basado en alimentos de picoteo"). En cuanto a las chicas, un mayor consumo de televisión y uso de internet en su tiempo de ocio está asociado con una mayor adherencia a los patrones dietéticos menos saludables ("DP basado en el picoteo de alimentos dulces y salados") y menor adherencia a los patrones más saludables ("DP basado en alimetnos saludables"). Además, el tiempo que los adolescentes estudian está asociado con una menor adherencia a los patrones menos saludables y con una mayor adherencia a los más saludables. Por último, los resultados obtenidos relativos al tercer objetivo indican que las agrupaciones de comportamientos caracterizadas por elevado tiempo dedicado a conductas sedentarias (televisión) pueden considerarse las más obesogénicas. En niños, la coexistencia junto con bajos niveles de AF, así como un bajo consumo de frutas y verduras, presenta la asociación más perjudicial.

Tanto el estudio IDEFICS como el estudio HELENA tienen un diseño transversal, y es una de las principales limitaciones de la presente Tesis Doctoral, debido a que no permite establecer relaciones causales. La información recogida sobre la ingesta y los comportamientos sedentarios fue aportada por los padres de los niños participantes y auto-registrada en el caso de los adolescentes, y por ello está sujeta a una variedad de errores de medida no intencionados. Por otra parte hay que tener en cuenta fenómenos de deseabilidad social y posible infradeclaración o sobrevaloración tanto de las variables de dieta como de los comportamientos sedentarios, que son factores que hay que tener en cuenta respecto a estas variables. En contraposición, la metodología utilizada en ambos estudios se ha coordinado de forma exhaustiva y protocolizado para homogenizar la recogida de información en los diversos países involucrados en cada estudio. Así mismo, la utilización de cuestionarios de valoración

de los comportamientos sedentarios y de la dieta permite obtener información respecto a múltiples aspectos relativos al impacto de los mismos en la salud de los jóvenes. Además, la validación de las herramientas de medida utilizadas en ambos estudios, permite dar fiabilidad a los resultados obtenidos.

En resumen, los resultados de la presente Tesis Doctoral ponen de manifiesto la importancia de conocer y describir las actividades sedentarias que realizan los niños y adolescentes europeos. Además, valorar el impacto de dichos comportamientos en la alimentación es un factor clave para el desarrollo de estrategias de prevención efectivas que se focalicen en los estilos de vida, y cuyo objetivo principal sea la prevención de enfermedades crónicas como es el caso de la obesidad.

3. General abstract

Childhood and adolescence are key periods for the development of healthy lifestyles and the adquisition of eating and activity patterns. Behaviours are established during this period and it will move up through the adulthood. Moreover, this period is characterized by rapid growth and development. During the last decades, sedentary behabiours in several age groups have been analising in depth due to their relationship with several cronic diseases as obesity, type 2 diabetes or cardiovascular diseases.

The aims of the present Doctoral Thesis are: 1) to evaluate the current situation of sedentary behaviours during childhood and adolescence, 2) to assess the association between sedentary behaviours and food intake in this group population, and 3) to contribute to the scientific knowledge about the relation between sedentary behaviours, physical activity (PA) and food intake, and their relation with body composition in young populations.

To analyse the current situttion related with sedentary behaviours a review was realized and measurements were obtained in 15.330 children aged 2 to 8 years as part of the IDEFICS (Identification and prevention of Dietary- and lifestyle-induced health EFfects In Children and InfantS) study, performed in eight European countries (Italy, Estonia, Cyprus, Belgium, Sweeden, Germany, Hungary and Spain). To address the second objective, measurements were obtained in 2.202 adolescents aged 12.5 to 17.5 years, from the HELENA-CSS (Healthy lifestyle in Europe by Nutrition in Adolescence-Cross- Sectional Study), performed in 8 European cities (Athens in Greece, Dortmund in Germany, Ghent in Belgium, Lille in France, Rome in Italy, Stockholm in Sweeden, Vienna in Austria and Zaragoza in Spain). Regarding the third objective, measurements were obtained in the IDEFICS study (n=11.674), from the eight European countries, in the same age-groups.

The findings of the review allow to stablish several recomendations to decrease sedentary behaviours in children and adolescents: (1) parents should be aware of how different lifestyles impact their children's health in order to promote healthy behaviours; (2) remove electronic devices outside children/adolescent's bedroom, specially television (TV) set; (3) children should not eat while watching TV; (4) families should minimize the amount of time that children are exposed to food advertisements; (5) governments should not incentive passive electronic entertainment; and (6) given the multi-factorial origin of obesity, all of them should be considerer in the prevention strategies in order to obtain a successful result for a long term.

Regarding the sedentary behaviour description, the results showed that approximately a third of the children failed to meet current screen time recommendations (<2hours/day). Moreover, availability of a television set in the

personal space, increased the risk of excess total screen time (>2hours/day). Concerning the third objective, findings showed that during adolescence, increased sedentary behaviours like television viewing, computer and Internet use were associated with a higher odds of consumption of sweetened beverages and lower odds of fruit consumption. On the other hand, analysing adolecents' food intake as a whole, current findings show that food intake and the time they spent on several sedentary behaviours are associated. In boys, high consumption of time watching television, playing computer games or using internet for recreational reasons had lower adherence to the healthy dietary patterns (DPs) ("plant based DP", "breakfast DP" and "health conscious DP") and higher adherence to the unhealthy DPs ("snacking DP). In girls, high consumption of time watching TV and using internet for recreational reasons was associated with high adherence to the unhealthy DPs ("confectionary and snacking DP") and low adherence to the healthy DPs. Also, the time that adolescents spent studying was associated with low adherence to the unhealthy DPs and with high adherence to the healthy DPs. Finally, findings related with the third objective showed that clusters characterized by high sedentary behaviours can be considered as the most obesogenic in children. In boys, clustering with low levels of PA and low fruit and vegetable consumption was the most deleterious association

Both studies (IDEFICS and HELEN) had a cros-sectional design, which is one of the main limitations of the present Doctoral Thesis as it does not allow drawing casual associations. Information on diet and sedentary behaviours are parental-reported for the children, and self-reported for the adolescents, which is subject to a variety of unintentional measurement errors. On the other hand, social desirability and under- or over-reporting of sedentary behaviours and dietary intake variables are taken into consideration. However, all the measurements were obtained following a highly standardized procedure in order to armonize data collection in the diverse countries involved. Additionally, the use of a combination of sedentary behaviours and dietary assessment tools, allow to obtain information regarding several aspects related with public health policies. Moreover, the validation of the questionnaires used in both studies, allow providing reliable findings.

In conclusión, findings of the current Doctoral Thesis highlight the need of knowing the importance to describe the time that European children and adolescent spent in several sedentary behaviours. Moreover, to evaluate their impact on food intakes is a key factor to develop effective prevention strategies focusing on lfestyle behaviours, which main aim was to prevent chronic disease like obestiy.

4. Introducción [Introduction]

En los últimos años se han incrementado el tiempo dedicado a conductas sedentarias, así como la inactividad física,[1-3] destacándose ésta como uno de los mayores responsables de muerte atribuibles a enfermedades crónicas[4] y observándose que las conductas sedentarias son, en sí mismas, factores de riesgo independientes en la etiología de dichas enfermedades.[5-7]

Se puede considerar que el desarrollo de obesidad tiene una causa multifactorial, debido a la interconexión de factores genéticos y ambientales.[8] En la actualidad, la controversia sobre el origen de las elevadas prevalencias de obesidad durante la infancia y adolescencia, se están centrando en dos aspectos esenciales relacionados con el balance energético: la ingesta de energía y el gasto energético.[9] Según algunos autores, el exceso de energía consumida es una de las causas primarias,[10, 11] mientras que las elevadas tasas de inactividad derivadas de los modernos estilos de vida así como las pautas alimentarias podrían ser algunos de los factores causales según otros autores.[12] En niños y adolescentes parece que la elevada ingesta alimentaria no es la principal causa de las elevadas prevalencias de obesidad.[13] Es asumible considerar, teniendo en cuenta la evidencia científica actual, que la combinación de una elevada ingesta alimentaria, junto con un bajo gasto energético son factores clave en edades tempranas.

Durante la niñez, la inactividad física y las conductas sedentarias, unido a unos hábitos dietéticos poco sanos, se han asociado con un mayor riesgo de sobrepeso y obesidad.[3, 14] Así mismo, una dieta saludable acompañada de una adecuada actividad física se han destacado como los principales indicadores de un estilo de vida saludable, siendo los de mayor impacto en la prevención de enfermedades crónicas.[15]

4.1 Comportamientos sedentarios

4.1.1 Definición y Clasificación

Todas aquellas actividades caracterizadas por un bajo gasto energético, se consideran conductas sedentarias,[16, 17] incluyen distintas actividades como ver la televisión, o jugar con ordenadores.[18, 19] Los comportamientos sedentarios son todas aquellas actividades que se realizan durante el día, que se realizan en posición sentada y que implican un bajo gasto energético (<2 equivalentes metabólicos (METs)).[20]

4.1.2 Valoración de los comportamientos sedentarios

Para evaluar los comportamientos sedentarios se pueden utilizar diversas herramientas, en función de los objetivos que se persiguen en el estudio. Según la revisión sistemática publicada por Bryant y cols.,[21] los métodos de valoración de los comportamientos sedentarios en niños y adolescentes se pueden clasificar en: observación directa, registros auto-administrados y cuestionarios auto-administrados.

Observación directa

Se realiza mediante la observación *in situ* del sujeto a estudiar y registrando directamente en un papel el tipo de actividad sedentaria realizada, así como el tiempo dedicado a la misma. Se puede considerar como el método de referencia, pero una de las principales limitaciones de esta herramienta es el tiempo necesario para registrarlo, por lo que no es factible para utilizarlo en estudios epidemiológicos de gran escala. Se ha utilizado de forma exitosa en algunos estudios.[22-25]

También se considera la grabación como una técnica de observación directa. Consiste en la implantación de una cámara en el espacio habitual donde se realizan las actividades de la vida diaria. También se puede realizar utilizando unos dispositivos electrónicos que se colocan junto al televisor y registran cuando está encendido. La ventaja de esta herramienta consiste en la monitorización del tiempo mediante el dispositivo en cuestión, pero dentro de las limitaciones que presenta, es que se deben incorporar varias cámaras para registrar otros espacios (salas de estudio, habitación, etc.) en los que también se realicen actividades sedentarias (por ejemplo, lectura, utilización de ordenadores, etc.). Además, el dispositivo electrónico vinculado al televisor, solamente permite registrar el tiempo dedicado a ver la televisión.

Registros auto-administrados

Consiste en la cumplimentación de un registro de forma detallada en el que se incluyen todas las actividades sedentarias que se realizan a lo largo del día/s de registro. Una de las ventajas de este tipo de registros es que los padres pueden ayudar en la cumplimentación de esta información. Se han utilizado de forma exitosa en algunos estudios,[26, 27] pero la principal limitación que la baja proporción de cumplimentación completa por los participantes del estudio.

Cuestionarios auto-administrados

Los cuestionarios auto-administrados son una de las herramientas más fáciles y rápidas para registrar el tiempo dedicado a las actividades sedentarias, pero son menos precisos que la observación directa.[21] Por ello es esencial evaluar la validez y

fiabilidad de los cuestionarios que se utilizan. Los padres pueden recordar los comportamientos sedentarios de sus hijos/as debido a que los niños no son capaces de recordar este tipo de información. Además, se pueden incluir todo tipo de actividades sedentarias (televisión, ordenadores, videoconsolas, lectura, estudio, trabajo, etc.) para lograr un adecuado registro de todos loc comportamientos sedentarios de los sujetos. Además, se puede recoger este tipo de información vía entrevista o auto-referido. Con esta herramienta se puede discernir el tiempo dedicado a diferentes comportamientos sedentarios, y dividirlos a su vez entre periodos entre semana y en fin de semana. Al mismo tiempo se pueden utilizar preguntas abiertas, o bien escalas o categorías (por ejemplo, 0-1hora/ día, 1-2 horas/día, 2-3 horas/día, etc.).

4.1.3 Recomendaciones internacionales

Según la Academia Americana de Pediatría[28] las recomendaciones del tiempo total de pantalla que deben dedicar los niños y adolescentes se establecen en no más de 2 horas al día. Más recientemente, se han establecido nuevas recomendaciones para el caso de los niños en edad preescolar (de 2 a 5 años), en las que se ha reducido el tiempo, limitándose éste a menos de una hora al día.[29] Las recomendaciones se basan en (1) limitar el tiempo total de pantalla; (2) quitar la televisión de la habitación de los niños; (3) disuadir a los niños menores de 2 años de ver la televisión, y promocionar actividades interactivas que promuevan un adecuado desarrollo cerebral (hablar, jugar, cantar y leer junto con ellos); (4) controlar los programas que ven los niños y adolescentes; (5) ver los programas de la televisión junto a los niños y adolescentes; (6) ver programas controvertidos para promover conversaciones sobre valores familiares, violencia, sexualidad o consumo de drogas; (7) utilizar videos para mostrar programas educacionales para niños; (8) apoyar los esfuerzos para establecer programas educativos de medios de comunicación en las escuelas; y (9) potenciar alternativas de entretenimiento para los niños, incluyendo actividades como la lectura, deporte, aficiones y juegos creativos.

En las recomendaciones se habla del tiempo total de pantalla, en el que se incluye todo el tiempo que se utiliza en actividades enfrente de una pantalla (televisión, ordenador, videoconsola, etc.), debiendo ser el cómputo total no superior a las recomendaciones establecidas.

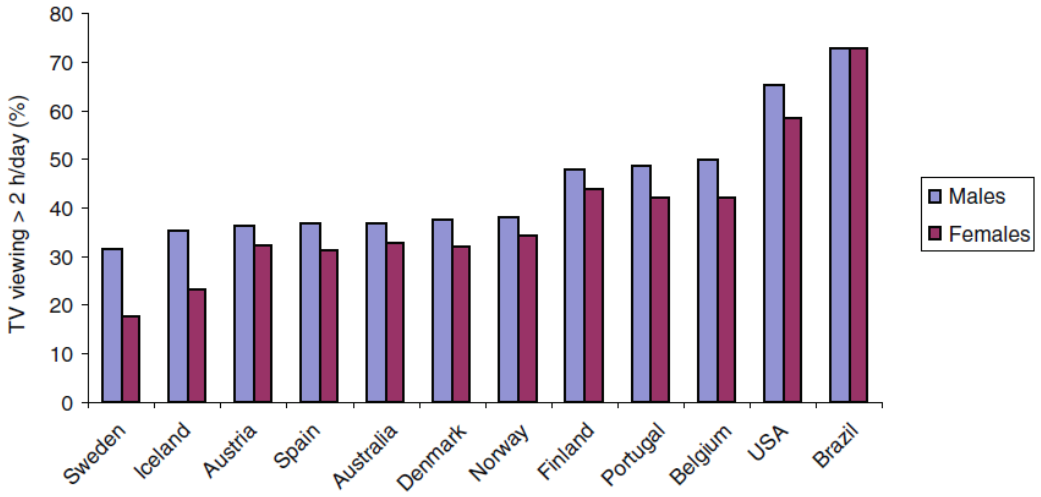
4.1.4 Epidemiología descriptiva

El estudio de los comportamientos sedentarios se está incrementando en las últimas décadas. Se ha observado que la prevalencia de estos comportamientos varía en función de la actividad sedentaria que se considere en cada caso. En una revisión sistemática realizada por Marshall y cols. [19] se observó que los jóvenes ven una media que oscila entre 1.8 y 2.8 horas de televisión, en función de la edad y el género. Así

mismo, se ha observado que los niños y las niñas juegan aproximadamente 60 y 23 minutos, respectivametne; y que adicionalmente utilizan unos 30 minutos el ordenador.

Existen importantes diferencias en el consumo de televisión entre diferentes países en relación al consumo de tiempo de televisión. Así mismo, valorando las recomendaciones internacionales (<2horas/ día) existe una gran proporción de niños y adolescentes que no las cumple.[3, 30] Por ejemplo, en datos procedentes del estudio "Health Behaviour in School Age Children" (HBSC), se observó que el 61% de los niños con edades comprendidas entre 11 y 15 años superaba las recomendaciones de tiempo dedicado a ver la televisión (>2horas/día). En el estudio HELENA, realizado en adolescentes con edades comprendidas entre 12.5 y 17.5 años, se ha observado que el 58% de los chicos y el 53% de las chicas exceden las recomendaciones del tiempo dedicado a ver la televisión.[31] En la Figura 1 se puede observar la proporción de niños y/o adolescentes que exceden las recomendaciones de la AAP para el tiempo dedicado a ver la televisión en diferentes estudios realizados en varios países del mundo.

Figura 1. Porcentaje de adolescentes que no cumple las recomendaciones de tiempo dedicado a ver la televisión (>2h/día).[3]



4.1.5 Asociación de los comportamientos sedentarios con enfermedades

La inactividad física se está estudiando en las últimas décadas tanto en población infanto-juvenil, como en poblaciones adultas, debido a las estrechas relaciones que se están estableciendo con diversos indicadores de salud. Recientemente se han estimado las muertes asociadas a diferentes conductas y estilos de vida modificables, presentándose tanto la inactividad física como el sobrepeso y obesidad como responsables de 1 de cada 10 muertes a nivel mundial, solamente precedido por el hábito de fumar y la tensión arterial elevada.[4]

Comportamientos sedentarios y obesidad

En los últimos años, se han incrementado los estudios que relacionan el tiempo sedentario con el riesgo de sobrepeso y obesidad, tanto en poblaciones infantiles como en adultos. Se ha observado que conductas como ver la televisión o jugar con video juegos son factores de riesgo para desarrollar sobrepeso (incremento del riesgo entre el 17% y 44%) u obesidad (incremento del riesgo entre 10% y 60%) en niños con edades comprendidas entre 7 y 11 años.[32] En niños europeos, también se ha asociado de forma independiente algunas actividades sedentarias como es el caso de la televisión y la práctica de actividad física con los niveles de adiposidad.[2]

Así mismo, diversos autores concluyen que es necesario valorar diversas conductas sedentarias al mismo tiempo, no solamente de forma individual, debido a que no todas se han relacionado con la obesidad.[33] Por otro lado se ha observado que permanecer en posiciones sentadas durante largos periodos de tiempo, puede ser causante de pérdida de oportunidades para gastar energía durante el día a día y por ende puede producir efectos crónicos en el desarrollo de sobrepeso.[7]

Comportamientos sedentarios y salud cardiovascular

Exceder las recomendaciones de tiempo sedentario tiene un impacto negativo sobre la salud y bienestar de los jóvenes. Los comportamientos sedentarios, como el caso de ver la televisión, se han asociado con una mayor prevalencia de enfermedades como el síndrome metabólico en jóvenes[2, 34] y adultos,[5] que es la aparición conjunta de diversos factores de riesgo cardiovascular como la obesidad, la hipertensión, la diabetes y la dislipemia[35] y con factores de riesgo de desarrollo de diabetes mellitus tipo 2 y enfermedades cardiovasculares.[36] Además los estudios recientes indican que las conductas sedentarias son un factor de riesgo para diferentes enfermedades crónicas,[7] como es la diabetes mellitus tipo 2 y enfermedades cardiovasculares,[36] independieentemente de la actividad física y la alimentación.[34]

4.1.6 Relación entre comportamientos sedentarios y estilos de vida

Relación entre comportamientos sedentarios y actividad física

Durante la niñez y la adolescencia temprana (entre los 5 y 13 años) se establecen tanto las habilidades sociales, como los comportamientos relacionados con los estilos de vida a largo plazo.[37] Es un periodo en el que los comportamientos que tengan los jóvenes serán decisivos para sus actitudes como futuros adultos. Los comportamientos sedentarios se han descrito en diferentes grupos poblacionales, siendo los niños más jóvenes aquellos en los que hay una mayor carencia de datos procedentes de estudios multi-céntricos.

Se ha observado que, en adolescentes, la mayor accesibilidad a dispositivos electrónicos se ha relacionado con un mayor tiempo de pantalla total.[31] Evaluar en poblaciones en edades pre-escolares y escolares si la disponibilidad de aparatos electrónicos en su espacio personal se relaciona con el tiempo invertido en actividades sedentarias es un argumento en el desarrollo de estrategias que permitan disminuir el tiempo sedentario y que al mismo tiempo permitan dirigir los estilos de vida hacia opciones más saludables.

No obstante, la relación entre los niveles de AF y tiempo dedicado a ver la televisión parecen ser actividades independientes,[38] lo cual sugiere que es necesario un adecuado reparto del tiempo diario para ambas actividades. Muchos de los estudios se han centrado en el consumo de tiempo de televisión, siendo éste una de las conductas sedentarias más estudiadas,[19, 39] pero no necesariamente representa toda la actividad del tiempo sedentario.[40]

Relación entre comportamientos sedentarios y dieta

En los últimos años se están evaluando las posibles relaciones existentes entre las conductas sedentarias y los patrones dietéticos. Una revisión reciente, revela que las actividades sedentarias, incluyendo particularmente el tiempo dedicado a ver la televisión, a jugar a video juegos entre otros, se asocian con un consumo elevado de alimentos.[41] Actualmente es frecuente una ingesta elevada de alimentos sin la sensación de hambre, lo cual enfatiza la importancia del valor hedónico de las ingesta alimentarias.[41] Además, se ha observado en diversos estudios en adolescentes, que las conductas sedentarias se asocian con el consumo de comidas poco saludables.[42-45] Por ejemplo, superar el tiempo recomendado (2h/día) viendo la televisión se ha asociado con un mayor riesgo de sobrepeso, así como con un consumo insuficiente de frutas y vegetales en adolescentes caucásicos (ambos géneros);[42] también se han asociado positivamente las conductas sedentarias con el consumo de patatas fritas y con el consumo de bebidas refrescantes azucaradas, y negativamente con un consumo elevado de zumos vegetales y de frutas.[43] Igualmente se han vinculado los comportamientos sedentarios con el consumo de alimentos de baja calidad nutricional.[46-48] Se ha observado que aquellos adolescentes que indican un menor consumo de tiempo viendo la televisión, consumen más fruta (chicos) y menos grasa y más fruta (chicas).[46] Además se ha observado que los niños procedentes de familias en las que se utiliza mucho tiempo la televisión consumen más energía derivadas de carnes, pizzas, snacks salados, y menos energía procedente de frutas, vegetales y zumos.[48]

Es esencial analizar los patrones de consumo de alimentos. Los seres humanos consumimos los alimentos de forma agrupada. Por ello, analizar los patrones de consumo alimentario permiten valorar las asociaciones entre alimentos y nutrientes consumidos de forma conjunta, y no solamente de forma aislada.[49] Esta metodología se ha utlizado en diversos estudios anteriormente, de forma que se puede valorar la

alimentación en su conjunto.[50] Por ejemplo, se ha observado que patrones dietéticos caracterizados por un elevado consumo de snacks y sedentarios se han asociado positiva y significativamente con sobrepeso en niños.[44] Además, las conductas sedentarias pueden influir en los hábitos dietéticos,[51] debido al impacto que puede tener la publicidad.[52] Las bebidas azucaradas son uno de los factores dietéticos más importante en el desaroollo del incremento de peso y de grasa corporal,[53] y a su vez éstas presentan una fuerte relación con determinadas conductas sedentarias, como es el caso del uso de la televisión.[52]

Los hábitos alimentarios, así como la AF y los comportamientos sedentarios son los principales determinantes de la obesidad,[54-56] y son los factores claves para prevenir el exceso en la ganancia de peso.[57]

Por estas razones, en la presente Tesis Doctoral se describe el consumo de diversos grupos alimentarios, principalmente aquellos relacionados con diferentes aspectos de la salud y la prevalencia de sobrepeso y obesidad.[58] Se considera no sólo el tiempo invertido viendo la televisión (que es la conducta más ampliamente estudiada), sino diferentes tipos de comportamientos sedentarios.

4.2 Ingesta de alimentos

En la presente Tesis Doctoral se han utilizado cuestionarios auto-administrados para evaluar los comportamientos sedentarios, así como recuerdos dietéticos de 24 horas y cuestionarios de frecuencia de consumo de alimentos (CFCA) para valorar las ingestas de alimentos. En relación a las variables para medir las ingestas de alimentos del estudio IDEFICS se utilizó ambos métodos de forma combinada para maximizar las ventajas de cada uno de los instrumentos de medida[59] y compensar las limitaciones. La combinación de registros dietéticos de 24 horas, junto con los CFCA es bastante frecuente en los estudios transversales.

4.2.1 Valoración de la ingesta de alimentos

Dentro de los diferentes métodos de evaluación dietética, diseñados para su uso en adultos, pero también apropiados para recopilar datos en poblaciones pediátricas,[60] existen distintos tipos: cuestionarios de frecuencia de consumo de alimentos (CFCA), recuerdos dietéticos de 24 horas, registros de alimentos e historia dietética. Cada uno de los métodos tiene limitaciones propias del instrumento, y se eligen teniendo en cuenta el objetivo del estudio.

Cuestionario de frecuencia de consumo de alimentos (CFCA)

Este tipo de cuestionario se utiliza para clasificar los individuos según su ingesta de alimentos o grupos de alimentos, y se utilizan de forma habitual en estudios de cohortes y estudios caso-control para valorar la asociación entre la dieta y el riesgo de enfermedades.[61-63] Los encuestados deben indicar la frecuencia con la que consumen cada uno de los alimentos, durante un periodo de tiempo especificado previamente.[59]

Si se incluye información relativa al tamaño de las porciones, se puede estimar *a posteriori* la ingesta de nutrientes utilizando bases de datos de composición de alimentos.[59] Este tipo de cuestionario implica un bajo coste de administración y permite estimar la ingesta durante largos periodos de tiempo. Generalmente son auto-administrados y requieren una carga de trabajo para el encuestado baja, de manera que son un método habitual en estudios epidemiológicos.[59] Entre las limitaciones, presenta un elevado error de medición,[64, 65] debido a que la cuantificación de la ingesta no es tan precisa como en los recuerdos, debido a listas de alimentos incompletas, dificultad para estimar la frecuencia de consumo del alimentos y su porción habitual, por lo que la estimación de la ingesta media del grupo es poco exacta.[59]

Recuerdo dietético de 24 horas

Esta herramienta de valoración dietética se utiliza cuando el objetivo es estimar la ingesta dietética de un grupo de personas, dado que las medias de consumo son robustas y no están influenciadas por la variabilidad intra-personal.[59] Para mejorar la valoración de la información aportada por esta herramienta se recurre a la obtención de recuerdos múltiples. Mediante este sistema, el encuestado debe recordar todos los alimentos y bebidas que consumió el día anterior, es decir las 24 horas previas al día de registro. Se realiza mediante entrevista personal o telefónica,[66, 67] o más recientemente asistida por ordenador[68] o mediante papel y lápiz. Se estructura para facilitar recordar todos los alimentos consumidos el día anterior, y es esencial la presencia de un entrevistador bien entrenado para llevar a cabo la entrevista. Éste debe tener conocimientos sobre alimentos y nutrición, debiendo estar informado sobre técnicas culinarias y alimentos típicos de la zona.[59] Entre las ventajas de esta herramienta y debido a la presencia del entrevistador, este sistema no requiere la alfabetización del encuestado; así mismo, debido a la proximidad de la fecha de registro, así como de las preguntas del encuestador, la persona encuestada es capaz de recordar la mayoría de los alimentos consumidos. Además, entrenando a los encuestadores, se puede utilizar en un amplio rango de grupos poblacionales, y al recoger la información tras el consumo de los alimentos es menos probable que se interfiera en el comportamiento alimentario.[59] Al mismo tiempo, disponer de herramientas informáticas que permitan registrar toda la información del recordatorio, permiten a su vez mejorar la recogida de la información, limitar las pérdidas de información y mejorar la estandarización de las entrevistas, así como reducir los costes del procesamiento de los datos.[69, 70] Por el contrario, entre las limitaciones de los recuerdos de 24 horas nos encontramos con que existe una gran variabilidad de la dieta de los individuos entre diferentes días, por lo que no es apropiado utilizar datos obtenidos de un solo día de medida, para caracterizar la dieta habitual de un individuo, ni tampoco para estimar si la población consume dietas adecuadas o inadecuadas.[59] Es necesario realizar múltiples recuerdos de 24 horas para poder valorar la variación

intra-personas y entre-personas.[59] Así mismo, existen diversos factores relacionados con el conocimiento, la memoria y la situación en la que tiene lugar la entrevista, que dificultan valorar la alimentación de forma precisa con el recuerdo dietético de 24 horas.[59]

Registros de alimentos

En los registros de alimentos se recoge toda la información sobre el tipo de alimentos y bebidas consumidas, así como de sus cantidades.[59] Éstas pueden ser medidas utilizando una báscula o medidas caseras (cucharadas, vasos, etc.) o estimadas utilizando fotos o modelos. En el caso de registrarse diferentes días, suelen ser consecutivos, y no prolongarse más de 3 ó 4 días, puesto que debido a la fatiga del entrevistador, se disminuyen las ingestas. Se deben anotar los alimentos consumidos cuando tiene lugar la ingesta, y se debe entrenar a los encuestados para cumplimentar los registros adecuadamente para garantizar que se recogen todos los detalles necesarios, incluyendo el método de preparación, recetas y tamaño de las porciones. Así mismo, al finalizar el periodo el entrevistador debe revisar los registros para comprobar que no se ha olvidado ningún alimento.[59] Entre las ventajas destaca que se registran los alimentos con una mayor precisión, y se evita el inconveniente de omitir alimentos consumidos. Además, las cantidades y tipos de alimentos están descritos de forma más precisa, y pueden cumplimentarse por personas distintas del sujeto de interés, por ejemplo para personas institucionalizadas o niños.[59] Por otro lado, una de las desventajas es que la persona que cumplimenta el cuestionario debe estar motivada, y saber leer y escribir, además es imprescindible su colaboración. Además, al aumentar el número de días de registro, se incrementa el número de registros incompletos,[59] y además conforme se van consumiendo alimentos, puede afectar al tipo de alimento elegido y a las cantidades consumidas.[71]

Historia dietética

Se incluye dentro del término "historia dietética" a la valoración de la dieta que determina las ingestas habituales de alimentos, así domo registra las características de los alimentos, así como la frecuencia y cantidad.[59] Se incluyen tres elementos clave, una entrevista detallada sobre el patrón de consumo habitual, un listado de alimentos en el que se indica la frecuencia y cantidad consumida, y un registro de alimentos de tres días.[72, 73] Una de las ventajas de las historia dietética es la valoración de los patrones de las ingestas y los detalles de las mismas, además todos los detalles permiten caracterizar mejor la ingesta de nutrientes.[59] Sin embargo, una de las principales desventajas es que al realizar diferentes valoraciones de las ingestas, el encuestado tiene que valorar los alimentos en diferentes aspectos, y es ocasiones dificulta la recogida de la información. Además, es difícil valorar los resultados de la historia dietética, debido a la falta de conocimiento independiente de la ingesta habitual a largo plazo del individuo.[59]

4.2.3 Valoración de la ingesta de alimentos en niños y adolescentes

Es indiscutible que valorar la ingesta de alimentos en niños y adolescentes es un factor esencial para conocer el estado nutricional de los mismos,[74-76] de manera que se pueda evaluar las asociaciones entre la alimentación y distintos factores relacionados con la salud. La obtención de datos fiables y precisos en niños y adolescentes es más complicado que hacerlo en población adulta, dado que existe una gran variabilidad en sus hábitos alimentarios diarios.[59] Además, la estimación de las cantidades y tipos de alimentos ingeridos se obtiene a través de los padres/ tutores legales.[59] Los padres suelen dar información precisa de la ingesta de sus hijos/as cuando los alimentos ingeridos se consumen en casa,[75, 76] siendo más difícil la estimación cuando el niño realiza las ingestas fuera de casa. Los adolescentes son capaces de registrar la información relativa a su alimentación; aunque en ocasiones el desinterés por proporcionar adecuadamente la información es un factor limitante.[59] En ocasiones, los adolescentes tienden a infra o sobrevalorar sus ingestas en función de lo que consideran correcto.[59]

4.2.4 Epidemiología descriptiva

Los patrones alimentarios de la población europea están especialmente caracterizados por una elevada ingesta de grasa, con un rango que representa entre el 30 y más del 40% de la ingesta energética, siendo especialemtente elevada en España y Francia para los niños, y en Grecia y Bélgica para población adulta.[77] Además, la alimentación se caracteriza por un bajo consumo de futas y verduras, así como una ingesta inadecuada de cereales integrales, lo cual implica un bajo consumo de fibra, y se observa de forma uniforme a lo largo de los países europeos.[77]

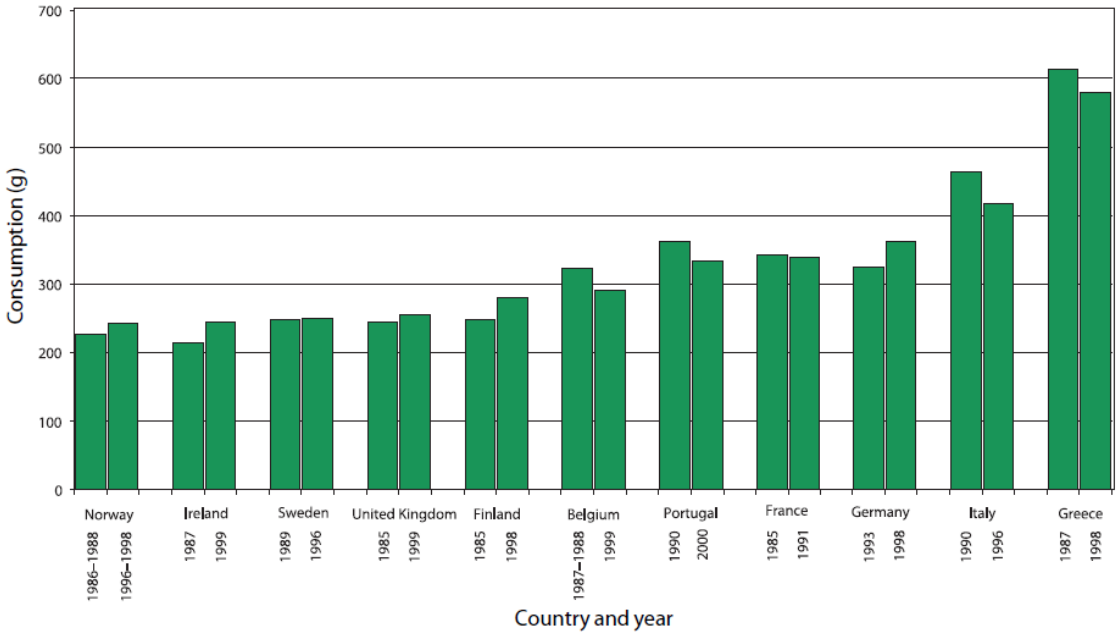
Se ha observado que los países mediterráneos tienen un mayor consumo de alimentos basado en plantas, aceites vegetales y pescado, pero los patrones alimentarios tradicionales están desapareciendo, especialmente en poblaciones jóvenes. Además, las tendencias de los hábitos dietéticos muestran que los países del sur de europa están perdiendo sus patrones de alimentación más saludable, y modificándolas hacia patrones alimentarios típicos del noreste de Europa.

Por otro lado, teniendo en cuenta el consumo de bebidas azucaradas, se observan grandes diferencias entre países, observándose un menor consumo en los países del sur de Europa, y en las mujeres respecto a los hombres.[77]

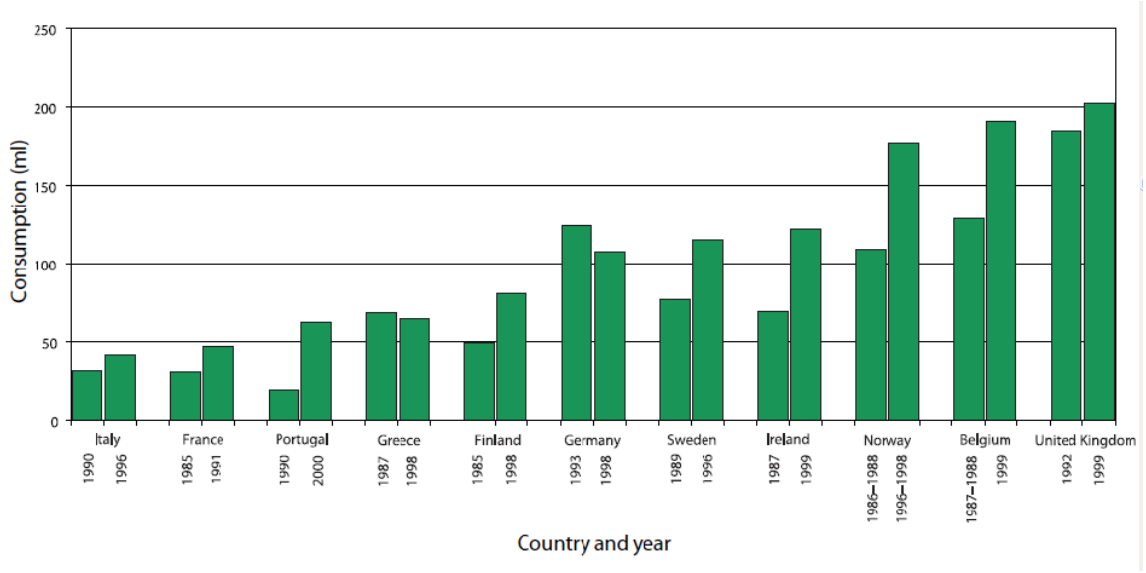
La alimentación en los países europeos se caracteriza por una dieta con una elevada densidad energética y con bajo poder saciantes. En la figura 2 se puede observar la tendencia en el consumo de frutas y vegetales (Figura 2.a), así como de refrescos azucarados (Fig 2.b) en diferentes países europeos

*Figura 2 Tendencias en el consumo de frutas y verduras (2.a), y refrescos azucarados (2.b) en diferentes países europeos.**

2.a Frutas y verduras



2.b Resfrescos azucarados



* Adaptado de DAFNE Data Food Networking[78]

4.3 Justificación

Es esencial valorar la situación actual de los estudios realizados en niños y adolescentes, sobre los comportamientos sedentarios y sus interacciones con el entorno, mediante una revisión bibliográfica, para así conocer la evidencia científica sobre los mismos (Artículo I).

Describir los comportamientos sedentarios y de actividad física, y valorar su relación con el tiempo de pantalla (artículo II) son factores clave en el desarrollo de estrategias preventivas efectivas y focalizadas en grupos específicos según edad, género y lugar de procedencia.

Así mismo, evaluar la asociación entre diferentes tiempos dedicados a conductas sedentarias y el consumo de diferentes grupos alimentarios (artículo III) es dunfamental para así poder enterder las relaciones existentes entre los mismos y poder hacer hincapié en las intervenciones específicas en función del comportamiento sedentario para mejorar sus hábitos alimentarios. Además, analizar los patrones de alimentación en jóvenes europeos y la relación de los mismos en función de los comportamientos sedentarios (artículo IV), permitirá valorar la alimentación en su conjunto, así como el impacto que tienen los comportamietnos sedentarios en los hábitos alimetnarios de forma global. Igualmente, debido a la importancia de los tres determinantes relacionados con los estilos de vida (alimentación, AF y conductas sedentarias), así como a la interacción entre ellos que se observa en población juvenil, se ha considerado esencial incluir la evaluación conjunta de los patrones de estilos de vida (alimentación, AF y conductas sedentarias) en relación con la composición corporal (artículo V).

Por lo tanto, los artículos que componen la presente Tesis Doctoral comparten una misma unidad temática, reflejándose a través del desarrollo de los objetivos, metodología, resultados y discusión que se presentan a continuación bajo el título de “Patrones de sedentarismo y su relación con la ingesta de alimentos en niños y adolescentes europeos”.

5. Objetivos

El objetivo general de la presente Tesis Doctoral es evaluar la situación actual de los comportamientos sedentarios en la infancia y adolescencia con el fin de valorar su asociación con los patrones de alimentación, así como ampliar el conocimiento científico actual sobre la relación entre los comportamientos sedentarios, la alimentación y los estilos de vida en niños y adolescentes.

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

Artículo I: Valorar la evidencia científica existente sobre la relación entre el tiempo dedicado a las actividades sedentarias (ver televisión/ vídeos/ DVDs y jugar en el ordenador/ videoconsolas) y la presencia de sobrepeso y obesidad en niños y adolescentes.

Artículo II: Describir los comportamientos sedentarios y de actividad física de los niños Europeos en función del sexo, edad y país de procedencia.

Artículo III: Describir el consumo de alimentos en función del tiempo dedicado a diferentes actividades sedentarias (principalmente basadas en actividades de pantalla), en adolescentes europeos.

Artículo IV: Valorar la asociación entre los patrones de alimentación y la práctica de diferentes actividades sedentarias (ver la televisión, utilizar ordenadores, jugar con videoconsolas, uso de internet, uso de internet por motivos escolares, tiempo de estudio), en adolescentes europeos de ambos sexos.

Artículo V: Valorar la agrupación de conductas relacionadas con los estilos de vida (alimentación, práctica de actividad física y tiempo dedicado a actividades sedentarias) en niños de ambos sexos, e investigar su asociación con indicadores de composición corporal (Índice de masa corporal, perímetro cintura y masa grasa) en niños europeos.

5. Objectives

The general objective of the present Doctoral Thesis is to evaluate the current situation of sedentary behaviours during childhood and adolescence, in order to assess its association with food intake in European children and adolescents, and to contribute to the scientific knowledge about the relation between sedentary behaviours, food intake and lifestyle behaviours in children and adolescents.

Specific objectives of each one of five manuscripts included in this Doctoral Thesis are:

Manuscript I: To evaluate the current evidence about the relation between sedentary time (TV/video/DVDs and Computer/video games) and overweight and obesity development in children and adolescents.

Manuscript II: To describe sedentary behaviours and physical activity levels in European children by sex, age and country.

Manuscript III: To examine the association between time spent on different (mainly screen-based) sedentary behaviours and the consumption of specified food and beverages in a simple of European adolescents.

Manuscript IV: To evaluate the association between dietary patterns and different sedentary activities (TV viewing, PC using, Video game using, internet use, internet use for recreational reasons, study time) in European adolescents.

Manuscript V: To identity clustered lifestyle behaviours (diet, physical activity and sedentary behaviours) and to examine their association with body composition indicators (body mass index, waist circumference and body fat percentage) in European children.

European PhD Thesis. Alba M Santaliestra-Pasías, 2014

6. Material y Métodos

La presente Tesis Doctoral está basada en un revisión inicial de la bibliografía existente (Artículo I), así como en datos procedente de los estudios IDEFICS (Artículos II y V) y HELENA (Artículos III y IV).

Se adjuntan como anexo los resúmenes de los artículos metodológicos de los estudios HELENA e IDEFICS (página 133)

6.1 Muestra y diseño del estudio

Estudio IDEFICS (Artículos II y V)

El estudio IDEFICS es un estudio prospectivo de cohortes multi-céntrico, con un estudio de intervención integrado, que se realizó en ocho países europeos (Italia, Estonia, Chipre, Bélgica, Suecia, Alemania, Hungría y España). *A priori* se seleccionaron una zona intervención y una zona control en cada uno de los países participantes, que fueran comparables en relación a sus características socio-demográficas y socio-económicas. Se contactó con los participantes a través de las escuelas y guarderías para así facilitar la participación en el estudio y la posterior implementación y seguimiento de las actividades relacionadas con la intervención. El tamaño muestral que se estableció fue de 16.000 niños (2.000 participantes/ país) distribuidos equitativamente por género, curso escolar y región. Los criterios de inclusión del proyecto para que los niños fueran sujetos válidos fueron que se hubieran recogido las medidas de altura y peso, así como que los padres hubieran cumplimentado el cuestionario de padres. La muestra comprendió a un total de 16.224 niños con edades comprendidas entre los 2 y 9 años. Los datos incluidos en la presente Tesis Doctoral se basan en las mediciones iniciales de la cohorte, que se realizaron en el curso escolar 2007-2008.

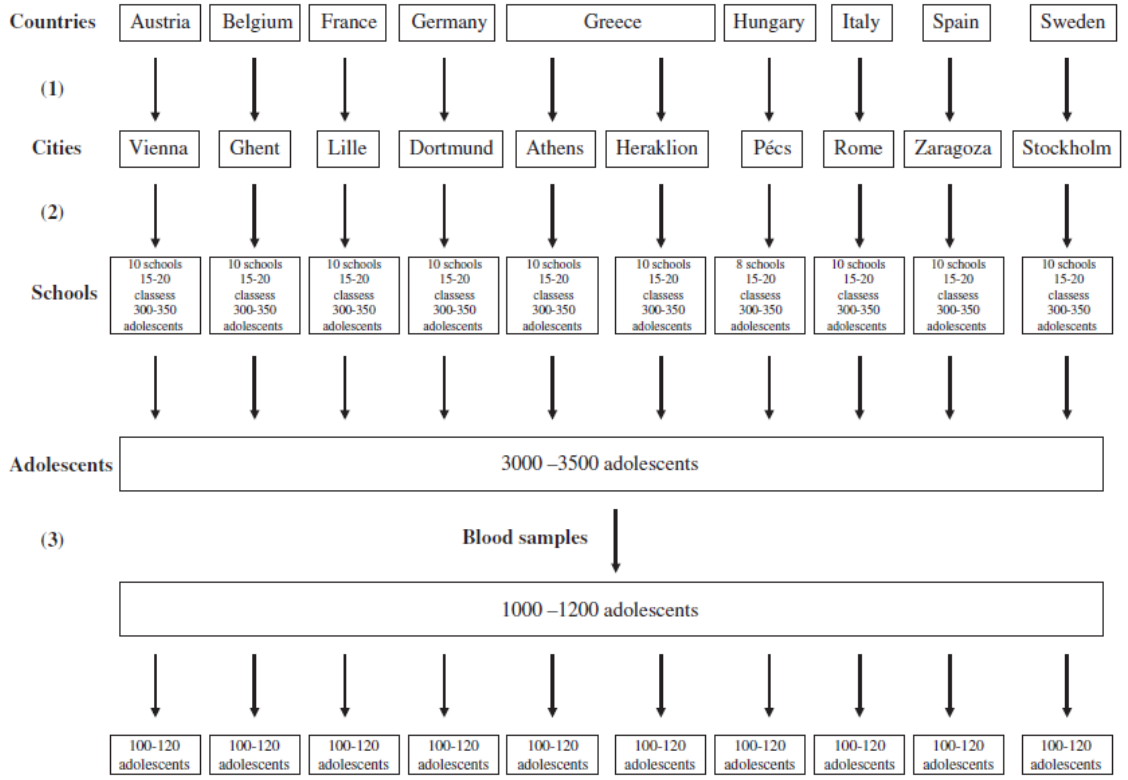
La muestra utilizada en el artículo II es de 15.330 participantes, lo que supone un 94% de la muestra total de los niños válidos del estudio IDEFICS [puede existir alguna variación debido a la presencia de valores perdidos en alguna de las variables de análisis]. Así mismo, la muestra del artículo V es de 11.674 participantes (71.9%), debido a que solamente se incluyeron aquellos niños que tenían todas las variables requeridas para realizar la agrupación de estilos de vida (registros dietéticos, comportamientos sedentarios y de actividad física), así como las variables de composición corporal [puede existir alguna variación debido a la presencia de valores perdidos en alguna de las variables de análisis de composición corporal].

La metodología detallada del estudio IDEFICS se ha publicado previamente.[79, 80] Los aspectos más relevantes en relación a la presente Tesis Doctoral se describen a continuación.

Estudio HELENA (Artículos III y IV)

El estudio HELENA es un estudio transversal multi-céntrico que se llevó a cabo durante los años 2006-2007, en 10 ciudades europeas: Dortmund (Alemania), Viena (Austria), Gante (Bélgica), Lille (Francia), Atenas y Heraklion (Grecia), Pécs (Hungría), Roma (Italia), Estocolmo (Suecia) y Zaragoza (España). Para reclutar a los participantes se realizó un muestreo aleatorio por conglomerados para lograr una muestra de 3.000 adolescentes con edades comprendidas entre 12.5 y 17.5 años, estratificados según la localización geográfica, la edad y el nivel socioeconómico. Se invitó a participar a todos los alumnos entre una selección de clases de todas las escuelas presentes en las 10 ciudades europeas, todas ellas mayores de 100.000 habitantes. Los criterios de inclusión del Estudio HELENA fueron que los participantes no debían estar participando simultáneamente en otro estudio clínico; no haber estado enfermo durante la semana anterior a la realización de las pruebas; tener entre 12.5 y 17.5 años; haber firmado el consentimiento informado; tener registradas las mediciones de peso, talla y haber cumplimentado al menos el 75% del resto de las pruebas. La muestra comprendió un total de 3.528 adolescentes de entre 12.5 y 17.5 años

Figura 3. Esquema sobre el proceso de muestreo utilizado en el estudio HELENA [81]



La valoración de la dieta se realizó mediante dos registros de 24 horas no consecutivos. Debido a que los datos de ingesta dietética obtenidos en Pécs y Heraklion fueron incompletos, tuvieron que excluirse de los análisis. La valoración de los comportamientos sedentarios se realizó a través de un cuestionario auto-administrado. Se incluyó como criterio de inclusión adicional que los adolescentes

hubieran cumplimentado al menos el 75% del cuestionario sobre comportamientos sedentarios.

En la presente Tesis Doctoral se han relacionado las variables de ingesta alimentaria y de comportamientos sedentarios, y tras incluir ambos criterios la muestra en la que se basan los artículos III y IV es de 2.202 adolescentes [puede existir alguna variación debido a la presencia de valores perdidos en alguna de las variables de análisis y/o criterios de inclusión establecidos en cada artículo].

Las características generales del estudio han sido publicadas previamente.[81, 82] Los aspectos más relevantes en relación a la presente Tesis Doctoral se describen a continuación.

6.2 Comités de ética

Estudio IDEFICS (Artículos II y V)

El protocolo del estudio se desarrolló según la normativa española y siguiendo las consignas éticas establecidas por la Declaración de Helsinki en 1975 (revisión Edimburgo en 2000). Dicho protocolo fue aprobado por el Comité de Ética de cada centro en el que se llevó a cabo el estudio. En el caso de Zaragoza, el protocolo fue aprobado por el Comité Ético de Investigación Clínica de Aragón (CEICA). Los padres de los niños que participaron en el estudio firmaron un consentimiento informado para participar en el mismo.

Estudio HELENA (Artículos III y IV)

El protocolo del estudio se desarrolló según la normativa española y siguiendo las consignas éticas establecidas por la Declaración de Helsinki en 1975 (revisión Edimburgo en 2000). Dicho protocolo fue aprobado por el Comité de Ética de cada centro en el que se llevó a cabo el estudio. En el caso de Zaragoza, el protocolo fue aprobado por el Comité Ético de Investigación Clínica de Aragón (CEICA). Además, tanto los adolescentes como los padres firmaron un consentimiento informado para participar en el estudio.

6.3 Métodos de medida

Estudio IDEFICS (Artículos II y V)

6.3.1 Factores socio-demográficos (Artículos II y V)

Para valorar los factores socio-demográficos se recogieron datos relativos a la edad, género, nivel educativo de los padres y nivel ocupacional de los padres. Debido a las diferencias en cuanto al nivel socioeconómico entre los países participantes en el estudio IDEFICS, para establecer un indicador común para valorar el nivel

socioeconómico se utilizó la Clasificación Internacional Normalizada de la Educación (ISCED).[83] Se tuvo en cuenta el mayor nivel educativo alcanzado por cualquiera de los dos padres.

6.3.2 Examen físico (Artículos II y V)

Las mediciones realizadas para valorar la composición corporal se realizaron por personal del estudio entrenado previamente para ello.[84] El peso (kilogramos, kg) se registró mediante una báscula electrónica (TANITA BC 420 SMA), precisión 100g y la altura (centímetros, cm) se midió utilizando un estadiómetro (SECA 225), precisión 0.1cm. Se midió a los participantes con ropa interior. Se calculó el índice de masa corporal dividiendo el peso en kg por la altura en metros al cuadrado.

Se realizó la valoración de la grasa corporal mediante la medición de pliegues cutáneos. Las mediciones se realizaron por duplicado mediante un lipómetro (Holtain Tanner/Whitehouse Lt., Crosswell, UK). Solamente se permitía llevar ropa interior a los participantes. Se evaluó la fiabilidad de las medidas de composición corporal en 298 niños (edad media 5.4 ± 1.2 años). Se calculó la fiabilidad intra- e inter-observador, siendo mayor de 0.95 y 0.98, respectivamente.[85] Las mediciones de plieques se realizaron en las siguientes localizaciones: (1) tríceps, punto medio entre el acromion y el olecranon en la parte posterior del brazo; (2) bíceps, al mismo nivel que el tríceps, directamente encima del centro de la fosa cubital; (3) subescápula, sobre 20 mm debajo de la punta de la escápula, con un ángulo de 45 grados hacia el lateral del cuerpo; (4) suprailíaco, sobre 20 mm encima de la cresta ilíaca y 20 mm hacia la línea intermedia. Las mediciones del tríceps y subescapular fueron obligatorias para todos los centros, mientras que las mediciones de los pliegues del bíceps y suprailíaco fueron opcionales. Se calculó el sumatorio de pliegues obligatorios (tríceps y subescapular) como medida de grasa corporal.

Además, se midió la circunferencia de cintura (cm) utilizando una cinta (SECA 200) (precisión 0.1 cm, rango 0-150 cm).

6.3.3 Dieta (Artículo V)

Se utilizó un cuestionario de frecuencia de consumo alimentario (CFCA) denominado *Children's Eating Habits Questionnaire-food frequency section* (CEHQ-FFQ), que fue diseñado como un instrumento de medida de los comportamientos alimentarios de los niños, relacionados con el riesgo de sobrepeso, obesidad y con la salud en general. El cuestionario se entregaba a los padres, y lo debían cumplimentar en sus casas, reportando información sobre el número de veces que su hijo/a había consumido los grupos de alimentos incluidos en el cuestionario, durante una semana típica del mes anterior. El CEHQ-FFQ incluía 14 grupos de alimentos: vegetales, frutas, bebidas, cereales de desayuno, leche, yogur, pescado, huevo, carnes y productos

cárnicos, productos a base de soja y/o sustitutivos de la carne, queso, productos para untar (mermeladas, miel, mantequilla, etc.), cereales (pan, pasta, arroz, etc.) y aperitivos o snacks (frutos secos, dulces, pasteles, chocolate, palomitas de maíz, etc.). Se adoptó una escala previamente utilizada para facilitar las respuestas del cuestionario,[86] incluyendo las siguientes categorías de consumo: "nunca/ menos de una vez por semana", "1-3 veces por semana", "4-6 veces por semana", "1 vez al día", "2 veces al día", "3 veces al día", "4 ó más veces al día" y "no lo sé". No se estimó el tamaño de las porciones. La fiabilidad del cuestionario de frecuencia de aliemtnos se ha evaluado mostrando un buen acuerdo en los estimadores de consumo grupal en los niños europeos.[87, 88] Los coeficientes de correlación varían entre 0.01 (para frutas azucaradas) a 0.48 (para leche azucarada) en los niños de 2 a 5.99 años (media 0.25), y entre 0.01 (cereales refinados) y 0.44 (agua) para los niños de 6 a 9 años (media 0.23).[87]

6.3.4 Comportamientos sedentarios (Artículos II y V)

Mediante la utilización de un cuestionario, se les preguntó a los padres el tiempo que dedicaba su hijo/a a realizar actividades sedentarias a través de las siguientes preguntas: "¿Cuánto tiempo suele ver su hijo/a la televisión/ vídeos/ DVDs por día? Y "¿Cuánto tiempo dedica su hijo/a jugar en el ordenador/ videoconsolas?" Se realizaban las preguntas de forma separada para cada una de las actividades sedentarias y para los días entre semana y para los días de fin de semana. Las respuestas eran categóricas e incluían las siguientes categorías: "nada en absoluto", "<30 minutos al día", "<1hora al día", "1-2 horas al día", 2-3 horas al día" y "> 3 horas al día".

En el caso del artículo II se utilizaron ambas cuestiones, y se obtuvo también el sumatorio del tiempo total de pantalla, de forma separada para los días entre semana [(horas/día de TV/ video/ DVD entre semana) + (horas/día de ordenadores/ videoconsolas entre semana)] y para los días de fin de semana [(horas/día de TV/ video/ DVD en fin de semana)+(horas/día de ordenadores/ videoconsolas en fin de semana)]. Así mismo se calculó el tiempo total de pantalla medio, aplicando la siguiente fórmula {[(horas/día entre semana de TV/ video/ DVD)+ (horas/día entre semana de ordenadores/ videoconsolas))*5]+ [((horas/día en fin de semana de TV/ video/ DVD)+ (horas/día en fin de semana de ordenadores/ videoconsolas))*2]/7}.

Para el artículo V, solamente se utilizaron las cuestiones relativas al tiempo que dedican los niños a ver la TV/videos/DVDs durante los días entre semana y en fin de semana.

Adicionalmente, en el artículo II se valoró la disponibilidad de aparatos electrónicos en el espacio personal de los niños/as. Se preguntaba a los padres la siguiente cuestión "¿Cuáles de los siguientes aparatos tiene su hijo/a en su habitación? La respuesta era categórica y tenía 5 opciones: "Televisión", "Ordenador", "Conexión a internet",

"Vídeo/DVD", "Ninguna de ellos". Las respuestas fueron agrupadas en función del número de aparatos electrónicos en 3 categorías: "0 aparatos electrónicos" "1 ó 2 aparatos electrónicos" y "3 o más aparatos electrónicos."

6.3.5 Actividad física (Artículos II y V)

La información sobre actividad física (AF) se recogió mediante un cuestionario auto-administrado a los padres. En el artículo II se pretendía describir la actividad física de los niños europeos, para la cual se utilizaron diversas preguntas del cuestionario de los padres. Los padres respondían a la siguiente pregunta: "Piense por un momento en el típico día entre semana de su hijo/a durante el último mes. ¿Cuánto tiempo diría que pasa su hijo jugando fuera en un día típico entre semana?". Los padres debían contestar el tiempo (horas y minutos) que empleaba su hijo/a durante los días entre semana. A continuación se les preguntaba: "Ahora piense en el típico día de fin de semana de su hijo/a durante el último mes. ¿Cuánto tiempo diría que pasa su hijo jugando fuera en un día típico de fin de semana? Los padres debían contestar el tiempo (horas y minutos) que empleaba su hijo durante los fines de semana. Las respuestas eran abiertas, para que pudieran determinar el tiempo en horas y minutos invertidos en cada uno de los periodos indicados.

Adicionalmente para el artículo II y para el artículo V se incorporó la información relativa a la AF mediante las siguientes preguntas: "Su hijo/a es miembro de algún club deportivo?" Se disponía de una respuesta dicotómica Sí/ No, y en el caso de que la respuesta fuera afirmativa se les preguntaba "¿Cuánto tiempo pasa a la semana haciendo ejercicio en un club deportivo su hijo/a?" La respuesta era abierta, para que pudieran determinar el tiempo en horas y minutos invertidos en la actividad.

Además, en el artículo II se incorporó la descripción de los medios de trasporte para ir y volver al colegio, como parte de la AF diaria que pueden realizar los niños. Se recogió esta información mediante un cuestionario en el que se preguntaba a los padres la siguiente cuestión: "¿Cómo va y vuelve su hijo/a a la guardería o colegio? La respuesta era categórica y los padres debían seleccionar de forma separada para el viaje de ida al colegio y de vuelta del colegio una de las siguientes categorías; "andando", "en bicicleta", "en autobús o transporte público", "en coche" y "otros". Los medios de trasporte se reagruparon en 3 categorías: transporte activo si los niños hacían los dos trayectos andando o en bicicleta; en trasporte pasivo si los niños hacían los dos trayectos en autobús, transporte público o coche; y mixto si hacían uno de los trayectos de forma activa y otro de forma pasiva. Aquellas familias que habían contestado la opción "otros", tenían un espacio reservado para incluir el medio de trasporte que utilizaban. Se valoró cada una de las opciones incluidas y se les asignó una de las categorías previamente indicadas. A modo de ejemplo, aquellos que incluían como otro el medio de trasporte en patinete o corriendo, se incluía como

transporte activo; si por el contrario el medio de transporte era en un trasportín de la bici, conducida por el padre/madre se incluía como transporte pasivo para el niño/a.

Estudio HELENA (Artículos III y IV)

6.3.6 Factores socio-demográficos (Artículos III y IV)

Se recogió información relativa al género y edad de los participantes. Para evaluar las diferencias en cuanto al nivel socio-demográfico entre los países participantes, se estableció como indicador comparable la escala de bienestar familiar (Family Affluence Scale, FAS).[89] Esta escala se basa en el concepto de las condiciones materiales de la familia.

6.3.7 Examen físico (Artículos III y IV)

Todas las mediciones se realizaron siguiendo las pautas internacionales en adolescentes. Se midió el peso (kg) con una báscula electrónica (SECA 861), precisión 100g, rango 0-150kg y la altura (cm) mediante un estadiómetro (SECA 225), precisión 0.1cm, rango 70-200 cm, respectivamente. Se calculó el índice de masa corporal dividiendo el peso en kg por la altura en metros al cuadrado.

6.3.8 Maduración sexual (Artículos III y IV)

En cada uno de los centros participantes, un médico designado a tal propósito realizó un breve examen físico para determinar en qué estadío de maduración sexual, definido mediante el método de Tanner y Whitehouse,[90] se encontraba cada uno de los adolescentes.

6.3.9 Dieta (Artículos III y IV)

La dieta de los adolescentes se valoró mediante un registro de 24 horas electrónico y auto-administrado denominado HELENA-DIAT, que está basado en un programa informático desarrollado previamente denominado YANA-C.[91, 92] Se obtuvieron dos recuerdos dietéticos de 24 horas no consecutivos, durante un periodo de dos semanas. Los adolescentes cumplimentaron el cuestionario en el centro escolar y durante el tiempo lectivo, siempre con la ayuda de un miembro del grupo de investigación. Debido a este motivo no hay información disponible sobre el consumo de los viernes y sábados. Se agruparon los alimentos en 31 grupos basados en su composición nutricional. Se calculó el consumo habitual de cada uno de los grupos mediante el *multiple source method* (MSM) para tener en cuenta la variación intra- y entre-individuos.[93] Las ingestas de los diferentes grupos alimentarios se expresan en gramos/

día. Los datos relativos a las ingestas de Pécs y Heraklion fueron excluidos debido a que no estaban completos. Se valoró la información nutricional de las ingestas de alimentos mediante las tablas de composición alemanas (German Food Code and Nutrition Data Base), debido a que son las más completas de toda Europa en cuanto a número de nutrientes y alimentos.[94] La ingesta de energía se expresa como kilocalorías (Kcal) por día.

6.3.10 Comportamientos sedentarios (Artículos III y IV)

El tiempo dedicado a las diversas actividades sedentarias se recogió mediante un cuestionario auto-administrado a los adolescentes. Se recogió de forma separada el tiempo que dedican a cada una de las siguientes actividades sedentarias: ver la televisión, utilizar ordenadores, jugar con videoconsolas, utilizar internet, utilizar internet por motivos escolares, tiempo dedicado a estudiar. Se les preguntó de forma separada para los días entre semana y para los días en fin de semana la siguiente cuestión: "Durante los días de entre semana/ fin de semana, ¿cuántas horas dedicas a sedentarias ver la televisión/ utilizar ordenadores/ jugar con videoconsolas/ utilizar internet/ utilizar internet por motivos escolares/ estudiar? Los adolescentes debían seleccionar una de las categorías de respuesta siguientes: 1) 0 minutos; 2) <30 minutos; 3) >30-60 minutos; 4) >60-120 minutos; 5) >120-180 minutos; 6) >180-240 minutos; y 7) >240 minutos. En base a las respuestas y a las recomendaciones internacionales de la Academia Americana de Pediatría[95] se agrupó a los adolescentes en 3 grupos para cada una de las actividades sedentarias: <2horas/día, 2-4 horas/día y >4 horas/día. La fiabilidad del cuestionario de sedentarismo se había estudiado previamente, presentando un buen grado de concordancia.[96]

6.4 Análisis estadísticos: consideraciones generales

De forma general las características descriptivas de los sujetos participantes se presentan en forma de porcentajes para las variables nominales, y como media e intervalo de confianza al 95%, para las variables contínuas. Las diferencias entre género y grupos de edad para las variables contínuas 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.

Todos los análisis mostrados a lo largo de los diferentes artículos incluidos en la presente Tesis Doctoral se realizaron separadamente por sexo, dado que las conductas sedentarias analizadas presentan interacciones por sexo tanto en el estudio IDEFICS como en el estudio HELENA.

El análisis de regresión logística binaria se utilizó (Artículo II, III y V) para analizar la asociación independiente entre el tiempo de pantalla total (en días entre semana, en fines de semana, y tiempo medio semanal) y la disponibilidad de medios electrónicos en el espacio personal de los niños/as de forma individual, y con las variables de actividad física (Artículo II). El análisis de regresión logística binaria se utilizó igualmente para analizar la relación entre el tiempo de los diferentes comportamientos sedentarios y el consumo (> mediana) de diferentes grupos de alimentos (1) pasteles, tartas y galletas; 2) aperitivos salados; 3) vegetales (patatas excluidas); 4) frutas; 5) zumos de frutas y vegetales; 6)refrescos azucarados y carbonatados; 7) leche; y 8) postres y postres lácteos, ajustado por nivel socioeconómico, estadío de maduración, BMI y centro (Artículo III). Se utilizó igualmente para analizar la asociación entre los agrupamientos de comportamientos de estilos de vida y los indicadores de composición corporal (IMC, perímetro de cintura y sumatorio de pliegues), ajustados por nivel socioeconómico y edad.

El análisis de covarianza (ANCOVA), junto con el test de Bonferroni, se utilizó (Artículos III y V) para analizar diferencias entre los diferentes comportamientos sedentarios agrupados por categorías (<2horas/día; 2-4 horas/día; > 4horas/día) y el consumo de diferentes grupos de alimentos, ajustando los análisis por nivel socioeconómico, estadío de maduración, IMC y país (artículo III); y para analizar las diferencias entre los diferentes agrupamientos de conductas sobre estilos de vida y los indicadores de composición corporal (IMC, perímetro de cintura y sumatorio de pliegues), ajustando los análisis por nivel socioeconómico y edad (Artículo V).

El análisis de componentes principales (*Principal component analysis*) (Artículo IV) se utilizó para identificar aquellos grupos alimentarios que tienden a consumirse juntos (patrones dietéticos o de alimentación). Se fijaron las puntuaciones factoriales en 0.3 (valor absoluto) y se tuvieron en cuenta en la determinación de los patrones dietéticos los gráficos obtenidos, que los valores propios (*eigenvalue*) fueran >1 y la interpretabilidad de los patrones. Las puntuaciones factoriales obtenidas para cada sujeto se utilizaron en los siguientes análisis del artículo.

La regresión lineal (Artículo IV) se utilizó para analizar la asociación entre las puntuaciones obtenidas de los patrones de alimentación y los comportamientos sedentarios estudiados, ajustando los análisis por la edad, nivel socioeconómico, IMC e ingesta energética.

El análisis de conjuntos o clusters (*cluster analysis*) (artículo V) se utilizó para crear agrupaciones de comportamientos relacionados con los estilos de vida en función del género. Para ello se incluyeron cuatro indicadores: 1.- Consumo de frutas y verduras; 2.- Consumo de bebidas carbonatadas azucaradas; 3.- Práctica de actividad física; y 4.-

Consumo de tiempo dedicado a ver la televisión /videos/DVD. Así mismo, se evaluó la estabilidad de los agrupamientos obtenidos mediante la *kappa ponderada* para valorar el grado de acuerdo dividiendo aleatoriamente la muestra en dos partes y repitiendo el análisis de clusters.

Los análisis estadísticos se llevaron a cabo utilizando el paquete estadístico *Predictive Analytics Software* (PASW) versión 18.0 (SPSS Inc., Chicago, IL, USA). Como norma general, el nivel de significación se estableció en el 5%. En cada uno de los artículos de la presente Tesis Doctoral aparece información más detallada acerca del proceso estadístico utilizado.

7. Resultados [Results]

Los resultados de la presente Tesis Doctoral se muestran en forma de artículos científicos. Se incluyen en el formato en que han sido publicados.

Artículo I [Paper I]

Obesity and sedentarism in children and adolescents: What should be done?

AM. Santaliestra-Pasías, JP. Rey-López and LA. Moreno Aznar
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Obesity and sedentarism in children and adolescents: What should be bone?

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Abstract

Paediatric overweight continues to be a public health problem, and the etiology of obesity is multifactorial and complex. Dietary patterns, physical activity (PA) and sedentary behaviors are acknowledged as major behavioural determinants of obesity. New technologies and electronic based activities have produced a decrease in PA levels, and an increase in sedentary activities in children and adolescents. Potential mechanisms that explain the association between TV viewing and childhood obesity are: displacement of PA, unhealthy food preferences produced by food advertisements, a higher energy intake by automatic eating and overconsumption caused by distraction. Interventions aimed to reduce time in sedentary behaviours are in children generally positive. However, their benefits on adiposity markers are small. Thus, if global and macro-level *obesogenic* factors are not changed substantially, the interventions oriented to prevent obesity will produce small benefits.

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Key words: *Obesity. Sedentary behaviour. Children. Adolescent.*

OBESIDAD Y SEDENTARISMO EN NIÑOS Y ADOLESCENTES: ¿QUÉ DEBERÍA HACERSE?

Resumen

El sobrepeso en población en edad pediátrica continúa siendo uno de los problemas de salud pública. La alimentación, actividad física y las conductas sedentarias son los mayores determinantes de la obesidad. Las nuevas tecnologías y las actividades basadas en la electrónica han producido un descenso en los niveles de actividad física y un aumento de las actividades sedentarias en niños y adolescentes. Diversos mecanismos se han sugerido para explicar la asociación entre ver la televisión y la obesidad: desplazamiento de actividad física, los efectos de la publicidad de alimentos, el aumento de la ingesta energética en ausencia de hambre (automáticamente), y el aumento de la ingesta producida por la distracción. Intervenciones orientadas a reducir el comportamiento sedentario en niños y adolescentes han mostrado ser exitosas. Sin embargo, su impacto sobre marcadores de adiposidad es pequeño. Por lo tanto, si los factores obesogénicos que dependen de escalas a nivel global y macro no son cambiados substancialmente, los beneficios de las intervenciones para prevenir la obesidad serán muy modestos.

Nutr Hosp 2013; 28 (Supl. 5):99-104

Palabras clave: *Obesidad. Conductas sedentarias. Niños. Adolescentes.*

Abbreviations

HELENA: Healthy Lifestyle in Europe by Nutrition in Adolescence.
PA: Physical Activity.
TV: Television.

Introduction

Paediatric overweight continues to be a major and growing public health problem, although stability or a levelling off in the prevalence of obesity has been observed among children and adolescents in several parts of the world.[1] A multi-factorial approach to obesity prevention requires changes in multiple factors contributing to energy imbalance. Dietary patterns, physical activity (PA) and sedentary behaviours are acknowledged as major behavioural determinants of obesity.[2-4]

In the last decades developed countries have suffered a deep change in the traditional way of life. Labour saving technologies and electronic based recreational activities have produced a marked decrease in children PA levels. In addition, sedentary activities are increasing, and involve all activities involving low levels of moderate-vigorous physical activity, including television (TV) and computer use, school work, reading, playing or listening music. The most prevalent form of sedentary behaviour is time spent in front of a screen, which includes television, videos, computer and video games. The American Academy of Pediatrics recommends that children limit their total media time to no

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more than 1-2 h a day;[5] while more restrictive limits are applied to pre-school children for instance in Australia, recommending less than 1 hour per day of sitting and watching TV and the use of other electronic media.[6] There is a huge variation on the prevalence on excessive sedentary time between countries. Children and adolescents spent on average 1.8 to 2.8 hours of TV per day, depending on age and gender.[7] For instance, in several European countries 61% of children aged between 11 to 15 years watched TV more than 2 hours/ day. In adolescents from the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study, the proportion of adolescents watching TV during weekend days, more than 2 hours/day was 58% in males and 53% in females.[8]

The aim of this study is to review the current literature regarding sedentary behaviours and their relation with obesity in children and adolescents.

Sedentary behaviours and obesity

Most of scientific community agree that the growth in worldwide prevalence of obesity during the last decades is due to profound changes in our (traditional) lifestyle. That is, today people are more sedentary (in transportation, jobs and leisure time). Furthermore, many countries are losing their traditional (healthy) diets by others rich in animal products, refined grains and sugar.

Several studies have showed the relationship between an increase of several sedentary behaviours, for instance television viewing or screen time, and weight gain.[4,9] In addition, a novel risk factor for weight gain in adolescents is TV availability in the bedroom. Those adolescent males who reported having a TV in the bedroom had higher risk of having higher body mass index, high waist circumference and body fat,[10] and to have a TV in the adolescent's bedroom increased the risk of having central obesity.[11] Moreover screen-viewing behaviour (TV viewing, playing computer games and using the internet) has been associated with higher consumption of energy dense foods (i.e. sweetened-beverages and savoury snacks) and lower consumption of healthy foods (i.e. fruits).[12] In the same line, an inverse association between several indicators of sedentary behaviours and healthy dietary patterns, and a positive association with snacking patterns has been observed in other young-age population groups.[13] On the other hand, we[14] and others[15] have observed that adolescents who spent long time playing with videogames were more likely of having cardiovascular risk factors. Interventions aimed at reducing screen time have been a focus of childhood obesity prevention and treatment, however the evaluation of their effectiveness need to be taking into account in order to develop successful prevention programs.

Currently, most children and adolescents spend the majority of their leisure time in sedentary behaviours. This is of concern for children's health because In 1985, Dietz and Gortmaker found a positive association between hours of TV viewing and obesity in children and adolescents.[16] Since then, multitudes of studies in different countries have found similar associations. In fact, we reviewed studies (cross-sectional, longitudinal and intervention) focused in the relationship between obesity markers and sedentary behaviours.[4] We concluded that there was enough evidence for the *obesogenic* effect of TV viewing, especially in children. More recent reviews support our findings. In children, a moderate evidence was observed between TV viewing and obesity.[17] In contrast, in adolescents insufficient evidence was found for a longitudinal positive relationship between TV viewing and body mass index or more specific indicators of fat mass.[18] For videogames and computer use more studies are needed, but not positive associations were found.[4] Several mechanisms can explain the *obesogenic* effect of TV viewing. Here, we briefly discuss the four main mechanisms.

Mechanisms linking TV viewing with obesity

Obesity has a multifactorial origin. TV viewing may promote a positive energy balance by different ways (fig. 1):

TV viewing and physical activity

One explanation is that TV viewing displaces time spent in physical activity. Some study supports this

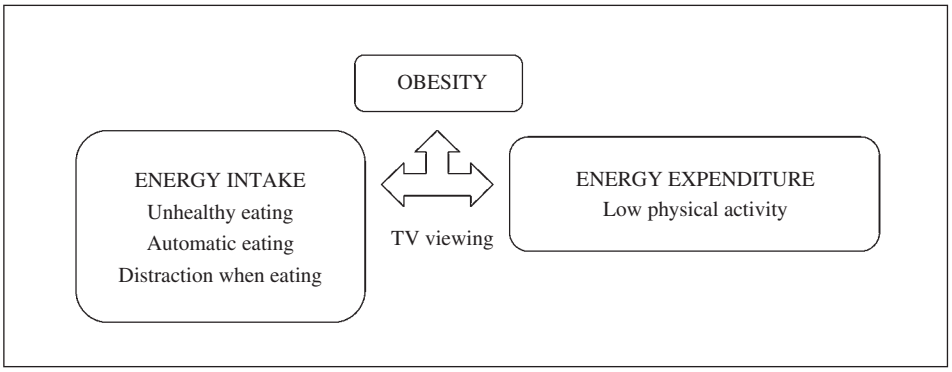


Fig. 1.—Potential mechanisms by which TV viewing may lead to obesity.

mechanism. Children spending more time watching television (>120 minutes/day) at age six were less active and had higher body mass indices at ages eight and ten.[19] However, in a cross-sectional study conducted in children and adolescents, TV viewing and physical activity were not associated.[20] Interestingly, in the latter study eating meals while watching TV was positively associated with obesity. Recently, we found that even adjusting for vigorous physical activity, a TV set in the bedroom was associated with abdominal obesity in European adolescents.[11] These findings indicate that TV viewing may favour a positive energy balance for mechanisms beyond the physical activity level.

TV viewing and unhealthy food advertisements

Currently, food industry makes use of different channels (internet, toys, games, sponsoring, and school material) to advertise their food and drinks to children and their parents. However, in children TV advertisements are the most effective and most heavily used marketing instrument.[21] Unfortunately, food companies have traditionally used TV adds to promote the consumption of caloric dense and highly palatable products.[22] In theory, the more food advertisements children see, the more primed they are to want to eat or drink the advertised food. Remarkably, it has been estimated in some studies that children are exposed to 25,000 TV ads per year. About 20% of them, are related with food/drink products.

Automatic eating while watching TV

This mechanism is based on the assumption that part of the human behaviours are automatic, cued by environmental stimuli, resulting in actions unaccompanied by conscious reflection. For instance, in laboratory studies children exposed to food adds ate automatically even in the absence of hunger.[23] Remarkably, the type of food advertised was not available for the concurrent consumption. Therefore, the overconsumption attributed to TV viewing can be explained by unconscious actions. Today food companies are replacing TV advertising with more subtle marketing strategies. Advertisers methodically place food products into programs, movies, musical videos. Product placements can be shown by direct visual or auditory signals but also indirectly (product is part of the background, but attention is not paid to the product). In summary, food placements can lead to obesity by increasing (automatically) the energy intake and favouring the less direct advertised food product.

Distraction while watching TV

In some countries is common to eat while watching TV. This distraction can lead to "mindless eating," or a lack of attention paid to the amount of consumed food. In laboratory studies, children consumed significantly more food when watching a continuous TV program than when they watched a repeated segment of a TV program.[24] Similarly, individuals who viewed TV while consuming a meal were less accurate in estimating the amount of food they had consumed than those who consumed the meal without TV.[25]

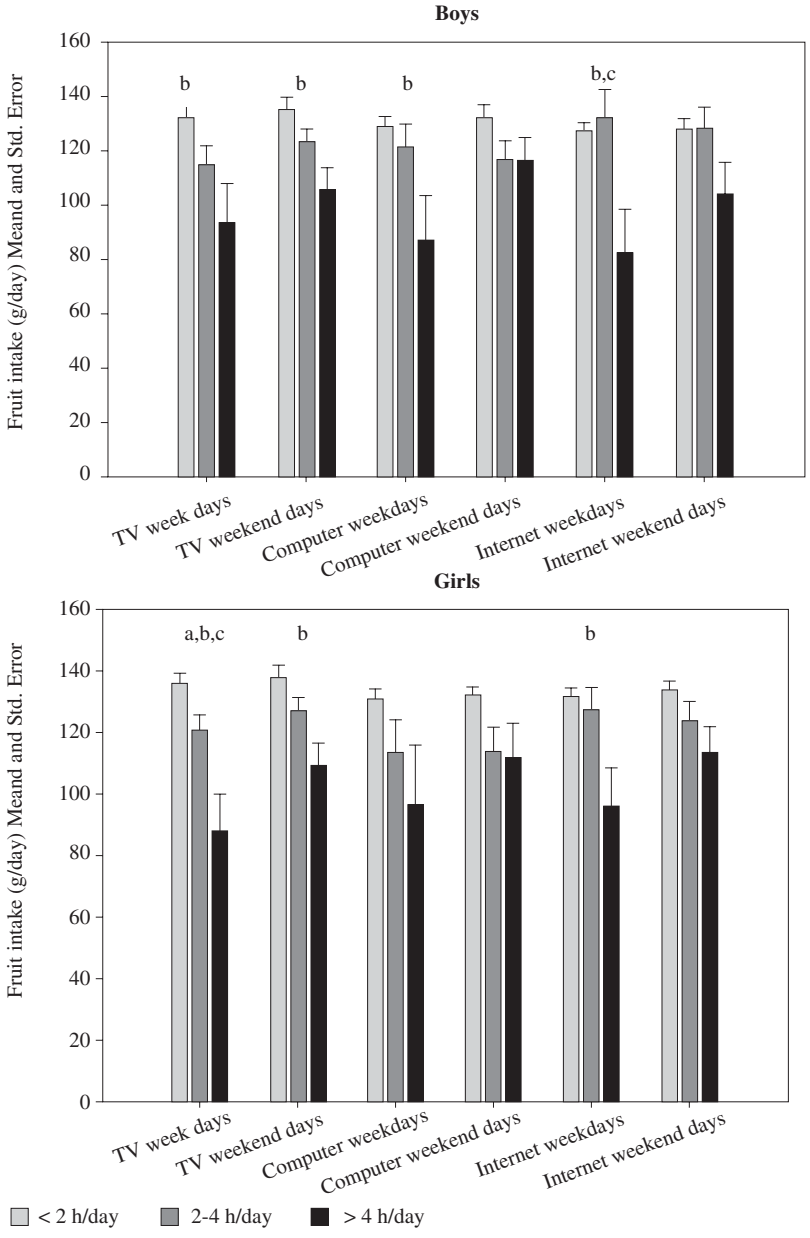
Food habits and sedentary behaviours

Several studies have been reported that those children who spent more time watching TV were more likely to consume sweets and drinks, and less likely to consume fruits and vegetables daily.[26] In addition, adolescents were more likely to consume energy-dense foods and drink products while watching TV.[27] Also, the amount of sugar sweetened beverages and snacks increased significantly when the adolescents spent more time in several sedentary behaviours like TV viewing, playing computer games and using the internet.[12] In the same population group, the amount of fruits consumed decreased when they spent more hours in these activities (figs. 2 y 3).

Interventions aiming to decrease sedentary behaviours

A huge variation of interventions has been published linking several sedentary behaviours and obesity. Several systematic reviews and meta-analysis have been recently published regarding the effectiveness of interventions aiming to decrease sedentary behaviours.[28,29] In a review, 13 trials with children aged between 3.9 to 11.7 years;[29] whereas another included both children and adolescents resulting in 34 intervention studies.[28] Effective interventions on reducing TV viewing have been described in pre-schoolers and young children, showing significantly decreases on time spent in this sedentary behaviour when comparing the intervention group versus the control one (24.4% reduction versus 11.8% increase; and 42.7% reduction versus 6.5% reduction, respectively).[30,31] In the same line, the results in the whole group are consistent with these results, reported that intervention on sedentary behaviours decreased significantly the time that children spent on it.[28] The intervention group compared with the control group showed a difference in mean change in screen time of –3.72 hours/week (95% CI –7.23 to –0.20 h/week) in children younger than 6 years; however no statistical significances were found in children and adolescents older than 6 years (–0.19 IC 95% –3.12 to 2.75).

Wahi et al did not showed enough evidence about the effectiveness of interventions aimed to reduce screen time in children to reduce body mass index (–0.10 (95% CI –0.28 to 0.09)).[29] Nevertheless, in the preschool age group significant reductions in the effect associations of screen time reductions and reducing BMI were obser-



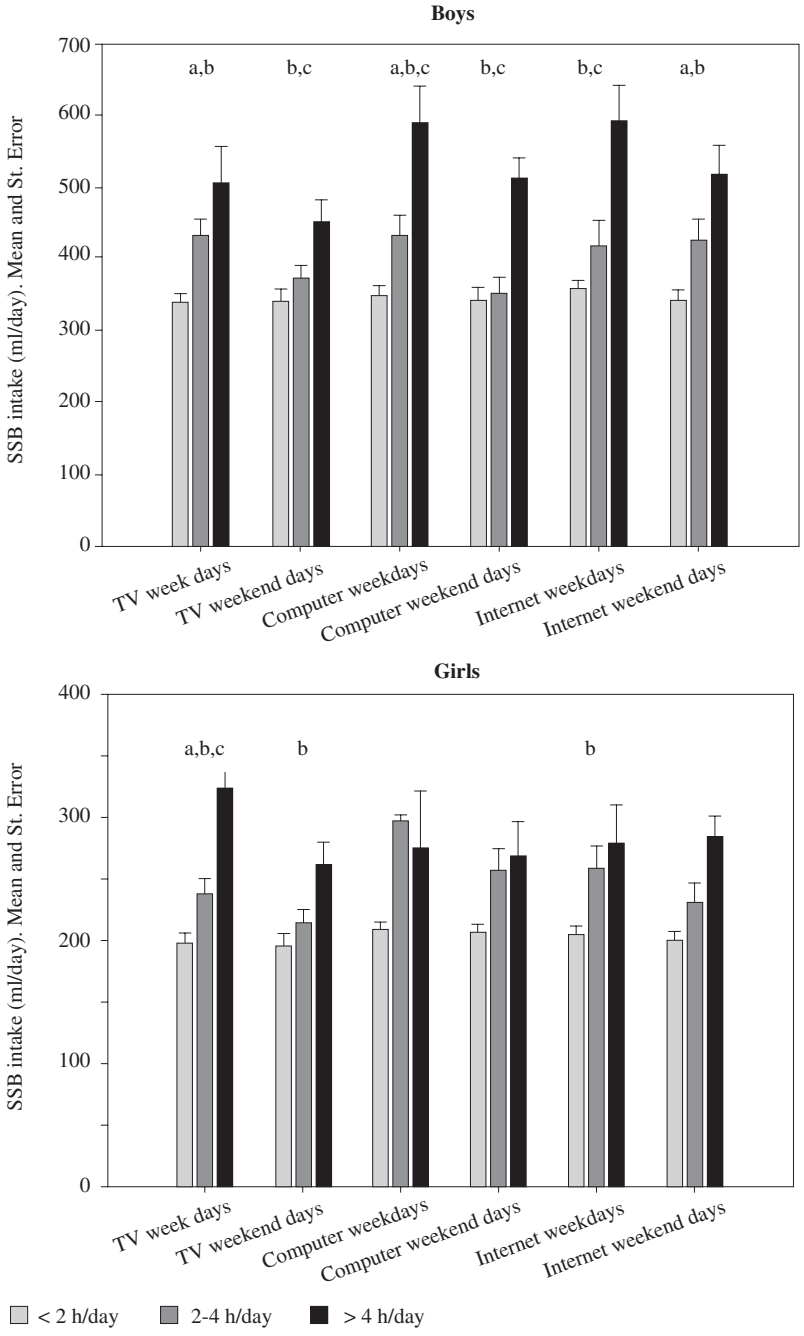
*Data obtained from Santaliestra-Pasías et al[12]
[a] Significant differences between less than 2 hours/day and 2 to 4 hours/day
[b] Significant differences between less than 2 hours/day and more than 4 hours/day
[c] Significant differences between 2 to 4 hours/day and more than 4 hours/day

Fig. 2.—Fruit intake according to sedentary behaviours in European adolescents by sex.*

ved.[29] In addition, when the meta-analysis of interventions includes only young children, the results indicate that interventions performed in school- and general population settings can help prevent excessive sedentary behaviour and unfavourable health outcomes.[28] Van Grieken et al. showed that for sedentary behaviours the post-intervention mean difference was -17.95 minutes/day (95% CI –26.61 to –9.28) and for BMI, the post-intervention group mean difference was –0.25kg/m^2 (95% CI –0.40 to –0.09).

Conclusion

The etiology of obesity is multifactorial and complex. The evidence of different *obesogenic* factors is stronger in some ages than others (Example: TV viewing is strongly associated with obesity in childhood but less consistently during adolescence). Currently, the prevalence of sedentary behaviours related with screen time is high,[12,32] therefore interventions to decrease time spent in sedentary behaviours may help to reduce



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[a] Significant differences between less than 2 hours/day and 2 to 4 hours/day
[b] Significant differences between less than 2 hours/day and more than 4 hours/day
[c] Significant differences between 2 to 4 hours/day and more than 4 hours/day

*Fig. 3.—Sugar sweetened beverages intake according to sedentary behaviors in European adolescents by sex**

the prevalence of obesity. The current evidence says that decreasing and breaking sedentary behaviours may be important for achieving a better population health. In order to obtain a benefit in terms of body composition indicators, it is highly recommended to focus on preschool population. Some practical recommendations can be made based on several observational and laboratory studies but the value of these recommendations should be tested by intervention studies. First, parents should be aware of how different lifestyles impact theirs children's health in order to promote healthy behaviours. Regarding the familiar environment, it seems recommendable to lay

TV sets outside children/adolescent's bedroom. Second, preferentially children should not eat while watching TV. Third, families should minimize the amount of time that children are exposed to food advertisements. Fourth, governments (i.e. by taxes) and communities (promoting competing sport-games activities) should not incentive passive electronic entertainment. Finally, given the multifactorial origin of obesity, (micro-level) prevention strategies can result unsuccessful if global and macro-levels *obesogenic* factors are not altered substantially.

Acknowledgements

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References

1. Rokholm B, Baker JL, Sorensen TI. The levelling off of the obesity epidemic since the year 1999—a review of evidence and perspectives. *Obes Rev* 2010 Dec; 11 (12): 835-46.
2. Global Strategy on diet and Physical Activity. World Health Assembly 5717. Geneva: World Health Organization, 2004.
3. Moreno LA, Rodríguez G. Dietary risk factors for development of childhood obesity. *Curr Opin Clin Nutr Metab Care* 2007 May; 10 (3): 336-41.
4. Rey-López JP, Vicente-Rodríguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. *Nutr Metab Cardiovasc Dis* 2008 Mar; 18 (3): 242-51.
5. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics* 2001 Feb; 107 (2): 423-6.
6. Healthy Eating and Physical activity Guidelines for Early Childhood Settings. Commonwealth of Australia; 2009.
7. Marshall SJ, Gorely T, Biddle SJ. A descriptive epidemiology of screen-based media use in youth: a review and critique. *J Adolesc* 2006 Jun; 29 (3): 333-49.
8. Rey-López JP, Vicente-Rodríguez G, Ortega FB, Ruiz JR, Martínez-Gómez D, De Henauw S et al. Sedentary patterns and media availability in European adolescents: The HELENA study. *Prev Med* 2010 Jul; 51 (1): 50-5.
9. Must A, Barish EE, Bandini LG. Modifiable risk factors in relation to changes in BMI and fatness: what have we learned from prospective studies of school-aged children? *Int J Obes* (Lond) 2009 Jul; 33 (7): 705-15.
10. Delmas C, Platat C, Schweitzer B, Wagner A, Oujaa M, Simon C. Association between television in bedroom and adiposity throughout adolescence. *Obesity* (Silver Spring) 2007 Oct; 15 (10): 2495-503.
11. Rey-López JP, Ruiz JR, Vicente-Rodríguez G, Gracia-Marco L, Manios Y, Sjostrom M et al. Physical activity does not attenuate the obesity risk of TV viewing in youth. *Pediatr Obes* 2012 Jun; 7 (3): 240-50.
12. Santaliestra-Pasías AM, Mouratidou T, Verbestel V, Huybrechts I, Gottrand F, Le Donne C et al. Food consumption and screen-based sedentary behaviors in european adolescents: The helena study. *Archives of Pediatrics & Adolescent Medicine* 2012: 1-11.
13. Craig LC, McNeill G, Macdiarmid JI, Masson LF, Holmes BA. Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity. *Br J Nutr* 2010 Feb; 103 (3): 319-34.
14. Rey-López JP, Bel-Serrat S, Santaliestra-Pasias A, de Moraes AC, Vicente-Rodríguez G, Ruiz JR et al. Sedentary behaviour and clustered metabolic risk in adolescents: The HELENA study. *Nutr Metab Cardiovasc Dis* 2012 Aug 17.
15. Martínez-Gómez D, Gómez-Martínez S, Ruiz JR, Ortega FB, Marcos A, Veiga OL. Video game playing time and cardiometabolic risk in adolescents: the AFINOS study. *Med Clin (Barc)* 2012 Sep 22; 139 (7): 290-2.
16. Dietz WH, Jr., Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics* 1985 May; 75 (5): 807-12.
17. te Velde SJ, van Nassau F, Uijtdewilligen L, van Stralen MM, Cardon G, De Craemer M et al. Energy balance-related behaviours associated with overweight and obesity in preschool children: a systematic review of prospective studies. *Obes Rev* 2012 Mar; 13 (Suppl 1): 56-74.
18. Chinapaw MJ, Proper KI, Brug J, van Mechelen W, Singh AS. Relationship between young peoples' sedentary behaviour and biomedical health indicators: a systematic review of prospective studies. *Obes Rev* 2011 Jul; 12 (7): e621-32.
19. Hands BP, Chivers PT, Parker HE, Beilin L, Kendall G, Larkin D. The associations between physical activity, screen time and weight from 6 to 14 yrs: the Raine Study. *J Sci Med Sport* 2011 Sep; 14 (5): 397-403.
20. Ekelund U, Brage S, Froberg K, Harro M, Anderssen SA, Sardinha LB et al. TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS Med* 2006 Dec; 3 (12): e488.
21. Reisch L, Gwozdz W, Beckmann S. Consumer behavior in childhood obesity research and policy. En: Moreno LA, Pigeot I, Ahrens W, eds. Epidemiology of obesity in children and adolescents Prevalence and etiology. New Yorker: Springer Science; 2011. p. 431-54.
22. Harrison K, Marske AL. Nutritional content of foods advertised during the television programs children watch most. *Am J Public Health* 2005 Sep; 95 (9): 1568-74.
23. Harris JL, Bargh JA, Brownell KD. Priming effects of television food advertising on eating behavior. *Health Psychol* 2009 Jul; 28 (4): 404-13.
24. Temple JL, Giacomelli AM, Kent KM, Roemmich JN, Epstein LH. Television watching increases motivated responding for food and energy intake in children. *Am J Clin Nutr* 2007 Feb; 85 (2): 355-61.
25. Moray J, Fu A, Brill K, Mayoral MS. Viewing television while eating impairs the ability to accurately estimate total amount of food consumed. *Bariatric Nursing and Surgical Patient Care* 2007; 2 (1): 71-6.
26. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviour and associations with food habits in different countries. *Public Health Nutr* 2006 Apr; 9 (2): 244-50.
27. Rey-López JP, Vicente-Rodríguez G, Repasy J, Mesana MI, Ruiz JR, Ortega FB et al. Food and drink intake during television viewing in adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. *Public Health Nutr* 2011 Sep; 14 (9): 1563-9.
28. van Grieken A, Ezendam NP, Paulis WD, van der Wouden JC, Raat H. Primary prevention of overweight in children and adolescents: a meta-analysis of the effectiveness of interventions aiming to decrease sedentary behaviour. *Int J Behav Nutr Phys Act* 2012; 9: 61.
29. Wahi G, Parkin PC, Beyene J, Uleryk EM, Birken CS. Effectiveness of interventions aimed at reducing screen time in children: a systematic review and meta-analysis of randomized controlled trials. *Arch Pediatr Adolesc Med* 2011 Nov; 165 (11): 979-86.
30. Dennison BA, Russo TJ, Burdick PA, Jenkins PL. An intervention to reduce television viewing by preschool children. *Arch Pediatr Adolesc Med* 2004 Feb; 158 (2): 170-6.
31. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *JAMA* 1999 Oct 27; 282 (16): 1561-7.
32. Rey-López JP, Tomas C, Vicente-Rodríguez G, Gracia-Marco L, Jiménez-Pavón D, Pérez-Llamas F et al. Sedentary behaviours and socio-economic status in Spanish adolescents: the AVENA study. *Eur J Public Health* 2010 Mar 19.

Artículo II [Paper II]

Physical activity and sedentary behaviour in European children: the IDEFICS study.

AM. Santaliestra-Pasías, T. Mouratidou, V. Verbestel, K. Bammann, D. Molnar, S. Sieri, A. Siani, T. Veidebaum, S. Märild, L. Lissner, C. Hadjigeorgiou, L. Reisch, I. Bourdeaudhuij and LA Moreno, on behalf of the IDEFICS Consortium
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Physical activity and sedentary behaviour in European children: the IDEFICS study

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Abstract

Objective: To estimate the prevalence of physical activity and sedentary behaviours in European children, and to evaluate the relationship between media availability in personal space and physical activity in relation to total screen time.

Design: Data from the baseline IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) cross-sectional survey. Information on hours of television/digital video disk/video viewing and computer/games-console use (weekday and weekend days), media device availability in personal space, sports club membership, hours of active organized play and commuting (to and from school) were assessed via a self-reported parental questionnaire. Total screen time was defined as the sum of daily media use and subsequently dichotomized into meeting or not meeting the guidelines of the American Academy of Pediatrics.

Setting: Eight survey centres (Italy, Estonia, Cyprus, Belgium, Sweden, Germany, Hungary and Spain).

Subjects: Children (*n* 15 330; 51 % males) aged 2–10 years.

Results: Percentage of children engaged in total screen time for >2 h/d was higher on weekend days (52 % *v.* 20 % on weekdays) and in the older group (71 % in males; 57 % in females), varying by country. Children with a television set in their bedroom were more likely not to meet the screen time recommendations (OR = 1·54; 95 % CI 1·60, 1·74).

Conclusions: Approximately a third of the children failed to meet current screen time recommendations. Availability of a television set in personal space increased the risk of excess total screen time. This information could be used to identify potential targets for public health promotion actions of young population groups.

Keywords
Sedentary behaviours
Children
Europe
Television watching
Screen time
Physical activity
Commuting
Leisure time
IDEFICS

Increasing levels of physical inactivity and sedentarism in young population groups are observed in several developed countries[1,2]. Sedentary time is often defined as the time spent on specific sedentary behaviours such as television (TV) viewing or games-console use[3]. The American Academy of Paediatrics (AAP) recommends parents to limit total media time exposure to no more than 1–2 h/d[4]; however, an increasing proportion of children and adolescents do not meet the recommendations in several countries[2,5,6].

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The relationship between physical activity (PA) and TV viewing is close to zero[7] suggesting adequate day time for both activities. A large number of studies focus on TV viewing making it one of the most commonly examined sedentary behaviours[3,8], although it might not necessarily reflect overall sedentary time[9]. Different patterns of PA and sedentary behaviours have been observed by age, gender and country[2,5,6]. For instance, the Health Behaviour in School-aged Children (HBSC) Study described such behaviours in a population of 11–15-year-olds, showing a high prevalence of sedentary time (61 % exceeded screen time recommendations) and lower time spent in PA (<26 % spent at least 1 h/d in moderate-to-vigorous PA)[5]. Moreover, greater accessibility to media sources in personal space was related to increased time spent in screen-viewing behaviours[6]. In addition, capturing non-school time PA and commuting could serve as potential indicators of PA given the growing evidence suggesting a positive relationship between these measures[10–12].

Sedentary behaviour is an independent risk factor for chronic diseases such as the metabolic syndrome or CVD[13], and during childhood has been associated with increased risk of overweight and obesity[2]. The effect of sedentary behaviour builds up over the course of childhood[14], making early adolescence an important life transition period. Children engaging in sports are more likely to be physically active during adolescence and adulthood[15] and to have a lower cardio-metabolic risk factors profile[16]. The aims of the present study were to: (i) estimate the prevalence of sedentary behaviours (TV/digital video disk (DVD)/video viewing, use of computer/games console, total screen time), electronic media availability in personal space and several PA variables in young children from eight European countries; (ii) describe regional-, country-, age- and sex-specific variations; (iii) assess the association between total screen time and media availability; and (iv) assess the association between total screen time and PA behaviours. In addition, the cumulative influence of total screen time could offer evidence to support effective prevention strategies aiming at reducing sedentary behaviour and increasing PA.

Methods

IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) is a community intervention study aiming to prevent obesity[17,18]. The baseline survey, a multi-centre cross-sectional study of children aged 2 to <10 years from eight European countries (Italy, Estonia, Cyprus, Belgium, Sweden, Hungary, Germany and Spain), is the focus of the present paper. Between September 2007 and June 2008, 16 864 children were recruited and approximately 96 % fulfilled the inclusion criteria (complete information on sex, height and weight). Participants were classified into two age groups: 2 to <6 years (pre-school children) and 6 to <10 years (schoolchildren).

The study was approved by the Research Ethics Committees in each centre involved. Parents or guardians provided written informed consent. Detailed operational study procedures are described elsewhere[17–19].

Data collection

Sociodemographic data

Information on demographic factors was collected by a standardized self-reported parental questionnaire including children's gender, age, country and parental educational level. The International Standard Classification of Education (ISCED) index was used to classify parental educational level[20] and was used as a proxy indicator of socio-economic status (SES) in subsequent analyses.

Physical activity and sedentary behaviours

The parental questionnaire was used to obtain information on children's PA and sedentary behaviours. Parents reported hours of TV/DVD/video viewing and computer/games-console use both for a typical weekday and weekend days. Response categories included: (i) not at all; (ii) <0·5 h/d; (iii) <1 h/d; (iv) between 1 and <2 h/d; (v) between 2 and <3 h/d; and (vi) >3 h/d. For the purposes of the current analysis, children's daily TV/DVD/video and computer/games-console use were summed to obtain the total screen time per day (total hours per day, during weekdays, weekend days and the whole week). Thereafter, participants were classified into two groups according to the AAP's guidelines on total screen time: ≤2 h/d and >2 h/d[4]. In 2–5-year-olds and 6–10-year-olds, low correlations were found between accelerometer-derived sedentary time and parental-reported screen time in both age groups (Spearman $r = 0{\cdot}09$, $P < 0{\cdot}001$ for age 2–5 years; Spearman $r = 0{\cdot}03$ for age 6–10 years; V Verbestel, S De Henauw, K Bammann *et al.*, unpublished results). The parents also completed a question on media availability (i.e. TV, computer, etc.) in the child's personal space (e.g. bedroom).

PA was obtained by the sum of hours that children spent playing outdoors (weekdays and weekend days) and weekly participation in sports club activities for a typical week in the previous month. Total PA was calculated with the following formula: [(PA playing outdoors on weekdays × 5) + (PA playing outdoors on weekend days × 2) + weekly sports participation]/7. The time children spent playing outside was assessed using an outdoor playtime measure, which significantly correlated with objective measures of PA in pre-school children in a previous study ($r = 0{\cdot}20$, $P = 0{\cdot}003$)[11].

In the IDEFICS study, children's weekly participation in sports club activities was significantly correlated with children's daily time spent in moderate-to-vigorous PA as measured by an accelerometer. In 2–5- and 6–10-year-olds,

a positive relationship was found between parental-reported sports participation and accelerometer-derived moderate-to-vigorous PA (Spearman $r = 0{\cdot}14$, $P < 0{\cdot}001$ for age 2–5 years; Spearman $r = 0{\cdot}15$, $P < 0{\cdot}001$ for 6–10-year-olds; V Verbestel, S De Henauw, K Bammann *et al*., unpublished results). Commuting to and from school were classified into three categories: (i) active commuting (walking or cycling); (ii) passive commuting (bus or car); and (iii) both (combination of active and passive commuting).

Statistical analysis

The Predictive Analytics SoftWare version 18·0 was used to analyse the data. Descriptive statistics of PA and sedentary behaviour variables stratified by age group, sex and country were computed using descriptive procedures. The χ^2 test was used to compare PA and sedentary behaviours by sex. Binary logistic regression analyses with adjusted odds ratios (and 95% confidence intervals) were used to examine the independent association between each variable and total screen time (>2 h/d). In addition, multiple logistic regression with adjusted odds ratios (and 95% confidence intervals) was performed to examine the cumulative association between all independent variables and total screen time (>2 h/d), resulting in four prediction models. Adjustments were made for age and gender, SES and country. The first model examined the association between total screen time and individual media availability in personal space; the second model assessed the association between total screen time and cumulative media availability; the third model examined the association between total screen time and individual PA variables; and the fourth model examined the association between total screen time and cumulative PA variables.

Results

Complete data on PA and sedentary behaviours patterns from 15 330 (94% of the original sample) participants were obtained (51% males). Approximately 45% of the children in both gender groups were classified in the <6 years age category. Table 1 presents descriptive data on PA and sedentary behaviours by sex. Additionally, Table A (online supplementary material) presents aggregated descriptive information for excessive media use by country and sex. Descriptive results on SES, PA and sedentary behaviour by sex and country are presented for younger (Table 2) and older children (Table 3) separately. Overall, characteristics on PA and sedentary behaviours were similar between males and females within countries and age groups.

Sedentary behaviours

Television/digital video disk/video viewing

Older males and females in Cyprus had the highest percentage of TV/DVD/video viewing time >2 h/d during weekdays (21% and 17%, respectively) and weekend days (59% and 56%, respectively; see Table 3). Similarly, the younger males and females in Cyprus had higher percentage of TV/DVD/video viewing time >2 h/d during weekdays (19% and 18%, respectively) and weekend days (46% and 41%, respectively; see Table 2).

Older Swedish and Spanish males, and older Swedish females had the lowest percentage of TV/DVD/video viewing time >2 h/d during weekdays (6·1% in both cases for males, 4·0% for females). Older German males and Italian females had the lowest percentage of TV/DVD/video viewing time during weekend days (33% in both cases; see Table 3). Younger Swedish males and females had the lowest percentage of TV/DVD/video viewing >2 h/d during weekdays (3·6 and 2·4%, respectively) and younger Swedish males and German females had the lowest percentage during weekend days (22% and 19%, respectively; see Table 2).

Computer/games-console use

Highest electronic media use (>2 h/d) was observed during weekend days in older Estonian males and females (23% and 6·2%, respectively; see Table 3). Lowest electronic media use was observed in younger Spanish males and Cypriot, Belgian and Swedish females (0% in all groups; see Table 2).

Total screen time

Twenty-nine per cent of the participants did not meet the AAP recommendations. Figure 1 shows the proportion of children having weekly total screen time on average >2 h/d by gender, age and country. In all countries, higher percentage of exceeding total screen time was observed in older males followed by older females and younger males and females (Fig. 1). In addition, higher percentage of total screen time >2 h/d was more common during weekend days as opposed to weekdays (Tables 2 and 3).

Media device availability

Media device availability in personal space was observed in approximately a third of the sample; 71% of the total sample reported non-availability (66% in males and 75% in females). Highest reported media availability in personal space was observed in Italy, where the majority of males (younger 73%; older 81%) and females (younger 65%; older 76%) had media devices available (Tables 2 and 3).

Physical activity

Physical activity and sports club participation

In most countries, older children were more physically active than the younger ones. A high proportion of males were members of sport clubs, mainly in Sweden and Estonia (75% and 72%, respectively, for older children). Great variability between countries in sports

Table 1 Description of media use and availability and physical activity practice by sex among 15 330 children aged 2–10 years in eight European countries; IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study, September 2007–June 2008

	Males	Females	*P* value*
Media use			
TV/DVD/video viewing (%)			
Weekdays			
>2 h/d	11·3	9·7	<0·001
Weekend days			
>2 h/d	39·8	36·7	<0·001
Computer/games-console use (%)			
Weekdays			
>2 h/d	1·3	0·4	<0·001
Weekend days			
>2 h/d	6·6	2·1	<0·001
Total screen time† (%)			
Weekdays			
>2 h/d	24·5	16·2	<0·001
Weekend days			
>2 h/d	57·3	47·9	<0·001
Whole week			
>2 h/d	33·5	25·0	<0·001
Media availability			
No. of media devices in personal space (%)			
0	58·2	62·7	<0·001
1 or 2	29·0	28·5	
3+	12·8	8·8	
Physical activity			
Physical activity‡ (%)			
≤2 h/d	61·7	58·2	<0·001
Child member of sports club (%)			
Yes	42·3	44·5	<0·001
Time spent in sports club (%)			
<1 h/week	82·1	83·7	<0·001
≥1 to <4 h/week	8·0	8·3	
≥4 h/week	9·9	8·1	
Transport (home–school)§ (%)			
Active	28·3	28·7	0·599
Both	54·6	54·8	
Passive	17·1	16·6	

TV, television; DVD, digital video disk.
*Gender differences using the Pearson χ^2 test.
†Total screen time: total number of hours usually spent watching TV, videos or DVD and playing on the computer or games console.
‡Physical activity: sum of hours that children spent playing outdoors (weekdays and weekend days) and weekly participation in sports club activities.
§Transport: active, children go to and from school by walking or cycling; passive, children go to and from school by bus or car; both, one way as active transport and the other as passive transport.

club membership was observed in both males (10 % in younger Hungarian to 75 % in older Swedish) and females (11 % in younger Hungarian to 80 % in older Swedish). The majority of children spent <1 h/week participating in a sports club, both in males (82 % in the younger group and 50 % in the older group) and females (75 % and 53 % in the younger and older group, respectively; Tables 2 and 3).

Commuting to and from school

The highest percentages of active commuting were observed in older German males and females (51 % and 55 %, respectively), and both in young and old Spanish males (54 % and 68 %, respectively) and females (54 % and 64 %, respectively). The lowest percentages were observed in Cypriot, Italian and Belgian participants of both genders (Tables 2 and 3).

Association between total screen time and availability of media devices

Table 4 presents the results of the logistic regression analyses for the total sample, separately for weekdays, weekend days and the whole week. The adjusted association between excess total screen time (>2 h/d) and individual media availability is described in model 1 (Table 4) and between cumulative media availability variables is presented in model 2 (Table 4). Presence of individual media devices in personal space increased the odds of having >2 h/d total screen time. The highest effect during weekdays, weekend days and the whole week was observed in those having a PlayStation/games console (OR = 2·41; 95 % CI 2·12, 2·75; OR = 2·20; 95 % CI 1·92, 2·52; and OR = 2·40; 95 % CI 2·11, 2·72, respectively) in their personal space. In model 2, the effects changed with the addition of predicting variables.

Table 2 Media use and availability and physical activity practice of younger children (2 to <6 years old) in eight European countries stratified by sex; IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study, September 2007–June 2008

	Italy		Estonia		Cyprus		Belgium		Sweden		Germany		Hungary		Spain		Total	
Younger children	Males (*n* 523)	Females (*n* 442)	Males (*n* 431)	Females (*n* 405)	Males (*n* 415)	Females (*n* 413)	Males (*n* 531)	Females (*n* 492)	Males (*n* 471)	Females (*n* 423)	Males (*n* 437)	Females (*n* 404)	Males (*n* 502)	Females (*n* 523)	Males (*n* 381)	Females (*n* 315)	Males (*n* 3691)	Females (*n* 3417)
Socio-economic status (%)																		
Low																		
0–2	19·6	19·6	1·0	1·1	3·3	1·1	2·4	1·6	0·9	0·7	16·5	16·7	1·5	2·9	12·1	8·5	7·1	6·3
Middle																		
3–4	62·3	60·6	84·3	84·7	35·2	36·9	32·3	32·5	28·1	25·4	62·7	62·8	53·6	49·9	30·8	33·6	48·9	48·2
High																		
5–8	18·2	19·8	14·7	14·1	61·5	62·1	65·3	65·9	71·0	73·8	20·8	20·5	44·9	47·2	57·0	57·9	44·0	45·4
Media use																		
TV/DVD/video viewing (%)																		
Weekdays																		
>2 h/d	18·0	16·3	9·0	9·4	18·8	18·2	6·6	5·1	3·6	2·4	7·6	5·4	9·6	8·4	3·7	4·8	9·7	8·8
Weekend days																		
>2 h/d	26·2	21·6	36·7	37·8	46·0	41·3	35·8	27·6	22·0	22·8	24·5	19·2	40·8	40·3	28·3	20·0	32·5	29·3
Computer/games-console use (%)																		
Weekdays																		
>2 h/d	2·3	0·2	1·2	0·3	0·3	0·0	0·9	0·0	0·2	0·0	0·7	0·3	0·4	0·4	0·0	1·0	0·8	0·2
Weekend days																		
>2 h/d	4·7	0·5	5·9	2·5	1·8	0·8	4·0	0·4	2·3	0·0	1·4	1·3	3·0	1·4	0·8	1·3	3·1	1·0
Total screen time* (%)																		
Weekdays																		
>2 h/d	28·5	18·7	20·7	18·5	23·6	21·3	13·0	6·9	10·3	4·3	12·4	8·1	15·3	10·9	5·1	5·9	16·3	11·9
Weekend days																		
>2 h/d	36·4	24·9	51·5	51·1	51·3	45·2	45·1	34·0	36·2	29·7	28·8	22·1	49·3	45·0	33·3	24·3	41·6	35·1
Media availability																		
No. of media devices in personal space (%)																		
0	26·9	35·3	61·3	63·7	62·8	67·6	88·6	91·6	78·2	86·3	80·6	83·3	56·6	57·7	89	90·1	67·4	71·3
1 or 2	50·2	50·1	30·3	27·1	30·1	30·5	8·3	7·0	17·5	13·0	15·0	12·5	34·5	35·5	10·2	8·6	24·8	23·4
3+	22·9	14·6	8·3	9·2	7·1	1·9	3·2	1·4	4·3	0·7	4·4	4·2	8·8	6·8	0·8	1·3	7·8	5·3
Physical activity																		
Physical activity† (%)																		
≥2 h/d	55·6	52·1	43·3	46·7	56·4	51·8	37·1	29·1	76·8	75·2	62·6	64·4	73·1	64·3	68·5	66·3	58·9	56·0
Child member of sports club (%)																		
Yes	17·5	25·1	24·2	29·8	15·0	26·6	25·5	34·5	22·1	32·7	42·9	50·8	9·8	11·2	32·0	32·3	23·5	29·9
Time spent in sports club (%)																		
<1 h/week	84·1	77·4	81·8	75·4	92·0	88·7	77·8	71·4	85·9	60·7	62·6	57·8	92·1	91·0	77·9	80·4	82·1	75·2
≥1 to <4 h/week	15·0	20·0	17·1	22·7	7·4	10·5	20·5	28·0	14·1	15·5	35·7	40·0	7·5	8·5	19·3	18·7	16·8	20·0
≥4 h/week	0·9	2·7	1·1	1·9	0·6	0·9	1·6	0·6	0·0	23·7	1·8	2·1	0·4	0·6	2·8	0·9	1·1	4·8
Transport (home–school)‡ (%)																		
Active	18·6	16·5	21·0	18·4	5·7	5·9	11·8	11·4	30·0	30·0	24·8	25·7	34·7	39·5	53·8	54·0	24·5	24·4
Both	7·8	7·7	25·9	26·6	4·4	5·7	21·7	20·1	20·6	19·1	26·0	23·3	19·5	16·1	18·9	17·2	18·1	16·9
Passive	73·5	75·8	53·0	55·0	89·9	88·4	66·5	68·4	49·4	50·9	49·2	50·9	45·7	44·4	27·3	28·8	57·4	58·7

TV, television; DVD, digital video disk.
*Total screen time: total number of hours usually spent watching TV, videos or DVD and playing on the computer or games console.
†Physical activity: sum of hours that children spent playing outdoors (weekdays and weekend days) and weekly participation in sports club activities.
‡Transport: active, children go to and from school by walking or cycling; passive, children go to and from school by bus or car; both, one way as active transport and the other as passive transport.

Table 3 Media use and availability and physical activity practice of older children (6 to <10 years old) in eight European countries stratified by sex; IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study, September 2007–June 2008

	Italy		Estonia		Cyprus		Belgium		Sweden		Germany		Hungary		Spain		Total	
Older children	Males (*n* 630)	Females (*n* 634)	Males (*n* 381)	Females (*n* 435)	Males (*n* 637)	Females (*n* 596)	Males (*n* 425)	Females (*n* 434)	Males (*n* 440)	Females (*n* 425)	Males (*n* 566)	Females (*n* 565)	Males (*n* 749)	Females (*n* 726)	Males (*n* 376)	Females (*n* 403)	Males (*n* 4204)	Females (*n* 4218)
Socio-economic status (%)																		
Low																		
0–2	21·5	21·0	2·3	1·5	3·8	2·5	2·1	3·1	2·5	0·5	20·4	22·6	3·3	2·2	10·9	9·9	8·8	8·5
Middle																		
3–4	60·2	58·8	83·7	83·6	40·7	35·3	38·0	36·5	27·3	32·9	59·1	55·5	52·3	54·6	33·5	33·7	49·9	49·8
High																		
5–8	18·3	20·2	14·0	14·9	55·5	62·2	59·9	60·4	70·3	66·6	20·4	21·9	44·4	43·3	55·6	56·4	41·3	41·7
Media use																		
TV/DVD/video viewing (%)																		
Weekdays																		
>2 h/d	18·9	15·7	19·7	15·9	21·4	16·8	10·6	9·2	6·1	4·0	9·5	9·1	6·9	5·5	6·1	5·7	12·6	10·4
Weekend days																		
>2 h/d	36·8	32·8	54·2	47·3	58·7	56·2	50·2	45·1	39·2	35·2	32·6	33·7	52·9	48·0	43·4	42·0	46·2	42·7
Computer/games-console use (%)																		
Weekdays																		
>2 h/d	4·5	1·0	5·5	0·9	0·8	0·3	0·9	0·5	0·7	0·0	0·7	0·2	0·3	0·6	0·5	0·0	1·7	0·5
Weekend days																		
>2 h/d	10·4	2·6	22·7	6·2	3·8	1·6	10·2	3·8	10·8	2·4	5·5	2·7	10·2	3·4	8·3	2·8	9·7	3·1
Total screen time* (%)																		
Weekdays																		
>2 h/d	43·9	26·2	64·3	41·7	30·0	20·2	24·1	15·2	36·3	16·3	26·0	17·5	19·5	12·0	17·0	1·1	31·7	19·0
Weekend days																		
>2 h/d	65·2	38·6	85·7	67·8	68·9	62·8	72·7	57·2	82·1	60·7	57·2	48·5	73·7	63·7	71·2	61·4	71.2	57.4
Media availability																		
No. of media devices in personal space (%)																		
0	18·9	23·7	43·5	51·6	58·3	66·2	78·9	81·9	47·3	56·3	58·4	64·1	41·6	43·1	74·7	82·4	50·2	55·9
1 or 2	45·2	51·3	35·9	35·9	30·1	29·7	14·7	13·7	32·6	30·5	32·5	28·3	38·1	40·9	21·9	15·6	32·7	32·5
3+	35·9	25·0	20·6	12·4	11·7	4·1	6·4	4·4	20·1	13·2	9·1	7·6	20·4	16·0	3·5	2·0	17·1	11·6
Physical activity																		
Physical activity† (%)																		
≥2 h/d	56·5	55·8	60·4	60·4	54·1	51·6	52·5	40·8	74·8	74·4	73·4	67·7	70·8	64·9	70·4	62·5	64·1	59·9
Child member of sports club (%)																		
Yes	53·5	52·9	71·7	73·3	47·6	46·3	58·5	59·6	75·4	79·8	65·5	59·0	42·1	35·9	70·3	57·9	58·5	56·1
Time spent in sports club (%)																		
<1 h/week	50·7	51·0	36·8	37·4	70·0	70·6	47·2	49·2	32·4	35·5	42·0	48·6	60·6	67·2	34·9	51·5	49·6	53·4
≥1 to <4 h/week	42·5	38·8	37·8	35·6	24·2	23·3	42·1	48·8	59·2	60·7	46·6	46·3	28·8	25·3	45·3	39·0	39·1	38·0
≥4 h/week	6·8	10·2	25·4	27·0	5·8	6·1	10·6	2·0	8·4	3·9	11·4	5·1	10·6	7·5	19·8	9·6	11·3	8·6
Transport (home–school)‡ (%)																		
Active	22·5	23·3	29·8	29·8	8·8	8·8	15·0	15·3	33·9	37·6	50·7	54·9	33·9	31·6	67·9	63·8	31·5	32·1
Both	5·7	6·0	31·9	30·7	8·6	9·5	24·3	22·9	25·3	21·4	20·8	21·6	12·2	11·7	12·8	14·7	16·3	16·3
Passive	71·8	70·6	38·3	39·5	82·5	81·7	60·7	61·8	40·8	40·9	28·5	23·6	53·8	56·7	19·3	21·6	52·2	51·6

TV, television; DVD, digital video disk.
*Total screen time: total number of hours usually spent watching TV, videos or DVD and playing on the computer or games console.
†Physical activity: sum of hours that children spent playing outdoors (weekdays and weekend days) and weekly participation in sports club activities.
‡Transport: active, children go to and from school by walking or cycling; passive, children go to and from school by bus or car; both, one way as active transport and the other as passive transport.

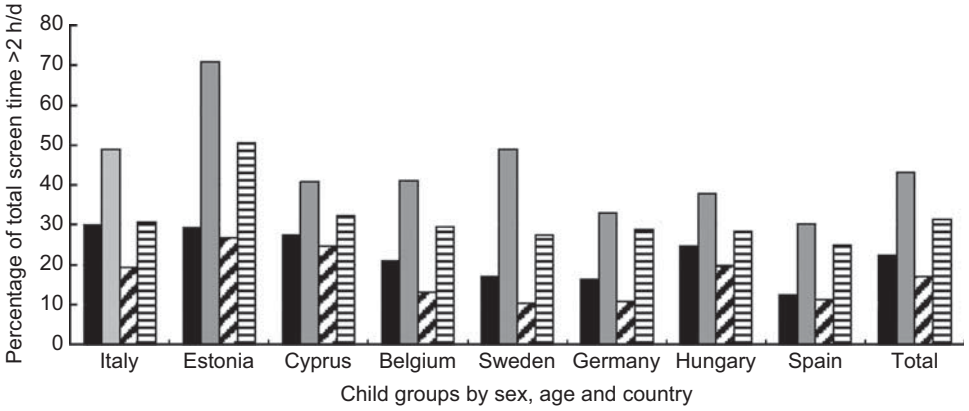

Fig. 1 Prevalence of weekly total screen time viewing >2 h/d among 15 330 children in eight European countries by sex and age group (■, younger males (2 to <6 years old); □, older males (6 to <10 years old); ◪, younger females (2 to <6 years old); ▤, older females (6 to <10 years old); IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study, September 2007–June 2008

Children with a TV in their personal space were more likely to have a total screen time of >2 h/d during weekdays (OR = 1·48; 95 % CI 1·30, 1·69), weekend days (OR = 1·58; 95 % CI 1·40, 1·78) and the whole week (OR = 1·54; 95 % CI 1·60, 1·74), whereas those having a computer or PlayStation/games console were less likely to have >2 h/d of total screen time (19 % and 44 % during weekdays; 16 % and 38 % during weekend days; and 21 % and 44 % during the whole week, respectively; Table 4, model 2).

Association between total screen time and physical activity

Model 3 (Table 5) describes the adjusted association between total screen time (>2 h/d) and individual PA variables, separately for weekdays and weekend days and stratified by age group. Sports club membership increased the odds of having >2 h/d total screen time (OR = 1·17; 95 % CI 1·07, 1·27), while passive commuting was associated with decreased total screen time (OR = 0·77; 95 % CI 0·69, 0·85). The effects changed with the inclusion of all variables in model 4 (Table 5). The only remaining significant factor was passive commuting, associated with a 23 % lower likelihood of total screen time of >2 h/d.

Discussion

The aim of the present study was to describe the prevalence of PA and sedentary behaviours in children participating in the IDEFICS study stratified by age, gender and country. To the authors' knowledge, the present study is the first one to provide comparable information on PA and sedentary behaviours, combined with media availability, in children aged 2–10 years old in different European countries. The study provides very rich data for understanding the screen-related sedentary behaviours among European children. The AAP recommends media time exposure of ≤2 h/d for mitigating negative health effects in youth people[4]. The main finding of our study was the proportion of children not meeting the AAP recommendation for media time, which was 29 % (33 % of males and 25 % of females), more evident during weekend days. Another major finding of our study was the high proportion of older participants failing to meet the AAP screen time recommendations (43 % of males and 31 % of females). No comparable information on compliance to total screen time recommendations in children or adolescents was identified in multi-national studies. Subsequently, comparisons with other studies are made on the basis of the most widely assessed sedentary behaviour, i.e. TV viewing. The HBSC Study[5] observed that 61 % of children aged 11–15 years watched TV for >2 h/d. In adolescents aged 12·5 to 17·5 years participating in the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study, the proportion who watched TV for more than 2 h/d during weekend days was 58 % in males and 53 % in females[6]. Evidence suggests that adolescence is the period during which the highest proportion fails to meet the screen time recommendation; therefore early age evidence could inform intervention strategies before levels of sedentary behaviours increase, i.e. in the transition period from childhood to adolescence. Another important finding of our study was the high proportion of older participants not meeting screen time recommendations during weekend days (71 % of males and 57 % of females). Previous research has also suggested higher screen-viewing time in older children[21]. We also observed a high proportion of males watching TV in excess, unlike in three reviews with a variety of age groups which reported no gender differences[3,8,22]. Large variations for computer/games-console use between countries, such as older Estonian females *v.* Swedish ones (6·2 % and 0 %

Table 4 Prediction models of total screen time viewing (>2 h/d) and its association with media devices availability among 15 330 children aged 2–10 years in eight European countries; IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study, September 2007–June 2008

	Model 1											
	Model 1·1		Model 1·2		Model 1·3		Model 1·4		Model 1·5		Model 2	
Variable	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
TST weekdays												
TV												
No*	**1·96**	**1·77, 2·17**	–		–		–		–		**1·48**	**1·30, 1·69**
Computer												
No*	–		**1·59**	**1·41, 1·78**	–		–		–		**0·81**	**0·71, 0·94**
Internet connection												
No*	–		–		**1·85**	**1·59, 2·16**	–		–		**0·79**	**0·65, 0·96**
Video/DVD player												
No*	–		–		–		**1·81**	**1·62, 2·02**	–		**0·88**	**0·76, 1·01**
PlayStation/games console												
No*	–		–		–		–		**2·41**	**2·12, 2·75**	**0·56**	**0·48, 0·64**
TST weekend days												
TV												
No*	**1·95**	**1·78, 2·14**	–		–		–		–		**1·58**	**1·40, 1·78**
Computer												
No*	–		**1·49**	**1·33, 1·66**	–		–		–		**0·84**	**0·73, 0·96**
Internet connection												
No*	–		–		**1·72**	**1·47, 2·02**	–		–		0·83	0·68, 1·01
Video/DVD player												
No*	–		–		–		**1·81**	**1·63, 2·00**	–		0·88	0·77, 1·00
PlayStation/games console												
No*	–		–		–		–		**2·20**	**1·92, 2·52**	**0·62**	**0·52,0·72**
TST week												
TV												
No*	**1·97**	**1·80, 2·17**	–		–		–		–		**1·54**	**1·60, 1·74**
Computer												
No*	–		**1·58**	**1·42, 1·76**	–		–		–		**0·79**	**0·69, 0·90**
Internet connection												
No*	–		–		**1·79**	**1·54, 2·07**	–		–		0·84	0·70, 1·01
Video/DVD player												
No*	–		–		–		**1·81**	**1·63, 2·00**	–		0·89	0·78, 1·01
PlayStation/games console												
No*	–		–		–		–		**2·40**	**2·11, 2·72**	**0·56**	**0·49, 0·65**

TST, total screen time; TV, television; DVD, digital video disk.
Model 1: 1.1, TV in bedroom; 1.2, computer in bedroom; 1.3, Internet connection in bedroom; 1.4, video/DVD player in bedroom; 1.5, PlayStation/games console in bedroom. Model 2: TV in bedroom + computer in bedroom + Internet connection in bedroom + video/DVD player in bedroom + PlayStation/games console in bedroom. Models 1 and 2: OR adjusted for socio-economic status, gender, age and country. Significant associations are indicated in bold font.
*Reference category.

Table 5 Prediction models of screen time viewing (>2 h/d) and its association with physical activity by age group among 15 330 children aged 2–10 years in eight European countries; IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study, September 2007–June 2008

	Model 3									
	Model 3·1		Model 3·2		Model 3·3		Model 3·4		Model 4	
Variable	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
TST weekdays in younger children (2 to <6 years old)										
Physical activity*										
≥2 h/d†	1·04	0.89, 1·22	–		–		–		1·04	0·88, 1·24
Member of sports club										
Yes†	–		**1·26**	**1·04, 1·53**	–		–		0·99	0·65, 1·51
Time spent in sports club										
≥4 h/week†										
<1 h/week	–		–		1·16	0·54, 2·29	–		1·13	0·48, 2·67
≥1 to<4 h/week	–		–		0·85	0·41, 1·78	–		0·89	0·41, 1·96
Transport between home and school										
Active†										
Passive	–		–		–		**0·76**	**0·63, 0·92**	**0·73**	**0·59, 0·89**
Both	–		–		–		**0·72**	**0·56, 0·93**	**0·75**	**0·58, 0·97**
TST weekdays in older children (6 to <10 years old)										
Physical activity*										
≥2 h/d†	1·07	0·95, 1·20	–		–		–		1·05	0·93, 1·19
Member of sports club										
Yes†	–		**1·33**	**1·18, 1·50**	–		–		1·36	0·98, 1·88
Time spent in sports club										
≥4 h/week†										
<1 h/week	–		–		**1·41**	**1·16, 1·71**	–		1·03	0·72, 1·47
≥1 to <4 h/week	–		–		1·15	0·95, 1·40	–		1·12	0·92, 1·37
Transport between home and school										
Active†										
Passive	–		–		–		0·73	0·63, 0·84	0·72	0·62, 0·83
Both	–		–		–		0·92	0·78, 1·09	0·89	0·74, 1·06
TST weekend days in younger children (2 to <6 years old)										
Physical activity*										
≥2 h/d†	1·01	0·88, 1·15	–		–		–		1·01	0·87,1·17
Member of sports club										
Yes†	–		1·06	0·90, 1·25	–		–		0·93	0·66, 1·32
Time spent in sports club										
≥4 h/week†										
<1 h/week	–				1·22	0·63, 2·35	–		1·30	0·61, 2·81
≥1 to <4 h/week	–		–		1·17	0·60, 2·29	–		1·16	0·57, 2·35
Transport between home and school										
Active†										
Passive	–		–		–		**0·82**	**0·69, 0·97**	**0·79**	**0·66, 0·94**
Both	–		–		–		0·83	0·67, 1·03	0·86	0·69, 1·07

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Table 5 *Continued*

Variable	Model 3								Model 4	
	Model 3·1		Model 3·2		Model 3·3		Model 3·4			
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
TST weekend days in older children (6 to <10 years old)										
Physical activity*										
≥2 h/d†	**1·12**	**1·02, 1·25**	–		–		–		**1·19**	**1·00, 1·25**
Member of sports club										
Yes†	–		**1·28**	**1·15, 1·42**	–				1·29	0·97, 1·71
Time spent in sports club										
≥4 h/week†										
<1 h/week	–		–		**1·26**	**1·06, 1·50**	–		0·97	0·71, 1·32
≥1 to <4 h/week	–		–		1·06	0·89, 1·26	–		1·04	0·87, 1·24
Transport between home and school										
Active†										
Passive	–		–		–		**0·76**	**0·68, 0·86**	**0·76**	**0·67, 0·86**
Both	–		–		–		0·93	0·79, 1·08	0·89	0·76, 1·04

TST, total screen time.
Model 3: 3·1, physical activity; 3·2, member of sport club; 3·3, time spent in sport club; 3·4, transport between home and school. Model 4: physical activity + member of sports club + time spent in sports club + transport between home and school. Models 3 and 4: OR adjusted for socio-economic status, gender, age and country. Significant associations are indicated in bold font.
*Physical activity: sum of hours that children spent playing outdoors (weekday and weekend days) and weekly participation in sports club activities.
†Reference category.

respectively), were found in our study. Similarly, country differences in TV watching and other sedentary behaviours have also been observed in another descriptive review[2]. In our study, regular engagement in sports was 43 % (42 % in males and 44 % in females). In other studies with adolescents, low engagement in organized sports activities was observed[1,15,23] and our results could suggest that habit formation of PA may be important at early ages. In our sample, sports participation was higher in older children; these results are somehow to be expected since pre-school children do not normally participate regularly in organized PA. Our results in the older group (58 % in males and 56 % in females) were comparable to those observed in US children (59 %)[24]. Commuting to and from school was predominantly passive in the majority of the countries in the present study and in agreement with Fainardi *et al.*[25]; it should be noted that active commuting might be related to SES, due to the results obtained by Hallal *et al.*[15] who found active commuting to be more common to be among poor adolescents.

Our findings are consistent with those observed in other studies suggesting an association between the presence of media devices in personal space and increased risk of screen-related behaviours, such as having a TV or a games console in the bedroom being associated with higher TV viewing[6,26]. For example, findings from the HELENA study indicated that adolescents who had a computer in their bedroom were 43 % less likely to have an excess of TV viewing[6]. Negative observed associations between the presence of other media devices and total screen time could be attributed to the fact that children spent a higher proportion of their sedentary time on TV/DVD/video viewing (81·62 (SD 18·9) % of their total screen time; data not shown). A recent review, however, showed unclear associations among young children[27]. No relationships between screen-viewing time and level of PA were observed in our study, similarly to other studies assessing PA using objective methods[1,28]. Besides, a longitudinal study of children aged 10–15 years indicated no relationship between changes in TV viewing and changes in high-intensity leisure-time activities[29]. Moreover, frequency of total screen and TV viewing time were not associated with sports participation in Brazilian adolescents[23]. Absence of such relationships could indicate other that factors potentially affect screen time, like other leisure activities. Very few reported studies have related screen-viewing time with active or passive commuting. Surprisingly, passive commuting was related with less total screen time in the current study. A higher proportion of passive commuting was reported in adolescents from higher SES backgrounds[30], who are also suggested to be involved in more extracurricular activities[31]. Therefore we hypothesize that time restraints due to increased commitments could explain our observations; i.e. children using passive commuting have more extra activities, and they use passive commuting

as a means of arriving on time and subsequently spend less time on sedentary activities like total screen time. Additionally, a higher proportion of adolescent members of sports clubs used passive commuting as means of transport to and from school (data not shown). In contrast with our results, no relationship between passive commuting and total screen time was reported by Mota *et al.*[30], supporting the fact that screen activities are generalized activities in youth.

The strengths of our study include the large sample of children from different European countries and the implementation of a harmonized methodology. The inclusion of other sedentary behaviours among children younger than 10 years like computer and games-console use is also strength of the study, as well as the assessment of other types of inactivity like passive commuting. In addition, the population included children from different age groups which allowed stratified analyses without loss of statistical power. The description of multiple indicators of PA and sedentary behaviours at the same time allowed us to provide a clearer picture of the current situation and to identify the most prevalent behaviours. Also, the presence of children from Southern, Western, Eastern and Northern countries offers the opportunity to have an overview at the European level. The study has some weaknesses. The inherent limitations of the cross-sectional design affect the assessment of the causal effect between total screen time and the specific PA and sedentary behaviours. Second, examined measures and associations were based on parental reports which might underestimate and misrepresent the prevalence of behaviours. Nevertheless, questionnaire use is the most common method to subjectively assess PA and sedentary behaviours and this is due mainly to the low cost and the ease of administration in a large European sample. In addition, PA was also reported via a questionnaire, which does not reflect objective measures of total PA[32]. However, it provides information about PA which is not available when using objective methods like accelerometry, i.e. type of sport. Another limitation of our study was the small number of children included in some groups, i.e. the high computer/games-console use categories.

Our findings contribute to the literature by providing information on the prevalence of sedentary behaviours, media availability, commuting types to and from school, as well as the PA behaviours of European children stratified by age, gender and country; such information could be used to identify potential targets for public health promotion actions of young population groups. In addition, comparisons between weekdays and weekend days could be the key point in developing effective intervention strategies to reduce specific sedentary behaviours at weekdays or weekend days. Further internationally comparable studies are needed to confirm or contrast our findings. Concerted public health efforts are needed to decrease the amount of daily time spent in sedentary behaviours given its important health implications. Country-specific public health strategies could be implemented to encourage children to decrease specific sedentary behaviours and increase daily PA, with the purpose of meeting international recommendations for media time and improving overall lifestyle factors.

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Supplementary material

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References

1. Ekelund U, Brage S, Froberg K *et al.* (2006) TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS Med* **3**, e488.
2. Rey-Lopez JP, Vicente-Rodriguez G, Bueno G *et al.* (2011) Sedentary behaviors and obesity in children and adolescents. In *Epidemiology of Obesity in Children and Adolescents: Prevalence and Etiology*, pp. 367–376 [LA Moreno, I Pigeot and W Ahrens, editors]. New York: Springer Science.
3. Marshall SJ, Gorely T & Biddle SJ (2006) A descriptive epidemiology of screen-based media use in youth: a review and critique. *J Adolesc* **29**, 333–349.
4. American Academy of Pediatrics (2001) Children, adolescents, and television. *Pediatrics* **107**, 423–426.
5. Currie C, Nic Gabhainn S, Godeau E *et al.* (2008) *Inequalities in Young People's Health: Health Behaviour in School-aged Children (HBSC) Study; International Report from the 2005/2006 Survey. Health Policy for Children and Adolescents* no. 5. Copenhagen: WHO Regional Office for Europe.
6. Rey-Lopez JP, Vicente-Rodriguez G, Ortega FB *et al.* (2010) Sedentary patterns and media availability in European adolescents: the HELENA study. *Prev Med* **51**, 50–55.

7. Marshall SJ, Biddle SJ, Gorely T *et al.* (2004) Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord* **28**, 1238–1246.
8. Hinkley T, Salmon J, Okely AD *et al.* (2010) Correlates of sedentary behaviours in preschool children: a review. *Int J Behav Nutr Phys Act* **7**, 66.
9. Biddle SJ, Gorely T & Marshall SJ (2009) Is television viewing a suitable marker of sedentary behavior in young people? *Ann Behav Med* **38**, 147–153.
10. Owen CG, Nightingale CM, Rudnicka AR *et al.* (2012) Travel to school and physical activity levels in 9–10 year-old UK children of different ethnic origin; Child Heart and Health Study in England (CHASE). *PLoS One* **7**, e30932.
11. Burdette HL, Whitaker RC & Daniels SR (2004) Parental report of outdoor playtime as a measure of physical activity in preschool-aged children. *Arch Pediatr Adolesc Med* **158**, 353–357.
12. Chillon P, Ortega FB, Ruiz JR *et al.* (2011) Active commuting and physical activity in adolescents from Europe: results from the HELENA study. *Pediatr Exerc Sci* **23**, 207–217.
13. Hamilton MT, Hamilton DG & Zderic TW (2007) Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes* **56**, 2655–2667.
14. Hancox RJ & Poulton R (2006) Watching television is associated with childhood obesity: but is it clinically important? *Int J Obes (Lond)* **30**, 171–175.
15. Hallal PC, Wells JC, Reichert FF *et al.* (2006) Early determinants of physical activity in adolescence: prospective birth cohort study. *BMJ* **332**, 1002–1007.
16. Jago R, Wedderkopp N, Kristensen PL *et al.* (2008) Six-year change in youth physical activity and effect on fasting insulin and HOMA-IR. *Am J Prev Med* **35**, 554–560.
17. Ahrens W, Bammann K, de Henauw S *et al.* (2006) Understanding and preventing childhood obesity and related disorders – IDEFICS: a European multilevel epidemiological approach. *Nutr Metab Cardiovasc Dis* **16**, 302–308.
18. Bammann K, Peplies J, Sjöström M *et al.* (2006) Assessment of diet, physical activity and biological, social and environmental factors in a multi-centre European project on diet- and lifestyle-related disorders in children (IDEFICS). *J Public Health* **14**, 279–289.
19. Ahrens W, Bammann K, Siani A *et al.* (2011) The IDEFICS cohort: design, characteristics and participation in the baseline survey. *Int J Obes (Lond)* **35**, Suppl. 1, S3–S15.
20. United Nations Educational, Scientific and Cultural Organization (2010) ISCED: International Standard Classification of Education. http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx (accessed April 2012).
21. Hoyos Cillero I, Jago R & Sebire S (2011) Individual and social predictors of screen-viewing among Spanish school children. *Eur J Pediatr* **170**, 93–102.
22. Gorely T, Marshall SJ & Biddle SJ (2004) Couch kids: correlates of television viewing among youth. *Int J Behav Med* **11**, 152–163.
23. Fernandes RA, Junior IF, Cardoso JR *et al.* (2008) Association between regular participation in sports and leisure time behaviors in Brazilian adolescents: a cross-sectional study. *BMC Public Health* **8**, 329.
24. Singh GK, Yu SM, Siahpush M *et al.* (2008) High levels of physical inactivity and sedentary behaviors among US immigrant children and adolescents. *Arch Pediatr Adolesc Med* **162**, 756–763.
25. Fainardi V, Scarabello C, Brunella I *et al.* (2009) Sedentary lifestyle in active children admitted to a summer sport school. *Acta Biomed* **80**, 107–116.
26. He M, Harris S, Piche L *et al.* (2009) Understanding screen-related sedentary behavior and its contributing factors among school-aged children: a social-ecologic exploration. *Am J Health Promot* **23**, 299–308.
27. Hoyos Cillero I & Jago R (2010) Systematic review of correlates of screen-viewing among young children. *Prev Med* **51**, 3–10.
28. Burke V, Beilin LJ, Durkin K *et al.* (2006) Television, computer use, physical activity, diet and fatness in Australian adolescents. *Int J Pediatr Obes* **1**, 248–255.
29. Taveras EM, Field AE, Berkey CS *et al.* (2007) Longitudinal relationship between television viewing and leisure-time physical activity during adolescence. *Pediatrics* **119**, e314–e319.
30. Mota J, Gomes H, Almeida M *et al.* (2007) Active versus passive transportation to school-differences in screen time, socio-economic position and perceived environmental characteristics in adolescent girls. *Ann Hum Biol* **34**, 273–282.
31. Johnston LD, Delva J & O'Malley PM (2007) Sports participation and physical education in American secondary schools: current levels and racial/ethnic and socioeconomic disparities. *Am J Prev Med* **33**, 4 Suppl., S195–S208.
32. Sirard JR & Pate RR (2001) Physical activity assessment in children and adolescents. *Sports Med* **31**, 439–454.

Artículo III [Paper III]

Food Consumption and Screen-Based Sedentary Behaviors in European Adolescents. The HELENA Study

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ARTICLE

ONLINE FIRST

Food Consumption and Screen-Based Sedentary Behaviors in European Adolescents

The HELENA Study

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Objective: To examine the association between time spent on different sedentary behaviors and consumption of certain food and beverage groups in a sample of European adolescents.

Design: Data from the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-sectional Study.

Setting: Eight survey centers (Athens, Dortmund, Ghent, Lille, Rome, Stockholm, Vienna, and Zaragoza).

Participants: A total of 2202 participants (45.5% boys) aged 12½ to 17½ years.

Main Outcome Measures: Information on sedentary behaviors (weekdays and weekends) collected via a standardized self-reported questionnaire, including watching television, playing computer and video games, using the Internet for studying or recreation, and studying. Food and beverage consumption data of selected groups were obtained using 2 nonconsecutive 24-hour recalls.

Results: Boys reporting more than 4 h/d of watching television, playing computer games, and using the Internet for recreation were more likely to consume sweetened beverages (weekends) (odds ratio [OR], 1.83 [95% CI, 1.21-2.75]; 1.99 [1.31-3.01]; and 1.73 [1.03-2.91], respectively), and less likely to consume fruit (weekdays) (0.39 [0.21-0.72], 0.37 [0.18-0.77], and 0.39 [0.19-0.78], respectively) than those who spent less than 2 h/d. Girls spending more time per day watching television and playing computer or video games (weekdays) and playing computer games or surfing the Internet for recreation (weekends) were more likely to drink sweetened beverages (OR, 1.89 [95% CI, 1.21-2.94]; 1.57 [1.00-2.46]; 2.14 [1.16-3.97]; and 2.30 [1.24-4.28], respectively) and less likely to consume fruit (weekdays) (0.43 [0.23-0.80], 0.40 [0.19-0.83], 0.37 [0.14-0.94], and 0.42 [0.20-0.85], respectively) than those who spent less than 2 h/d.

Conclusion: Increased television viewing and computer and Internet use during adolescence is associated with higher odds of consumption of sweetened beverages and lower odds of fruit consumption.

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DECREASING LEVELS OF PHYSICAL activity, unhealthy dietary habits, and the adoption of sedentary behaviors in children and adolescents are some of the main contributors to the increasing incidence of chronic diseases.[1,2] Sedentary behaviors act as independent risk factors of chronic diseases[3,4] and are defined as behaviors characterized by little physical movement and low energy expenditure (eg, sitting, watching television [TV], and using the computer and the Internet).[5] A recent review[6] suggested that sedentary behaviors can independently and differently influence food consumption and dietary intake depending on the type of activity—that is, the screen-viewing behavior found to be associated with unhealthy food consumption.[7,8] In addition, engagement in sedentary behaviors has been associated with increased food consumption[9,10] and subsequently increased risk of obesity.[11] Television viewing is one of the most studied behaviors and is the dominant sedentary behavior during leisure time in adolescence.[12] It has been shown to coincide with excess energy intake,[13] increased meal frequency, and unhealthy eating patterns and food intake[14,15]—that is, consumption of energy-dense foods and beverages with lower nutritional value advertised on TV.[16-18] Increased TV viewing in adolescents has been associated with higher consumption of sweets,[17,19] savory snacks,[13-15] soda,[15] and soft drinks[17,19] and with lower consumption of fruit and vegetables.[17,19]

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Group Information: Members of the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Cross-sectional Study Group are listed at the end of the article.

A number of mechanisms have been proposed to explain the association between TV viewing and obesity including reduced time available for physical activity,[20] reduced resting metabolic rate,[21] and/or increased total energy intake.[13,22] Food and beverage advertisements on TV have been highlighted as having a powerful effect on the diet of young population groups.[16]

There are few studies examining the relationship using a comprehensive list of screen-time behaviors and the consumption of food and beverages. The aim of this study was to examine the association between time spent on different (mainly screen-based) sedentary behaviors and the consumption of specified food and beverages in a sample of European adolescents.

METHODS

STUDY DESIGN

The Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) Cross-sectional Study is a European Union–funded project on lifestyle and nutrition among adolescents from 10 European cities: Athens, Heraklion, Dortmund, Ghent, Lille, Pécs, Rome, Stockholm, Vienna, and Zaragoza.[23] The HELENA Cross-sectional Study inclusion criteria were age from 12½ to 17½ years, not participating simultaneously in another clinical trial, and free of any acute infection during the week before inclusion.[24] From October 1, 2006, through December 31, 2007, a total of 3528 adolescents (46.9% boys) aged 12½ to 17½ years were recruited. Participants from Heraklion (Greece) and Pécs (Hungary) (n=678) were not included in subsequent analyses owing to insufficient dietary intake data; there were too many adolescents who did not complete the second 24-hour recall (24HR). For the purposes of the current analysis, 2202 adolescents (45.5% boys) fulfilled the following inclusion criteria: to have completed at least 75% of the sedentary questionnaire (128 adolescents were excluded) and to have two 24HR available (1198 were excluded). Statistically significant differences in body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) and socioeconomic status (SES) ($P<.001$) were observed between included and excluded adolescents (data not shown). A significantly higher proportion of excluded adolescents were included in the overweight/obese category (26.5% vs 21.1%) and in the lowest SES (20.0% vs 9.4%). Participants were recruited at schools. To guarantee that the heterogeneity of social background of the population would be represented, schools were randomly selected after stratification on school zone or district. Up to 3 classes from 2 grades were selected per school. All the adolescents within selected classrooms were invited to participate. Only adolescents from classrooms where more than 70% of the individuals consented to participate were included. Detailed operational study procedures are described elsewhere.[23,24]

The study was approved by the research ethics committees of each city involved. Written informed consent was obtained from the adolescents' parents and the adolescents themselves.[25]

SOCIOECONOMIC STATUS

Collected demographic data included information on sex, age, and SES by means of a standardized self-reported questionnaire. A modified version of the Family Affluence Scale developed by Currie et al[26] was used as a proxy of SES status; the scale is based on the concept of material conditions in the family. The adolescents completed a questionnaire asking about the number of cars and computers at home, having access to Internet at home, and whether the adolescent had his or her own room. For the purposes of the HELENA study, the Family Affluence Scale was slightly modified by replacing the item on frequency of family holidays by Internet availability at home. Adolescents were scored from 0 (very low SES) to 8 (very high SES). Subsequently, categories were merged into 3 groups: a score of 0 to 2 was grouped as low SES, 3 to 5 as medium SES, and 6 to 8 as high SES.

ANTHROPOMETRIC MEASUREMENTS

The weight and height of the adolescents were measured by trained researchers in accordance with a standardized protocol.[27] Weight was recorded to the nearest 0.1 kg using an electronic scale (model 861; SECA), and height was recorded to the nearest 0.1 cm using a telescopic height-measuring instrument (model 225; SECA). Lightweight indoor clothing was worn, excluding shoes, long trousers, and sweaters. Body mass index and age- and sex-specific BMI *z* scores were calculated on the basis of standard definitions.[28] A physical examination was performed by a physician classifying the adolescents in 1 of the 5 stages of pubertal maturity defined by Tanner and Whitehouse.[29]

SEDENTARY BEHAVIORS

A self-reported sedentary behavior questionnaire[30] was administered during school hours. Adolescents reported the frequency of specified sedentary behaviors using predefined response categories separately for weekdays and weekends. Behaviors assessed included watching TV, playing computer games, playing video games, surfing the Internet for recreation, surfing the Internet for study purposes, and studying (nonschool time). The predefined response categories were (1) none, (2) less than a half hour, (3) at least a half hour but less than 1 hour, (4) at least 1 but less than 2 hours, (5) at least 2 but less than 3 hours, (6) at least 3 but not more than 4 hours, (7) more than 4 hours. Participants were thereafter classified into 3 groups for each behavior (<2 h/d; 2-4 h/d; and >4 h/d). Grouping was based on the American Academy of Pediatrics' recommendations for media time.[31]

The reliability (1-week test–retest) of the questionnaire was studied in 183 adolescents (79 boys and 104 girls; age range, 12½ to 17½ years). For most variables, the Cohen κ values using quadratic weights showed a good agreement (>0.7).[32]

DIETARY ASSESSMENT TOOL

Dietary consumption was assessed using the self-administered, computerized 24HR HELENA Dietary Assessment Tool based on the Young Adolescents' Nutrition Assessment software validated in European adolescents[33] (r_s=0.86-0.91) for all nutrient and energy intakes. The adolescents completed the 24HR twice (within 2 weeks) during school time; both times, trained staff including a dietitian were present. The HELENA Dietary Assessment Tool used special techniques to support and enhance respondents' memory, which allowed a more detailed description and quantification of the foods consumed.

The European Food Consumption Survey Method project indicated the repeated 24HR as the most suitable method to obtain population means and distributions.[34] Of the total 43 food groups, 8 were selected: (1) cakes, pies, and cookies; (2) savory snacks (ie, chips and crackers); (3) vegetables, excluding potatoes; (4) fruit; (5) fruit and vegetable juices; (6) sweetened beverages (carbonated, soft, and isotonic drinks); (7) milk; and (8) desserts and milk-based puddings. Selection of these food groups was based on their relationship to the health-related practices and to the prevalence of overweight and obesity.[35] Food and beverage consumption was expressed as grams and milliliters per day, respectively.

Table 1. Sample Characteristics of 2202 Participants

Variable	Boys (n = 1032)	Girls (n = 1170)	*P* Value[a]
Age, mean (95% CI), y	14.76 (14.68-14.83)	14.73 (14.66-14.80)	.57
Age categories, y, %			
12.50-13.99	31.1	32.9	.77
14.00-14.99	26.1	24.5	
15.00-15.99	22.9	22.9	
16.00-17.49	20.0	19.7	
Socioeconomic status, %[b]			
Low, 0-2	7.6	10.8	.03
Medium, 3-5	55.6	54.2	
High, 6-8	36.8	35.0	
Pubertal maturity, Tanner stage, %			
1-3	34.4	29.2	.04
4	41.0	44.6	
5	24.6	26.2	
Body mass index, mean (95% CI)[c]	21.28 (21.04-21.51)	21.19 (20.99-21.39)	.58
Optimal weight, %	76.0	81.3	.003
Overweight or obese, %	24.0	18.7	
Sedentary behaviors, mean (95% CI), min/d			
Television	110.27 (106.14-114.40)	108.76 (104.98-112.54)	.60
Computer	75.09 (70.50-79.68)	40.21 (36.85-43.56)	<.001
Video games	47.27 (43.38-51.15)	10.82 (9.19-12.45)	<.001
Internet	65.78 (61.48-70.08)	73.03 (68.87-77.19)	.02
Internet for study	25.18 (22.81-27.55)	29.07 (27.04-31.10)	.01
Study	61.23 (57.46-64.99)	77.83 (74.03-81.63)	<.001
Food group consumption			
Cakes, pies, and cookies, g/d			
Mean (95% CI)	57.80 (55.09-60.50)	51.39 (49.33-53.46)	<.001
Median (IQR)	46.8 (20.48-86.26)	44.6 (20.96-72.87)	
Savory snacks, g/d			
Mean (95% CI)	9.93 (8.80-11.05)	6.56 (5.86-7.25)	<.001
Median (IQR)	2.43 (1.56-4.53)	1.34 (0.71-3.16)	
Vegetables, g/d[d]			
Mean (95% CI)	88.32 (84.64-92.01)	91.45 (88.34-94.34)	.20
Median (IQR)	77.1 (42.33-120.23)	81.5 (51.95-121.49)	
Fruit, g/d			
Mean (95% CI)	125.05 (118.53-131.57)	128.85 (123.62-134.07)	.37
Median (IQR)	96.6 (39.52-176.74)	111.6 (53.83-182.73)	
Juices, mL/d[e]			
Mean (95% CI)	165.92 (155.65-176.19)	141.82 (134.10-149.54)	<.001
Median (IQR)	119.9 (39.76-239.50)	112.6 (35.76-208.95)	
Sweetened beverages, mL/d[f]			
Mean (95% CI)	376.37 (354.10-398.64)	215.09 (202.22-227.96)	<.001
Median (IQR)	279.3 (97.36-529.22)	140.1 (41.30-316.12)	
Milk, mL/d			
Mean (95% CI)	196.02 (183.67-208.37)	134.85 (126.05-142.34)	<.001
Median (IQR)	142.0 (40.65-281.37)	92.6 (25.48-199.31)	
Desserts and milk-based pudding, g/d			
Mean (95% CI)	10.60 (9.03-12.17)	13.48 (12.12-14.83)	<.05
Median (IQR)	1.4 (1.02-2.35)	2.3 (2.20-6.13)	

Abbreviation: IQR, interquartile range.
[a] Sex differences using Pearson χ^2 test for categorized variables and *t* test for continuous variables.
[b] Based on the Family Affluence Scale.
[c] Calculated as weight in kilograms divided by height in meters squared, with categories based on the cutoff values of Cole et al.[28]
[d] Vegetables exclude potatoes.
[e] Juices include fruit and vegetable juices.
[f] Beverages include carbonated, soft, and isotonic drinks.

STATISTICAL ANALYSIS

Predictive Analytics software, version 18.0 (SPSS Inc), was used to analyze the data. All analyses were sex-specific because of observed significant differences in both sedentary behaviors and food and beverage consumption patterns. According to the nature of the studied variables, the χ^2 test and the unpaired *t* test were used to compare sample characteristics stratified by sex. Differences in food consumption according to time spent in each sedentary behavior was analyzed by 1-way analysis of covariance, adjusted for SES, Tanner stage, BMI, and country. The consumption of the predefined food and beverage groups was dichotomized on the basis of their medians. Binary logistic regression analyses were performed to obtain odds ratios (ORs) and 95% CIs of food group consumption (above the median) by specified sedentary behaviors after adjusting for SES, Tanner stage, BMI, and center. The median cutoff selection was based on the lack of food group consumption recommendations for all countries. $P \leq .05$ was considered to be statistically significant.

RESULTS

Table 1 presents descriptive information on mean age, SES, pubertal stage, mean BMI, time spent in each sedentary behavior (minutes per day), and food group con-

Table 2. Analysis of Covariance of Food Group Consumption by Sedentary Behaviors Categories in 1032 Boys[a]

Variable	Consumption, Mean (SE)							
	Cakes, Pies, Cookies, g/d	Savory Snacks, g/d	Vegetables, g/d[b]	Fruit, g/d	Juices, mL/d[c]	Sweetened Beverages, mL/d[d]	Milk, mL/d	Desserts and Milk-Based Pudding, g/d
TV weekdays, h								
<2	58.04 (1.55)	7.97 (0.67)[e,f]	90.63 (2.25)	132.91 (4.03)[f]	170.13 (6.34)	340.05 (12.61)[e,f]	199.37 (6.90)	10.66 (0.97)
2-4	57.18 (2.58)	13.00 (1.11)[e]	84.85 (3.74)	115.45 (6.71)	157.71 (10.56)	433.15 (20.98)[e]	193.87 (11.48)	10.02 (1.61)
>4	56.17 (5.63)	17.09 (2.43)[f]	81.39 (8.15)	93.68 (14.61)[f]	159.01 (22.98)	509.05 (45.68)[f]	161.54 (25.00)	11.95 (3.51)
TV weekends, h								
<2	60.26 (1.97)	7.99 (0.86)[f]	90.26 (2.87)	135.29 (5.13)[f]	166.28 (8.07)	340.10 (16.15)[f]	206.82 (8.79)	9.39 (1.23)
2-4	57.23 (2.05)	9.38 (0.89)[g]	91.17 (2.97)	123.40 (5.32)	172.04 (8.38)	375.40 (16.76)[g]	194.48 (9.11)	11.93 (1.28)
>4	51.80 (3.24)	15.38 (1.41)[f,g]	78.88 (4.71)	105.87 (8.44)[f]	153.97 (13.29)	452.99 (26.58)[f,g]	171.08 (14.46)	9.79 (2.02)
Computer weekdays, h								
<2	57.87 (1.43)[f]	9.12 (0.62)	89.38 (2.08)	129.28 (3.72)[f]	168.49 (5.83)[f]	350.74 (11.60)[e,f]	200.40 (6.37)	10.31 (0.89)[f]
2-4	58.38 (3.45)	10.39 (1.49)	85.78 (5.00)	121.31 (8.96)	168.13 (14.04)	433.02 (27.94)[e,g]	184.09 (15.33)	8.66 (2.14)[g]
>4	54.43 (6.39)[f]	17.38 (2.76)	87.89 (9.27)	87.28 (16.59)[f]	100.96 (26.01)[f]	590.43 (51.75)[f,g]	152.64 (28.40)	21.45 (3.97)[f,g]
Computer weekends, h								
<2	58.49 (1.68)	8.71 (0.73)[f]	90.54 (2.39)	133.23 (4.38)	169.15 (6.87)	344.60 (13.58)[f]	204.89 (7.47)	10.80 (1.03)
2-4	57.29 (2.64)	8.95 (1.14)[g]	80.76 (3.76)	117.42 (6.89)	165.01 (10.80)	353.63 (21.40)[g]	185.05 (17.74)	7.83 (1.62)
>4	56.91 (3.43)	14.87 (1.48)[f,g]	93.38 (4.88)	116.68 (8.95)	156.91 (14.02)	514.37 (27.72)[f,g]	180.54 (15.24)	13.37 (2.10)
Video games weekdays, h								
<2	57.81 (1.36)	9.16 (0.59)[f]	89.75 (1.96)	128.97 (3.54)	167.14 (5.53)	355.39 (10.98)[e,f]	197.28 (6.02)	9.93 (0.78)
2-4	58.20 (5.32)	13.35 (2.32)	78.61 (7.71)	109.47 (13.89)	143.46 (21.71)	533.91 (43.11)[e]	187.04 (23.63)	14.67 (3.07)
>4	53.73 (8.05)	19.34 (3.50)[f]	76.54 (11.65)	91.31 (21.00)	183.36 (32.83)	641.79 (65.18)[f]	174.76 (35.72)	3.27 (4.65)
Video games weekends, h								
<2	58.17 (1.49)	8.82 (0.65)[f]	90.80 (2.16)	130.89 (3.89)	169.03 (6.09)	347.00 (12.14)[e,f]	198.94 (6.62)	9.93 (0.86)
2-4	47.81 (3.33)	10.05 (1.44)[g]	79.03 (4.82)	112.68 (8.67)	163.37 (13.56)	434.81 (27.07)[e]	189.08 (14.76)	11.62 (1.93)
>4	56.80 (4.76)	18.30 (2.06)[f,g]	89.64 (6.89)	111.55 (12.41)	143.64 (19.41)	523.48 (38.73)[f]	174.43 (21.13)	8.25 (2.75)
Internet weekdays, h[h]								
<2	57.84 (1.40)	9.25 (0.61)[f]	89.53 (2.03)	127.49 (3.61)[f]	166.13 (5.72)	358.29 (11.38)[f]	201.10 (6.21)	10.33 (0.87)
2-4	59.48 (4.11)	10.51 (1.79)	83.93 (5.95)	132.31 (10.62)[g]	168.14 (16.82)	419.69 (33.44)[g]	171.14 (18.27)	10.67 (2.55)
>4	52.62 (6.29)	17.75 (2.74)[f]	80.61 (9.10)	82.64 (16.24)[f,g]	156.35 (25.72)	593.55 (51.14)[f,g]	146.29 (27.94)	12.22 (3.91)
Internet weekends, h[h]								
<2	57.91 (1.52)	8.84 (0.66)[f]	90.40 (2.20)	128.42 (3.95)	167.03 (6.16)	344.29 (12.30)[e,f]	205.56 (6.73)	10.72 (0.95)
2-4	56.85 (3.06)	11.16 (1.33)	84.81 (4.44)	128.65 (7.97)	164.72 (12.45)	428.89 (24.85)[e]	174.07 (13.59)	7.88 (1.91)
>4	57.29 (4.63)	14.31 (2.01)[f]	84.33 (6.71)	104.05 (12.04)	155.80 (18.79)	518.51 (37.52)[f]	162.21 (20.52)	15.63 (2.89)
Internet for study weekdays, h								
<2	57.84 (1.31)	9.69 (0.57)	88.72 (1.90)	127.64 (3.43)	166.70 (5.37)	369.48 (10.74)	196.66 (5.85)	10.57 (0.82)
2-4	61.00 (8.25)	10.31 (3.60)	94.93 (11.93)	89.92 (21.54)	172.39 (33.73)	429.57 (67.44)	190.84 (36.74)	9.94 (5.16)
>4	45.57 (14.28)	5.48 (6.24)	49.34 (20.66)	121.52 (37.29)	117.19 (58.40)	366.26 (116.77)	114.90 (63.61)	18.12 (8.93)
Internet for study weekends, h								
<2	58.06 (1.32)	9.64 (0.58)	88.49 (1.91)	127.46 (3.45)	165.89 (5.40)	367.74 (10.80)	197.57 (5.86)	10.32 (0.82)
2-4	56.54 (7.39)	12.73 (3.23)	94.49 (10.69)	102.87 (19.31)	178.51 (30.20)	459.68 (60.48)	162.32 (32.80)	16.95 (4.61)
>4	34.46 (13.50)	10.88 (5.91)	66.35 (19.53)	99.41 (35.29)	167.96 (55.19)	467.05 (110.53)	133.92 (59.94)	19.09 (8.43)
Study weekdays, h								
<2	58.86 (1.39)	9.89 (0.61)	87.44 (2.02)	123.87 (3.60)	165.31 (5.68)	383.30 (11.31)[e]	194.03 (6.19)	10.80 (0.87)
2-4	52.21 (4.21)	8.38 (1.84)	97.13 (6.12)	138.34 (10.94)	184.04 (17.24)	282.43 (34.34)[e]	206.48 (18.81)	8.29 (2.64)
>4	44.82 (7.35)	9.00 (3.22)	95.25 (10.68)	153.47 (19.09)	149.88 (30.09)	294.06 (59.92)	225.60 (32.82)	12.53 (4.61)
Study weekends, h								
<2	58.96 (1.46)	9.85 (0.64)	87.10 (2.11)[f]	124.38 (3.78)	168.41 (5.95)	388.52 (11.89)	197.89 (6.49)	11.08 (0.91)
2-4	54.93 (3.28)	9.08 (1.44)	91.31 (4.76)	128.24 (8.52)	155.08 (13.43)	297.87 (26.84)	191.10 (14.66)	9.25 (2.06)
>4	45.15 (6.63)	11.09 (2.91)	110.91 (9.61)[f]	152.10 (17.21)	166.72 (27.12)	316.14 (54.20)	191.81 (29.60)	6.83 (4.15)

Abbreviation: TV, television.
[a] Covariates were socioeconomic status, Tanner stage, body mass index *z* score, and center.
[b] Vegetables exclude potatoes.
[c] Juices include fruit and vegetable juices.
[d] Sweetened beverages include carbonated, soft, and isotonic drinks.
[e] Significant differences between less than 2 hours and 2 to 4 hours ($P < .05$).
[f] Significant differences between less than 2 hours and greater than 4 hours ($P < .05$).
[g] Significant differences between 2 to 4 hours and greater than 4 hours ($P < .05$).
[h] Internet use for recreation.

sumption (grams or milliliters per day). Sex differences were observed in SES and Tanner stage ($P < .05$) and in all sedentary activities ($P < .001$ or $P < .05$), except for TV viewing ($P > .60$). A high proportion of boys and girls (76.0% and 81.3%, respectively) were categorized into the optimal weight status (by BMI). Also, food group consumption differed by sex in all food groups ($P < .05$), except for vegetables and fruits ($P = .20$ and $P = .37$, respectively). In general, mean consumptions were higher for boys than girls with the exception of fruit, vegetables, and desserts and milk-based puddings (which were higher in girls). **Table 2** and **Table 3** present the analysis of covariance results (means and SEs) for food group consumption by sedentary behavior categories for boys and girls, respectively. **Table 4** and **Table 5** present the results of the logistic regression analysis by sedentary behavior and food group consumption for boys and girls, respectively.

Table 3. Analysis of Covariance of Food Group Consumption by Sedentary Behaviors Categories in 1170 Girls[a]

Variable	Consumption, Mean (SE)							
	Cakes, Pies, Cookies, g/d	Savory Snacks, g/d	Vegetables, g/d[b]	Fruit, g/d	Juices, mL/d[c]	Sweetened Beverages, mL/d[d]	Milk, mL/d	Desserts and Milk-Based Pudding, g/d
TV weekdays, h								
<2	52.42 (1.26)	6.18 (0.43)[e]	94.35 (1.92)	135.88 (3.21)[e,f]	136.71 (4.70)	197.91 (7.53)[e,f]	135.10 (4.74)	12.91 (0.83)
2-4	48.83 (2.06)	6.75 (0.70)[g]	87.66 (3.14)	120.74 (5.25)[f,g]	151.10 (7.68)	239.04 (12.31)[f,g]	132.51 (7.74)	13.83 (1.36)
>4	53.91 (4.78)	11.31 (1.63)[e,g]	83.64 (7.31)	88.03 (12.21)[e,g]	159.24 (17.87)	323.80 (26.65)[e,g]	114.89 (18.01)	17.77 (3.16)
TV weekends, h								
<2	52.68 (1.60)	6.09 (0.54)[e]	96.98 (2.43)[f]	137.77 (4.07)[e]	142.42 (5.95)	196.45 (9.42)[e]	140.32 (5.99)	13.19 (1.06)
2-4	50.84 (1.63)	6.03 (0.55)[g]	87.34 (2.47)[f]	127.43 (4.14)	133.78 (6.06)[g]	215.16 (9.60)[g]	128.49 (6.09)	13.07 (1.08)
>4	49.92 (2.78)	9.69 (0.95)[e,g]	90.64 (4.23)	109.42 (7.08)[e]	163.64 (10.36)[g]	262.25 (16.40)[e,g]	126.47 (10.4)	15.13 (1.84)
Computer weekdays, h								
<2	51.62 (1.09)	6.44 (0.37)	93.05 (1.66)	131.20 (2.79)	141.04 (4.07)	208.46 (6.56)[f]	136.56 (4.08)	13.27 (0.72)
2-4	49.95 (4.12)	8.72 (1.41)	82.80 (6.29)	113.47 (10.57)	132.63 (15.38)	297.55 (2.48)[f]	103.66 (15.45)	13.01 (2.72)
>4	53.43 (7.76)	6.58 (2.66)	70.68 (11.86)	96.49 (19.90)	201.34 (28.98)	275.21 (46.75)	118.24 (29.09)	24.04 (5.13)
Computer weekends, h								
<2	52.26 (1.15)	6.31 (0.39)	92.53 (1.76)	1321.8 (2.94)	143.19 (4.29)	205.54 (6.93)[f]	137.16 (4.30)	13.08 (0.76)[e]
2-4	48.12 (3.01)	7.59 (1.03)	92.53 (4.60)	113.96 (7.71)	118.87 (11.23)	257.34 (18.17)[f]	126.46 (11.28)	11.93 (1.99)[g]
>4	49.15 (4.42)	8.28 (1.51)	82.24 (6.76)	111.75 (11.3)	163.18 (16.49)	270.41 (26.68)	102.94 (16.6)	21.60 (2.92)[f,g]
Video games weekdays, h								
<2	51.25 (1.04)	6.56 (0.36)	92.19 (1.60)	129.72 (2.68)	141.36 (3.91)	214.11 (6.33)	134.20 (3.93)	13.35 (0.69)
2-4	67.19 (9.88)	4.29 (3.38)	84.49 (15.17)	112.09 (25.45)	124.38 (37.05)	329.71 (60.01)	86.81 (37.29)	12.79 (6.56)
>4	30.78 (25.02)	0.66 (8.56)	63.56 (38.39)	64.32 (64.43)	151.30 (93.79)	229.71 (151.91)	166.83 (94.40)	27.52 (16.60)
Video games weekends, h								
<2	51.51 (1.06)	6.60 (0.36)	91.86 (1.63)	130.24 (2.73)	141.53 (3.98)	212.31 (6.44)	135.09 (3.99)	13.35 (0.70)
2-4	47.75 (5.70)	6.73 (1.94)	96.65 (8.71)	120.63 (14.63)	135.02 (21.29)	278.87 (34.49)	115.83 (21.40)	13.90 (3.77)
>4	64.55 (11.25)	3.15 (3.84)	86.11 (17.22)	97.99 (28.92)	157.99 (42.08)	288.33 (68.16)	89.05 (42.30)	16.88 (7.45)
Internet weekdays, h[h]								
<2	51.92 (1.15)	6.20 (0.40)	94.11 (1.76)	131.60 (2.95)[e]	143.01 (4.32)	204.68 (6.96)[f]	139.50 (4.34)[f]	12.89 (0.76)
2-4	50.71 (2.83)	8.17 (0.97)	84.55 (4.32)	127.29 (7.22)	130.89 (10.58)	259.22 (17.03)[f]	103.46 (10.61)[f]	14.04 (1.85)
>4	47.43 (5.05)	9.20 (1.73)	77.59 (7.70)	95.92 (12.89)[e]	147.81 (18.88)	278.68 (30.39)	116.70 (18.94)	18.99 (3.30)
Internet weekends, h[h]								
<2	52.53 (1.27)	5.77 (0.43)[e,f]	93.08 (1.93)	133.74 (3.25)	144.46 (4.74)	200.59 (7.63)[e]	142.30 (4.76)[f]	13.18 (0.84)[e]
2-4	49.23 (2.32)	8.03 (0.79)[f]	91.01 (3.53)	123.93 (5.94)	129.44 (8.67)	231.10 (13.95)[g]	116.31 (8.71)[f]	11.42 (1.53)[g]
>4	50.63 (3.25)	9.14 (1.11)[e]	84.04 (4.95)	113.42 (8.33)	147.14 (12.15)	284.64 (15.53)[e,g]	113.53 (12.20)	18.92 (2.14)[e,g]
Internet for study weekdays, h								
<2	51.21 (1.05)	6.55 (0.36)	91.58 (1.61)	130.08 (2.70)	140.73 (3.93)	215.37 (6.39)	133.59 (3.97)	13.34 (0.70)
2-4	64.24 (6.32)	6.79 (2.17)	106.98 (9.68)	127.71 (16.24)	164.33 (23.61)	200.30 (38.38)	143.82 (23.84)	13.52 (4.19)
>4	41.94 (17.73)	4.18 (6.08)	99.71 (27.16)	72.52 (45.57)	75.21 (66.25)	196.97 (107.68)	120.59 (68.89)	25.69 (11.75)
Internet for study weekends, h								
<2	51.45 (1.06)	6.57 (0.36)	91.99 (1.63)	130.12 (2.73)	141.61 (3.98)	215.00 (6.44)	133.35 (4.01)	13.07 (0.69)
2-4	52.40 (5.53)	7.01 (1.90)	91.93 (8.49)	130.54 (14.24)	141.92 (20.70)	226.76 (33.56)	132.94 (20.87)	17.03 (3.62)
>4	92.67 (17.71)	3.44 (6.09)	106.23 (27.20)	74.36 (45.64)	58.77 (66.36)	114.17 (107.56)	196.92 (66.88)	39.64 (11.61)
Study weekdays, h								
<2	50.74 (1.17)	6.55 (0.40)	90.78 (1.79)	126.65 (2.99)[e]	137.90 (4.37)	218.65 (7.10)	134.64 (4.43)	13.57 (0.78)
2-4	54.47 (2.77)	5.76 (0.95)	94.60 (4.24)	132.96 (7.07)[g]	153.27 (10.35)	195.23 (16.81)	127.66 (10.48)	12.58 (1.84)
>4	56.65 (5.11)	7.89 (1.75)	103.96 (7.83)	164.18 (13.05)[e,g]	169.60 (19.11)	216.31 (31.04)	146.70 (19.35)	11.75 (3.40)
Study weekends, h								
<2	50.73 (1.23)	6.90 (0.42)	90.39 (1.88)	125.10 (3.13)[f]	139.01 (4.61)	223.06 (7.44)	134.21 (4.65)	13.61 (0.81)
2-4	52.73 (2.28)	5.21 (0.78)	93.69 (3.47)	141.23 (5.80)[f]	144.82 (8.53)	188.28 (13.77)	134.46 (8.60)	12.00 (1.51)
>4	59.59 (4.61)	6.61 (1.58)	104.92 (7.04)	143.91 (11.76)	171.18 (17.30)	210.48 (27.92)	130.58 (17.43)	14.54 (3.05)

Abbreviation: TV, television.
[a] Covariates were socioeconomic status, Tanner stage, body mass index *z* score, and center.
[b] Vegetables exclude potatoes.
[c] Juices include fruit and vegetable juices.
[d] Sweetened beverages include carbonated, soft, and isotonic drinks.
[e] Significant differences between less than 2 hours and greater than 4 hours ($P < .05$).
[f] Significant differences between less than 2 hours and 2 to 4 hours ($P < .05$).
[g] Significant differences between 2 to 4 hours and greater than 4 hours ($P < .05$).
[h] Internet use for recreation.

Boys who spent more time watching TV, using computers, playing video games, or using the Internet for recreation during weekdays and weekends were more likely to consume more savory snacks and sweetened beverages (Table 2). During weekdays and weekends, adolescents who watched TV more than 4 h/d were 1.96 (95% CI, 1.06-3.64) and 1.83 (1.21-2.75) times more likely to drink sweetened beverages above the median amount, respectively (Table 4). In contrast, boys studying less than 2 h/d during weekdays and weekends were less likely to drink sweetened beverages than those who studied from 2 to 4 h/d (Table 2). The odds of drinking sweetened beverages decreased when the adolescents reported from 2 to 4 hours of study during weekdays (OR,

Table 4. Binary Logistic Regression Analysis Predicting Food Group Consumption Above the Median Related to Sedentary Behaviors in Boys[a]

Variable	Consumption Above the Median, OR (95% CI)							
	Cakes, Pies, Cookies	Savory Snacks	Vegetables[b]	Fruits	Juices[c]	Sweetened Beverages[d]	Milk	Desserts and Milk-Based Pudding
TV weekdays, h								
2-4	1.10 (0.80-1.52)	1.37 (1.01-1.86)	0.81 (0.60-1.10)	0.68 (0.51-0.92)	0.80 (0.59-1.08)	1.75 (1.27-2.42)	0.94 (0.68-1.29)	0.89 (0.64-1.23)
>4	0.85 (0.45-1.59)	1.64 (0.97-2.98)	0.63 (0.35-1.15)	0.39 (0.21-0.72)	0.72 (0.40-1.30)	1.96 (1.06-3.64)	0.83 (0.44-1.54)	0.89 (0.47-1.68)
TV weekends, h								
2-4	0.92 (0.68-1.24)	1.12 (0.84-1.50)	1.05 (0.79-1.41)	0.87 (0.66-1.16)	1.13 (0.84-1.50)	1.32 (0.98-1.79)	0.90 (0.66-1.22)	1.26 (0.93-1.71)
>4	0.80 (0.54-1.20)	1.49 (1.01-2.19)	0.76 (0.52-1.12)	0.49 (0.33-0.72)	0.75 (0.51-1.10)	1.83 (1.21-2.75)	0.70 (0.47-1.04)	0.93 (0.62-1.41)
Computer weekdays, h								
2-4	0.92 (0.62-1.37)	0.93 (0.64-1.36)	0.75 (0.51-1.10)	0.72 (0.50-1.04)	0.80 (0.55-1.16)	1.61 (1.08-2.40)	0.74 (0.50-1.10)	1.05 (0.70-1.57)
>4	0.80 (0.39-1.64)	0.92 (0.47-1.79)	0.87 (0.45-1.69)	0.37 (0.18-0.77)	0.38 (0.19-0.78)	2.03 (0.99-4.15)	0.80 (0.40-1.62)	1.36 (0.68-2.71)
Computer weekends, h								
2-4	0.96 (0.69-1.34)	1.17 (0.86-1.62)	0.75 (0.54-1.03)	0.72 (0.53-0.98)	0.98 (0.71-1.34)	1.09 (0.78-1.51)	1.02 (0.73-1.42)	0.90 (0.64-1.26)
>4	0.69 (0.46-1.04)	1.01 (0.68-1.48)	1.06 (0.72-1.55)	0.66 (0.46-0.97)	0.68 (0.46-0.99)	1.99 (1.31-3.01)	0.86 (0.58-1.28)	1.13 (0.75-1.70)
Video games weekdays, h								
2-4	1.00 (0.57-1.78)	1.23 (0.70-2.13)	0.63 (0.36-1.11)	0.45 (0.25-0.80)	0.69 (0.39-1.20)	1.75 (0.96-3.20)	0.93 (0.52-1.65)	1.21 (0.66-2.22)
>4	0.44 (0.17-1.11)	3.10 (1.24-7.75)	0.64 (0.28-1.50)	0.45 (0.19-1.05)	0.59 (0.26-1.36)	7.84 (2.55-24.10)	0.94 (0.40-2.22)	0.47 (0.19-1.18)
Video games weekends, h								
2-4	0.96 (0.66-1.41)	1.14 (0.79-1.65)	0.69 (0.48-1.01)	0.57 (0.40-0.83)	0.81 (0.56-1.18)	1.35 (0.91-1.99)	0.89 (0.60-1.30)	1.02 (0.69-1.52)
>4	0.79 (0.47-1.33)	1.84 (1.09-3.09)	1.07 (0.65-1.77)	0.61 (0.37-1.00)	0.70 (0.42-1.15)	3.04 (1.72-5.39)	0.85 (0.50-1.44)	0.91 (0.52-1.56)
Internet weekdays, h[e]								
2-4	1.26 (0.79-2.01)	1.05 (0.68-1.63)	0.71 (0.45-1.11)	1.09 (0.71-1.67)	1.34 (0.86-2.07)	1.24 (0.79-1.96)	0.71 (0.45-1.13)	0.78 (0.49-1.25)
>4	0.92 (0.46-1.83)	1.27 (0.66-2.44)	0.92 (0.48-1.77)	0.39 (0.19-0.78)	0.71 (0.37-1.36)	2.26 (1.11-4.60)	0.47 (0.23-0.97)	1.23 (0.62-2.42)
Internet weekends, h[e]								
2-4	1.03 (0.71-1.49)	1.20 (0.84-1.70)	0.80 (0.56-1.13)	0.97 (0.69-1.36)	0.95 (0.68-1.34)	1.58 (1.10-2.26)	0.69 (0.48-0.99)	0.88 (0.61-1.27)
>4	1.13 (0.67-1.89)	0.97 (0.59-1.59)	0.88 (0.54-1.44)	0.59 (0.36-0.97)	0.88 (0.54-1.43)	1.73 (1.03-2.91)	0.60 (0.35-1.01)	1.18 (0.70-1.99)
Internet for study weekdays, h								
2-4	1.36 (0.63-2.98)	1.13 (0.53-2.41)	0.66 (0.31-1.44)	0.60 (0.28-1.28)	0.74 (0.35-1.55)	2.13 (0.94-4.85)	0.58 (0.26-1.30)	1.99 (0.88-4.55)
>4	0.46 (0.11-1.98)	0.87 (0.22-3.55)	0.88 (0.23-3.39)	0.31 (0.06-1.52)	0.51 (0.13-1.98)	1.60 (0.38-6.66)	0.60 (0.15-2.40)	0.99 (0.21-4.60)
Internet for study weekends, h								
2-4	0.92 (0.38-2.24)	1.54 (0.66-3.60)	0.88 (0.38-2.02)	0.50 (0.21-1.19)	0.99 (0.43-2.31)	1.67 (0.68-4.09)	0.84 (0.34-2.04)	0.98 (0.39-2.47)
>4	0.73 (1.16-3.41)	0.69 (0.15-3.15)	0.31 (0.06-1.63)	0.54 (0.12-2.37)	0.24 (0.05-1.24)	1.85 (0.43-8.04)	0.55 (0.12-2.48)	2.43 (0.46-12.88)
Study weekdays, h								
2-4	0.70 (0.44-1.12)	0.65 (0.41-1.03)	1.24 (0.78-1.95)	1.69 (1.07-2.66)	1.49 (0.94-2.34)	0.51 (0.31-0.84)	1.45 (0.90-2.34)	0.78 (0.48-1.28)
>4	0.42 (0.18-0.97)	0.74 (0.34-1.62)	1.42 (0.66-3.04)	1.18 (0.56-2.48)	0.97 (0.46-2.06)	0.65 (0.29-1.47)	1.28 (0.57-2.88)	1.01 (0.44-2.31)
Study weekends, h								
2-4	0.97 (0.66-1.41)	0.76 (0.53-1.10)	1.14 (0.79-1.64)	1.30 (0.90-1.87)	0.86 (0.60-1.24)	0.57 (0.38-0.84)	1.22 (0.83-1.78)	0.78 (0.52-1.15)
>4	0.50 (0.24-1.03)	0.78 (0.39-1.56)	2.45 (1.17-5.16)	1.44 (0.72-2.85)	0.84 (0.42-1.67)	0.66 (0.32-1.36)	0.87 (0.43-1.78)	0.71 (0.34-1.50)

Abbreviations: OR, odds ratio; TV, television.
[a] The first category (<2 hours) was the reference category. Covariates were socioeconomic status, Tanner stage, body mass index *z* score, and center.
[b] Vegetables exclude potatoes.
[c] Juices include fruit and vegetable juices.
[d] Sweetened beverages include carbonated, soft, and isotonic drinks.
[e] Internet use for recreation.

0.51 [95% CI, 0.31-0.84]) and weekends (0.57 [0.38-0.84]) (Table 4). In addition, boys spending more than 4 h/d watching TV during weekdays and weekends and playing computer games or using the Internet for recreation during weekdays, were less likely to consume fruits than those who spent less than 2 h/d (Table 2). The odds of consuming fruit decreased with increasing time spent watching TV, playing computer or video games, or using the Internet for recreation. For instance, those who reported spending from 2 to 4 h/d playing video games were less likely to consume fruit during weekdays (OR, 0.45 [95% CI, 0.25-0.80]) and weekends (0.57 [0.40-0.83]) than those who reported spending less than 2 h/d. Also, the odds of consuming fruit increased with increasing study time (Table 4).

Girls spending more than 4 h/d watching TV or using the Internet for recreation were more likely to consume savory snacks and sweetened beverages than those who spent less than 2 h/d (Table 3). Girls who reported spending more time watching TV, playing computer or video games, or using the Internet for recreation had increased odds of drinking sweetened beverages and de-

Table 5. Binary Logistic Regression Analysis Predicting Food Group Consumption Above the Median Related to Sedentary Behaviors in Girls[a]

Variable	Consumption Above the Median, OR (95% CI)							
	Cakes, Pies, Cookies	Savory Snacks	Vegetables[b]	Fruits	Juices[c]	Sweetened Beverages[d]	Milk	Desserts and Milk-Based Pudding
TV weekdays, h								
2-4	1.08 (0.78-1.48)	0.86 (0.58-1.27)	0.81 (0.59-1.11)	0.68 (0.49-0.90)	0.80 (0.59-1.08)	1.83 (1.28-2.62)	0.91 (0.66-1.26)	0.97 (0.65-1.44)
>4	0.87 (0.47-1.63)	1.29 (0.58-2.91)	0.64 (0.35-1.18)	0.43 (0.23-0.80)	0.77 (0.43-1.37)	1.76 (0.90-3.45)	0.82 (0.44-1.54)	1.16 (0.54-2.50)
TV weekends, h								
2-4	0.87 (0.64-1.18)	0.94 (0.64-1.35)	1.09 (0.82-1.47)	0.77 (0.59-1.03)	1.00 (0.75-1.33)	1.35 (0.99-1.86)	0.92 (0.68-1.26)	1.36 (0.94-1.97)
>4	0.73 (0.49-1.09)	1.01 (0.61-1.68)	0.85 (0.58-1.26)	0.50 (0.34-0.74)	0.69 (0.47-1.01)	1.89 (1.21-2.94)	0.76 (0.51-1.14)	0.98 (0.57-1.67)
Computer weekdays, h								
2-4	0.93 (0.63-1.39)	1.01 (0.62-1.66)	0.77 (0.52-1.13)	0.69 (0.47-1.00)	0.83 (0.56-1.21)	1.28 (0.84-1.97)	0.74 (0.50-1.09)	0.84 (0.50-1.41)
>4	0.86 (0.42-1.75)	1.14 (0.47-2.74)	0.67 (0.33-1.34)	0.40 (0.19-0.83)	0.47 (0.24-0.92)	1.88 (0.82-4.31)	0.73 (0.37-1.47)	1.79 (0.84-1.41)
Computer weekends, h								
2-4	0.90 (0.65-1.26)	1.29 (0.85-1.97)	0.79 (0.58-1.01)	0.73 (0.53-0.99)	0.88 (0.64-1.21)	1.02 (0.72-1.44)	1.11 (0.79-1.57)	0.67 (0.43-1.05)
>4	0.71 (0.47-1.07)	1.06 (0.65-1.75)	1.06 (0.72-1.55)	0.69 (0.47-1.02)	0.70 (0.48-1.04)	1.57 (1.00-2.46)	0.84 (0.56-1.27)	1.11 (0.68-1.82)
Video games weekdays, h								
2-4	0.94 (0.53-1.66)	0.68 (0.35-1.34)	0.70 (0.39-1.25)	0.57 (0.32-1.01)	0.67 (0.39-1.17)	1.74 (0.88-3.44)	0.62 (0.35-1.11)	1.56 (0.80-3.05)
>4	0.50 (0.20-1.25)	1.82 (0.52-6.39)	0.54 (0.22-1.31)	0.37 (0.14-0.94)	0.69 (0.31-1.56)	7.26 (1.65-31.89)	0.62 (0.26-1.47)	0.23 (0.03-1.73)
Video games weekends, h								
2-4	0.90 (0.61-1.32)	0.89 (0.56-1.40)	0.79 (0.54-1.15)	0.61 (0.42-0.88)	0.77 (0.53-1.11)	1.35 (0.89-2.03)	1.04 (0.70-1.55)	1.32 (0.82-2.12)
>4	0.78 (0.46-1.31)	1.03 (0.53-1.99)	1.04 (0.63-1.73)	0.64 (0.38-1.06)	0.69 (0.42-1.14)	2.14 (1.16-3.97)	0.77 (0.45-1.30)	0.71 (0.32-1.54)
Internet weekdays, h[e]								
2-4	1.32 (0.83-2.12)	1.20 (0.66-2.19)	0.72 (0.46-1.13)	1.05 (0.68-1.61)	1.21 (0.78-1.87)	1.45 (0.86-2.43)	0.86 (0.54-1.37)	1.16 (0.67-2.00)
>4	0.98 (0.49-1.96)	1.07 (0.45-2.55)	0.82 (0.42-1.60)	0.42 (0.20-0.85)	0.91 (0.48-1.72)	2.38 (1.01-5.63)	0.57 (0.29-1.15)	1.13 (0.51-2.54)
Internet weekends, h[e]								
2-4	1.04 (0.72-1.50)	0.98 (0.63-1.51)	0.78 (0.55-1.11)	0.97 (0.69-1.36)	0.82 (0.58-1.15)	1.57 (1.07-2.32)	0.67 (0.46-0.97)	0.79 (0.49-1.28)
>4	1.13 (0.67-1.89)	0.97 (0.51-1.82)	0.86 (0.52-1.41)	0.65 (0.40-1.07)	0.95 (0.58-1.55)	2.30 (1.24-4.28)	0.69 (0.41-1.15)	1.57 (0.89-2.76)
Internet for study weekdays, h								
2-4	0.87 (0.36-2.13)	1.05 (0.36-3.00)	1.05 (0.45-2.44)	0.50 (0.20-1.23)	1.01 (0.43-2.34)	1.27 (0.50-3.23)	0.59 (0.24-1.42)	1.19 (0.39-3.62)
>4	0.69 (0.15-3.21)	NA	NA	0.63 (0.14-2.77)	0.39 (0.09-1.70)	0.74 (0.17-3.21)	1.03 (0.18-5.80)	1.99 (0.36-11.11)
Internet for study weekends, h								
2-4	1.28 (0.59-2.81)	0.95 (0.37-2.43)	0.78 (0.36-1.71)	0.53 (0.24-1.19)	0.73 (0.34-1.53)	1.44 (0.61-3.42)	0.52 (0.24-1.14)	1.57 (0.61-4.06)
>4	0.43 (0.10-1.86)	2.03 (0.23-17.75)	0.36 (0.07-1.78)	0.37 (0.08-1.81)	0.72 (0.19-2.76)	1.00 (0.25-4.08)	1.73 (0.33-9.00)	2.63 (0.48-14.48)
Study weekdays, h								
2-4	0.70 (0.44-1.12)	0.83 (0.48-1.42)	1.14 (0.72-1.79)	1.74 (1.11-2.73)	1.71 (1.08-2.72)	0.52 (0.33-0.84)	1.30 (0.78-2.17)	0.61 (0.31-1.21)
>4	0.47 (0.21-1.08)	1.47 (0.53-4.10)	1.67 (0.78-3.59)	1.23 (0.59-2.59)	1.64 (0.75-3.55)	0.60 (0.28-1.31)	1.59 (0.65-3.90)	1.07 (0.39-2.91)
Study weekends, h								
2-4	0.94 (0.64-1.37)	0.80 (0.51-1.25)	1.16 (0.80-1.67)	1.25 (0.87-1.79)	0.89 (0.62-1.29)	0.54 (0.37-0.79)	1.12 (0.75-1.66)	0.87 (0.53-1.42)
>4	0.53 (0.26-1.09)	1.33 (0.52-3.40)	2.53 (1.22-5.24)	1.52 (0.77-3.00)	1.24 (0.62-2.47)	0.52 (0.26-1.05)	1.17 (0.55-2.51)	0.58 (0.20-1.71)

Abbreviations: NA, not available (impossible to calculate the odds ratio [OR] [95% CI] because the group size is too small); TV, television.
[a] The first category (<2 hours) was the reference category. Covariates were socioeconomic status, Tanner stage, body mass index *z* score, and center.
[b] Vegetables exclude potatoes.
[c] Juices include fruit and vegetable juices.
[d] Sweetened beverages include carbonated, soft, and isotonic drinks.
[e] Internet use for recreation.

creased odds of consuming fruits (Tables 3 and 5). In contrast, girls who reported studying from 2 to 4 h/d during weekends were less likely to drink sweetened beverages than those spending less than 2 h/d (Table 5). The odds of consuming fruits decreased with increasing time spent watching TV, playing computer games, or using the Internet for recreation (Table 5).

COMMENT

To our knowledge, this is the first study to examine the relationship between sedentary activities and the consumption of food and beverages using a comprehensive list of sedentary activities in adolescents. The increased

prevalence of electronic game playing (computer and video games) and non–school-related computer access[12] promoted the examination of the effect of this medium on several lifestyles, including food consumption. Previous studies addressing similar associations have often focused on a single sedentary behavior, mainly TV viewing, and others have focused only on specific food groups—that is, only soft drinks[36] or fruits and vegetables.[15] Television viewing and Internet use were the predominant sedentary behaviors in this population of European adolescents. The study findings suggest that adolescents who spent more time in sedentary activities, mainly watching TV, playing computer games, and using the Internet for leisure time, had a higher consumption of sweetened beverages and savory snacks and a lower consumption of fruits.

Home environment and parental influence have an important effect on the development of health-related behaviors.[37,38] For instance, consumption of unhealthy foods is more frequent during afterschool time, and it is related to unsupervised food consumption at home and the availability of unhealthy snacks. As expected, adolescents spending a significant amount of time in sedentary behaviors and exceeding the 2-hour recommendation were more likely to consume more sweetened beverages. It is likely that individuals whose parents allow them to spend time in sedentary activities might also be those allowed to snack and drink sweetened beverages. Grim et al[39] also showed that, in children aged 8 to 13 years, watching TV 3½ hours or more per day was related to higher odds of consumption of soft drinks than watching less TV per day. Several studies in young age groups observed high TV viewing and computer use to be associated with an increased consumption of advertised foods (soft drinks and snacks).[16] Adolescents in this study who reported more TV viewing and computer and video game use were less likely to consume fruits, which agrees with the findings of other studies.[16-18] These trends could possibly result from the displacement of fruit by other frequently advertised foods. Screen viewing time activities, in particular TV viewing, have been associated with unhealthy eating practices[8,40,41] and may partly explain the relationship between sedentary behaviors and obesity.[42] During the past few years, sugar-sweetened beverage consumption emerged as the dietary factor most consistently associated with increasing weight status or fatness and subsequently with the obesity epidemic.[37,43,44] Parallel increases in the consumption of sweetened beverages and the prevalence of obesity suggest a causal relation between them.[8] This has resulted in the current recommendation of the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition to use water as the main source of fluids for children instead of sugar-sweetened beverages to avoid the development of obesity in children.[45]

It is possible that low levels of physical activity combined with cultural and/or parental attitudes toward watching TV, playing computer or video games, using the Internet for studying, and the availability of the Internet in the home might influence the amount of time adolescents spend in each sedentary behavior and their consumption of food. Identification of sedentary behaviors that increased the risk of obesity through its influence on energy balance is important in providing evidence of causality.

Several limitations of the present study should be addressed. First, no causal conclusions can be drawn because of the cross-sectional design of the study. Second, sedentary behaviors and food consumption data were based on self-reported questionnaires, and therefore a social bias must be considered. However, both questionnaires have been tested and validated, indicating acceptable accuracy.[32,33] Evaluation of the home environment as well as parental attitudes and practices have not been addressed in this study. Therefore, further studies are needed to assess their possible interactions with the observed findings. Generalizability of the findings is limited to the study population because the HELENA participants are not representative of the European population. Moreover, the differences between countries could be the result of different laws on advertising foods or special protection for children, among others.[46] For instance, Sweden controls the advertising of food to its young population, unlike other European countries.

Strengths of the study include a large and culturally diverse sample of European adolescents. The highly standardized procedures used within the HELENA study are also an important strength. In addition, the use of multiple 24-hour dietary recall interviews in estimating dietary behaviors combined with sedentary behaviors on weekdays and weekends is a relatively new approach because food frequency questionnaires were previously used.

In conclusion, excessive TV viewing and computer and Internet use during adolescence is associated with higher consumption of sweetened beverages and lower consumption of fruits. These adolescents could be at a greater risk of overweight and obesity and of poorer nutritional status. Efforts to promote healthy foods and to replace adolescents' sedentary time with alternative activities appear to offer a way forward in the short term. In addition, the role of the parents in creating a healthy eating environment should be considered in public strategies.

The increased consumption of sweetened beverages associated with video game and Internet use is a novel finding and essential in gaining a better insight into the determinants of obesity.[47] Given the fact that computer game playing is rapidly becoming the leisure-time activity of choice for a large group of children and adolescents, a better understanding of the influence that this activity has on dietary intake is important. This study adds evidence to support the American Academy of Pediatrics' recommendation for limiting media time to no more than 1 to 2 h/d for populations of this age.

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REFERENCES

1. Rey-Lopez JP, Vicente-Rodriguez G, Bueno G, Moreno LA. Sedentary behaviors and obesity in children and adolescents. In: Moreno LA, Pigeot I, Ahrens W, eds. *Epidemiology of Obesity in Children and Adolescents: Prevalence and Etiology*. New York, NY: Springer Science; 2011:367-376.
2. World Health Organization. World Health Assembly 57.17: global strategy on diet and physical activity. http://apps.who.int/gb/ebwha/pdf_files/WHA57/A57_R17-en.pdf. Published 2004. Accessed May 27, 2012.
3. Dunstan DW, Salmon J, Owen N, et al; AusDiab Steering Committee. Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults. *Diabetologia*. 2005;48(11):2254-2261.
4. Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes*. 2007;56(11):2655-2667.
5. Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev*. 2010;38(3):105-113.
6. Chaput JP, Klingenberg L, Astrup A, Sjödin AM. Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obes Rev*. 2011;12(5):e12-e20. doi:10.1111/j.1467-789X.2010.00772.x.
7. Rosenberg DE, Norman GJ, Sallis JF, Calfas KJ, Patrick K. Covariation of adolescent physical activity and dietary behaviors over 12 months. *J Adolesc Health*. 2007;41(5):472-478.
8. Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. *Best Pract Res Clin Endocrinol Metab*. 2005;19(3):343-358.
9. Chaput JP, Visby T, Nyby S, et al. Video game playing increases food intake in adolescents: a randomized crossover study. *Am J Clin Nutr*. 2011;93(6):1196-1203.
10. Chaput JP, Tremblay A. Acute effects of knowledge-based work on feeding behavior and energy intake. *Physiol Behav*. 2007;90(1):66-72.
11. Stettler N, Signer TM, Suter PM. Electronic games and environmental factors associated with childhood obesity in Switzerland. *Obes Res*. 2004;12(6):896-903.
12. Kaiser Family Foundation. Generation M: media in the lives of 8-18 year-olds. http://www.kff.org/entmedia/entmedia030905pkg.cfm.
13. Van den Bulck J, Van Mierlo J. Energy intake associated with television viewing in adolescents, a cross-sectional study. *Appetite*. 2004;43(2):181-184.
14. Stroebele N, de Castro JM. Television viewing is associated with an increase in meal frequency in humans. *Appetite*. 2004;42(1):111-113.
15. Coon KA, Goldberg J, Rogers BL, Tucker KL. Relationships between use of television during meals and children's food consumption patterns. *Pediatrics*. 2001;107(1):e7. doi:10.1542/peds.107.1.e7.
16. Wiecha JL, Peterson KE, Ludwig DS, Kim J, Sobol A, Gortmaker SL. When children eat what they watch: impact of television viewing on dietary intake in youth. *Arch Pediatr Adolesc Med*. 2006;160(4):436-442.
17. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviour and associations with food habits in different countries. *Public Health Nutr*. 2006;9(2):244-250.
18. Verzeletti C, Maes L, Santinello M, Baldassari D, Vereecken CA. Food-related family lifestyle associated with fruit and vegetable consumption among young adolescents in Belgium Flanders and the Veneto Region of Italy. *Appetite*. 2010;54(2):394-397.
19. Campbell KJ, Crawford DA, Ball K. Family food environment and dietary behaviors likely to promote fatness in 5-6 year-old children. *Int J Obes (Lond)*. 2006;30(8):1272-1280.
20. Marshall SJ, Biddle SJ, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord*. 2004;28(10):1238-1246.
21. Salmon J, Bauman A, Crawford D, Timperio A, Owen N. The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. *Int J Obes Relat Metab Disord*. 2000;24(5):600-606.
22. Crespo CJ, Smit E, Troiano RP, Bartlett SJ, Macera CA, Andersen RE. Television watching, energy intake, and obesity in US children: results from the third National Health and Nutrition Examination Survey, 1988-1994. *Arch Pediatr Adolesc Med*. 2001;155(3):360-365.
23. Moreno LA, González-Gross M, Kersting M, et al; HELENA Study Group. Assessing, understanding, and modifying nutritional status, eating habits, and physical activity in European adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr*. 2008;11(3):288-299.
24. Moreno LA, De Henauw S, González-Gross M, et al; HELENA Study Group. Design and implementation of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-sectional Study. *Int J Obes (Lond)*. 2008;32(suppl 5):S4-S11.
25. Béghin L, Castera M, Manios Y, et al; HELENA Study Group. Quality assurance of ethical issues and regulatory aspects relating to good clinical practices in the HELENA Cross-sectional Study. *Int J Obes (Lond)*. 2008;32(suppl 5):S12-S18.
26. Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-aged Children (HBSC) Family Affluence Scale. *Soc Sci Med*. 2008;66(6):1429-1436.
27. Nagy E, Vicente-Rodriguez G, Manios Y, et al; HELENA Study Group. Harmonization process and reliability assessment of anthropometric measurements in a multicenter study in adolescents. *Int J Obes (Lond)*. 2008;32(suppl 5):S58-S65.
28. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000;320(7244):1240-1243.
29. Tanner JM, Whitehouse RH. Clinical longitudinal standards for height, weight, height velocity, weight velocity, and stages of puberty. *Arch Dis Child*. 1976;51(3):170-179.
30. Rey-López JP, Vicente-Rodriguez G, Ortega FB, et al; HELENA Study Group. Sedentary patterns and media availability in European adolescents: the HELENA Study. *Prev Med*. 2010;51(1):50-55.

31. Committee on Public Education, American Academy of Pediatrics. American Academy of Pediatrics: children, adolescents, and television. *Pediatrics*. 2001;107 (2):423-426.
32. Rey-Lopez JP, Ruiz JR, Ortega FB, et al. Reliability and validity of a screen time-based sedentary behaviour questionnaire for adolescents: the HELENA study. *Eur J Public Health*. 2012;22(3):373-377.
33. Vereecken CA, Covents M, Sichert-Hellert W, et al; HELENA Study Group. Development and evaluation of a self-administered computerized 24-h dietary recall method for adolescents in Europe. *Int J Obes (Lond)*. 2008;32(suppl 5) :S26-S34.
34. Brussaard JH, Löwik MR, Steingrímsdóttir L, et al; EFCOSUM Group. A European food consumption survey method: conclusions and recommendations. *Eur J Clin Nutr*. 2002;56(suppl 2):S89-S94.
35. Commission of the European Communities. Green paper: promoting healthy diets and physical activity: a European dimension for the prevention of overweight, obesity, and chronic disease. http: //ec .europa .eu /health /ph _determinants /life _style/nutrition/documents/nutrition_gp_en .pdf. Published 2005. Accessed May 27, 2012.
36. Kremers SP, van der Horst K, Brug J. Adolescent screen-viewing behaviour is associated with consumption of sugar-sweetened beverages: the role of habit strength and perceived parental norms. *Appetite*. 2007;48(3):345-350.
37. Must A, Barish EE, Bandini LG. Modifiable risk factors in relation to changes in BMI and fatness: what have we learned from prospective studies of school-aged children? *Int J Obes (Lond)*. 2009;33(7):705-715.
38. Holsten JE, Deatrick JA, Kumanyika S, Pinto-Martin J, Compher CW. Children's food choice process in the home environment: a qualitative descriptive study. *Appetite*. 2012;58(1):64-73.
39. Grimm GC, Harnack L, Story M. Factors associated with soft drink consumption in school-aged children. *J Am Diet Assoc*. 2004;104(8):1244-1249.
40. Hare-Bruun H, Nielsen BM, Kristensen PL, Møller NC, Togo P, Heitmann BL. Television viewing, food preferences, and food habits among children: a prospective epidemiological study. *BMC Public Health*. May 13, 2011;11:311. doi: 10.1186/1471-2458-11-311.
41. Charreire H, Kesse-Guyot E, Bertrais S, et al. Associations between dietary patterns, physical activity (leisure-time and occupational), and television viewing in middle-aged French adults. *Br J Nutr*. 2011;105(6):902-910.
42. Blass EM, Anderson DR, Kirkorian HL, Pempek TA, Price I, Koleini MF. On the road to obesity: television viewing increases intake of high-density foods. *Physiol Behav*. 2006;88(4-5):597-604.
43. World Health Organization (WHO)/Food and Agriculture Organization of the United Nations. WHO Technical Report Series 916: diet, nutrition and the prevention of chronic diseases. http://whqlibdoc.who.int/trs/who_trs_916.pdf. Published 2003. Accessed May 27, 2012.
44. Moreno LA, Rodríguez G. Dietary risk factors for development of childhood obesity. *Curr Opin Clin Nutr Metab Care*. 2007;10(3):336-341.
45. Agostoni C, Braegger C, Decsi T, et al; ESPGHAN Committee on Nutrition. Role of dietary factors and food habits in the development of childhood obesity: a commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr*. 2011;52(6):662-669.
46. Caraher M, Landon J, Dalmeny K. Television advertising and children: lessons from policy development. *Public Health Nutr*. 2006;9(5):596-605.
47. Moreno LA, Rodriguez G, Fleta J, Bueno-Lozano M, Lazaro A, Bueno G. Trends of dietary habits in adolescents. *Crit Rev Food Sci Nutr*. 2010;50(2):106-112.

Artículo IV [Paper IV]

Increased sedentary behaviour is associated with unhealthy dietary patterns in European adolescents participating in the HELENA study

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ORIGINAL ARTICLE

Increased sedentary behaviour is associated with unhealthy dietary patterns in European adolescents participating in the HELENA study

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BACKGROUND/OBJECTIVES: To assess dietary patterns (DPs) in European adolescents and to examine their relationship with several indicators of sedentary behaviour.
SUBJECTS/METHODS: A multinational cross-sectional study was carried out in 2202 adolescents (45.4% boys) aged 12.5–17.5 years. A self-reported questionnaire with information on sedentary behaviours, separately for weekdays and weekend days, and two non-consecutive 24 h-recalls were used. Principal component analysis was used to obtain DPs, and linear regression examined the association between DPs scores and sedentary behaviour.
RESULTS: Four DPs for boys ('plant based', 'snacking', 'breakfast' and 'health conscious') and five DPs for girls ('confectionary and snacking', 'plant based', 'breakfast', 'animal protein' and 'health conscious') were obtained. Boys who spent >4 h/day watching television (TV) had lower adherence to the 'plant based', 'breakfast' and 'health conscious' DPs, and higher adherence to the 'snacking' DP. Higher computer use and internet use for recreational reason were associated with higher adherence to the 'snacking' DP. In girls, TV viewing and using internet for recreational reasons for >4 h/day was associated with higher adherence to the 'confectionary and snacking' and lower adherence with 'health conscious' DP. Also, studying between 2 and 4 h during weekend days was associated with lower adherence to the 'snacking' and with higher adherence to the 'plant based' and 'breakfast' DPs.
CONCLUSION: Adolescents' DPs are related with the time spent in several sedentary behaviours. Such findings may help to generate interventions focusing on decreasing unhealthy dietary habits and specific sedentary behaviours.

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Keywords: sedentary behaviours; dietary patterns; television; adolescents

INTRODUCTION

Dietary pattern (DP) analysis has emerged as an alternative and complementary approach to addressing diet-diseases associations.[1] Traditional analysis in nutritional epidemiology typically reflects diet in relation to a single or a few nutrients or foods; however, analysis using DP offers a different view of possible associations as foods and nutrients are consumed in combination and not isolated.[1] Current findings in young-age population groups have indicated an inverse association between 'healthy' DPs and indicators of sedentary behaviour, and a positive association between 'snacking' patterns and sedentary behaviours.[2] A recent review has suggested that sedentary behaviours like television (TV) viewing or video games playing can independently and differentially influence food consumption.[3] Also screen-viewing behaviour has been associated with unhealthy food consumption, that is, savoury snacks.[4] At the opposite, other sedentary behaviours like studying have been associated positively with healthy food consumption (that is, vegetables).[5]

Adolescence is an important transition period in which lifestyle habits are continued to be established following childhood. The stability of DPs has been observed to be small to moderate between middle childhood and early adolescence.[6] Targeted and effective public health interventions require multiple approaches as DPs, physical activity and also sedentary behaviours often

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coexist and interrelate making potential interactions as determinants of obesity.[7–10] Principal component analysis (PCA), which groups together correlated variables, is a commonly used method for the identification of DPs.[11] To date, only few studies have examined adolescent's DPs using PCA; in addition, there is a lack of studies examining their relationship with several indicators of sedentary behaviour. The aims of the present study were (1) to identify DPs of European adolescents participating in the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA)-Cross Sectional Study (CSS) using PCA and (2) to examine the association of obtained DPs with a comprehensive set of sedentary behaviours such as TV viewing, playing computer and video games, internet use for studying or recreational use and studying.

MATERIALS AND METHODS

Study design

HELENA is a multicentre study focusing on lifestyle and nutrition. The HELENA-CSS was performed in adolescents aged 12.5–17.5 years in 10 European cities (Athens, Heraklion, Dortmund, Ghent, Lille, Pecs, Rome, Stockholm, Vienna and Zaragoza) between 2006 October and 2007 December. Participants were recruited at schools. Schools were randomly selected after stratification on school zone or district to ensure heterogeneity of social background. Up to three classes from two grades were selected per school. All the adolescents within selected classrooms were invited to participate. A class was considered eligible if the participation rate was at least 70%. More details on operational and sampling procedures have been published elsewhere.[12,13] In total, 3528 (46.9% boys) adolescents met the HELENA inclusion criteria: being within the age range of 12.5–17.5 years old, not participating simultaneously in a clinical trial and being free of any acute infection lasting less than 1 week before the inclusion.[14] Because of logistical reasons, data from Heraklion and Pecs were not included in the dietary intake analysis (7% of the total sample). Extra inclusion criteria for the purpose of the current analysis included: having 75% complete of the sedentary behaviour questionnaire ($n = 128$ adolescents were excluded) and having provided two 24-h dietary recalls (24 H-DR). The study was approved by the Research Ethics Committees of each city involved.[15] Written informed consent was obtained from the adolescents' parents and the adolescents themselves.

Socioeconomic status

Demographic information including age and socioeconomic status (SES) was collected via a standardized self-reported questionnaire. A modified version of the Family Affluence Scale developed by Currie *et al.*[16] was used as a proxy of SES. For the purposes of the HELENA study, the Family Affluence Scale was slightly modified by replacing the item on frequency of family holidays by internet availability at home. Each adolescent completed a questionnaire asking about the number of cars and computers at home, internet availability at home and personal space at home. Family Affluence Scale indicates the SES of the adolescent on a scale from 0 (very low SES) to 8 (very high SES), thereafter categories were merged into three groups: 0–2 adding up to low SES; 3–5 adding up to medium SES; and 6–8 adding up to high SES.

Anthropometric measurements

Weight and height were measured by trained researchers according to a standardized protocol with participants barefoot and in underwear.[17] Body weight (kg) and height (cm) were measured with an electronic scale (Type SECA861, precision = 100 g, range = 0–150 kg) and a stadiometer (Type SECA 225, precision = 0.1 cm, range = 70–200 cm), respectively. Body mass index (BMI (kg/m^2) was calculated as the ratio of weight (kg) to squared metres (m^2). Age- and gender-specific BMI *z*-scores were calculated and BMI categories were estimated according to Cole *et al.*[18] A physical examination was performed by a physician classifying the adolescents in one of the five stages of pubertal maturity defined by Tanner and Whitehouse.[19]

Dietary assessment tool (HELENA-DIAT)

Dietary intakes were assessed using the self-administered, computerised 24 H-DR HELENA-DIAT based on the Young Adolescents' Nutrition Assessment software (YANA-C) and validated in European adolescents for all nutrients and energy intakes ($r_s = 0.86–0.91$)[20] The adolescents completed the 24 H-DR twice during school time and within a time-span of 2 weeks; both times, trained staff including a dietician were present. The HELENA-DIAT used special techniques to support and to enhance the respondent's memory, which allowed a more detailed description and quantification of the foods consumed. The Multiple Source Method [21] was used to calculate usual energy and nutrient intake removing the effect of day-to-day within-person variability and random error in the recalls.

The European Consumption Survey Method project (EFCOSUM) indicated the repeated 24 H-DR as the most suitable method to obtain population means and distributions.[22] The 43 food groups included in the HELENA-DIAT list were aggregated into 31 food groups according to their nutritional values, presented in Table 2, and were thereafter included in subsequent analysis.

Sedentary behaviours

A standardized self-reported sedentary behaviour questionnaire was administered.[23] Adolescents reported the frequency of specified sedentary behaviours using predefined response categories separately for weekdays and weekends. Behaviours assessed included: TV viewing, playing computer and video games, internet use for studying or recreational use and studying. The predefined response categories were: (1) none, (2) less than ½ h, (3) between ½ and <1 h, (4) between 1 and <2 h, (5) between 2 and <3 h, (6) between 3 and <4 h, (7) more than 4 h. Participants were thereafter classified into three groups for each behaviour (<2 h/day; between 2 and 4 h/day; and >4 h/day). Grouping was based on the American Academy of Pediatrics' recommendations for media time.[24]

The reliability (1-week test–retest) of the questionnaire was studied in 183 adolescents (79 boys, 104 girls; age range 12.5–17.5 years). For the majority of the variables, Cohen's kappa values using quadratic weights showed a good agreement (>0.7).[25]

Statistical analysis

All analyses were gender-specific because of observed significant differences in both sedentary behaviours and food and beverage consumption patterns between boys and girls. According to the nature of the studied variables, analysis of variance was used to compare gender-specific sample characteristics and mean DPs scores.

PCA with varimax rotation was used to obtain DPs in our sample. It is a technique often used in data reduction to identify a small number of factors that explain most of the variance observed in a much larger number of variables by defining sets highly interrelated. Each obtained DP represents a linear combination of all food groups, which are weighted by their factor loading (those with an absolute value of >0.3 were considered important contributors to each DP). The following criteria were used when deciding the number of components to be retained: eigenvalue >1, the scree plot (a graphical presentation of eigenvalues) and the interpretability of each component.[26–28] The first pattern explains as much inter-individual variation of the food groups as possible, the next pattern explains as much of the remaining variation as possible and so on. Each subject receives a score for each DP, with a higher score indicating a higher adherence to the respective pattern. The factor scores for each adolescent were used in subsequent analyses.

Linear regression examined the association between DPs scores (dependent variable) and sedentary behaviour indicators (independent variable), adjusted by age, SES, centre, BMI and energy intake (kcal/day) and expressed as unstandardised regression β-coefficients (95% confidence interval, CI). The Predictive Analytics Software (PASW) version 18.0 (SPSS Inc., Chicago, IL, USA) was used to analyse the data. *P*-values $\leqslant 0.05$ were considered to be statistically significant.

RESULTS

In total, 2202 adolescents (45% boys) were included in the analysis. Table 1 presents gender-specific socio-demographic characteristics on mean age, SES, pubertal stage, mean BMI, BMI categories based on *z*-scores according to cutoffs defined by Cole *et al.*[18] and the differences in time spent in each sedentary behaviour (min/day) among gender categories. Statistical significant differences in BMI, overweight/obese category (26 versus 21% ($P < 0.001$)) and SES ((lowest and highest, 20% versus

Table 1. Descriptive characteristics of the European adolescents sample from HELENA study ($n = 2202$)

Variables	*Mean (95% CI)*	*Boys ($n = 1032$)*		*Girls ($n = 1170$)*		P *value*[a]
Age (years)		*14.76*	*14.68; 14.83*	*14.73*	*14.66; 14.80*	*0.565*
Age categories						
12.5–13.99 (%)	*n (%)*	321	31.1	385	32.9	0.769
14–14.99 (%)	*n (%)*	269	26.1	287	24.5	
15–15.99 (%)	*n (%)*	236	22.9	268	22.9	
16–17.49 (%)	*n (%)*	206	20.0	230	19.7	
SES						
Low (0–2) (%)		7.6		10.8		0.034
Medium (3–5) (%)		55.6		54.2		
High (6–8) (%)		36.8		35.0		
Pubertal maturity (Tanner stage)						
Stage 1–3 (%)		34.4		29.2		0.035
Stage 4 (%)		41.0		44.6		
Stage 5 (%)		24.6		26.2		
BMI (kg/m^2)[b]		21.28	21.04; 21.5	21.19	20.99; 21.39	0.582
Optimal weight (%)		76.0		81.3		<0.05
Overweight-Obese (%)		24.0		18.7		
Sedentary behaviours (min/day and percentage of each category by week and weekend days)						
TV	Mean (95% CI)	110.27	106.14; 114.40	108.76	104.98; 112.54	0.597
Week days (>2 h/day)	*n* (%)	308	29.8	368	31.4	0.711
Weekend days (>2 h/day)	*n* (%)	560	54.3	667	57.0	0.538
Computer	Mean (95% CI)	75.09	70.50; 79.68	40.21	36.85; 43.56	<0.001
Week days (>2 h/day)	*n* (%)	184	17.8	98	8.4	<0.001
Weekend days (>2 h/day)	*n* (%)	389	37.7	209	17.9	<0.001
Video games	Mean (95% CI)	47.27	43.38; 51.15	10.82	9.19; 12.45	<0.001
Week days (>2 h/day)	*n* (%)	86	8.3	15	1.3	<0.001
Weekend days (>2 h/day)	*n* (%)	231	22.4	50	4.3	<0.001
Internet	Mean (95%CI)	65.78	61.48; 70.08	73.03	68.87; 77.19	0.018
Week days (>2 h/day)	*n* (%)	145	14.0	221	18.9	0.013
Weekend days (>2 h/day)	*n* (%)	262	25.4	376	32.1	0.026
Internet for study	Mean (95% CI)	25.18	22.81; 27.55	29.07	27.04; 31.10	0.014
Week days (>2 h/day)	*n* (%)	32	3.1	39	3.3	0.257
Weekend days (>2 h/day)	*n* (%)	39	3.8	46	3.9	0.185
Study	Mean (95% CI)	61.23	57.46; 64.99	77.83	74.03; 81.63	<0.001
Week days (>2 h/day)	*n* (%)	127	12.3	230	19.6	<0.001
Weekend days (>2 h/day)	*n* (%)	145	14.0	221	18.9	0.013

Abbreviations: BMI, body mass index; HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence; SES: Socioeconomic status; TV, television.
SES, socioeconomic status based on Family Affluence Scale. Pubertal maturity based on Tanner stage. [a]Gender differences using Pearson χ^2 test for categorised variables and *t*-test for continuous variables. [b]BMI categories was estimated according to T. Cole's cutoff.[18]

9%, respectively ($P<0.001$)) were observed between included and excluded adolescents (data not shown). Gender differences were observed in SES and pubertal stage ($P<0.05$) and in the majority of the sedentary activities. A high proportion of boys and girls were categorised into the optimal weight status, 76% and 81%, respectively.

Four DPs in boys and five DPs in girls were derived from PCA accounting for 25% of the variance in food group intakes in boys and 28% in girls. The food group loadings for each component are presented in Table 2. Individual components were labelled based on the retained individual foods with high loadings (>0.30 and closer to 1). In boys, the first component was labelled as 'plant based' DP and was positively correlated with intakes of vegetable oil, vegetables, cheese, pasta, rice, pulses, cakes, pies and biscuits, bread and water. The second component was labelled 'snacking' DP and included items related to the intake of soft drinks, savoury snacks, chocolate, non-confectionary chocolate, sauces and bread and negatively with water. The third component was labelled 'breakfast' DP and was positively correlated with the intake of cheese, butter and animal fats, sugar, jam and syrup, margarine, bread and rolls. The fourth component was labelled 'health conscious' DP and was positively correlated with the intake of cheese, white milk, cereals, fruit and starch roots, and negatively with fruit and vegetable juices.

In girls, the first component was labelled 'confectionary and snacking' DP and was positively correlated with the intakes of sweetened beverages, savoury snacks, chocolate, confectionary non chocolate, cakes, pies and biscuits and meat. The second component was labelled 'plant based' DP and was positively correlated with the intake of vegetables, vegetable oils, eggs, water and pulses. The third component was labelled 'breakfast' DP and was positively correlated with the intake of butter and animal fats, sugar, honey, jam and syrup, margarine and lipids of mixing

Table 2. Gender-specific factor loadings of identified dietary patterns for the HELENA participants

Food groups	*Boys*				*Girls*				
	Plant-based DP	*Snacking DP*	*Breakfast DP*	*Health conscious DP*	*Confectionary and Snacking DP*	*Plant-based DP*	*Breakfast DP*	*Animal protein DP*	*Health conscious DP*
Water	0.36	−0.33				0.36			
Vegetable oils	0.80					0.63		0.38	
Vegetables excluding potatoes	0.60					0.52			
Fruit				0.41					0.38
Fruit and vegetable juices				−0.32					
Pulses	0.39					0.36			
Nuts, seeds, olives and avocado									
Meat substitutes and vegetarian products									
Soups, bouillon									
Potatoes and starch roots.				0.33	0.36				0.38
Pasta and rice and other cereals	0.44							0.64	
Cheese	0.47		0.34					0.63	
White milk				0.64					0.55
Milk products				0.32					0.39
Dessemilk-based products									
Bread and rolls	0.34	0.39	0.39				0.43	0.43	
Breakfast cereals				0.53					0.55
Meat					0.33		−0.35	0.33	
Fish									
Eggs						0.47			
Sauces		0.30							
Cakes, pies and biscuits	0.33				0.33				
Savoury snacks		0.58			0.51				
Confectionery non chocolate		0.42			0.41				
Chocolate		0.45			0.42				
Sugar, honey, jam and syrup			0.53				0.56		
Butter and animal fats			0.65				0.41		
Margarine and lipids of mixing origins			0.43				0.48		
Coffee, tea			0.38				0.57		
Sweetened beverages		0.72			0.60				
Beer, wine and other alcoholic beverages									−0.30
Percentage of variance explained by individual component	7.1	6.3	6.0	5.7	5.8	5.7	5.6	5.4	5.1
Total cumulative variance explained				24.9					27.6

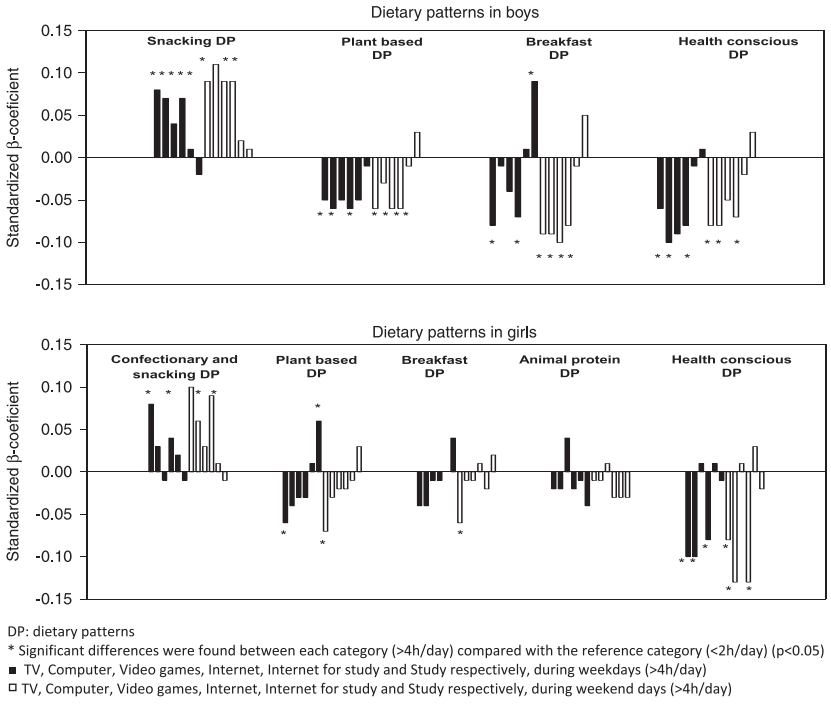
Abbreviations: HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence; DP, dietary pattern. *Absolute value <0.30 was not represented in the table for simplicity.

origins, bread and rolls, coffee and tea, and negatively with animal protein. The fourth component was labelled 'Plant based' DP and was correlated with vegetable oils, cheese, pasta, rice and other cereals, meat and bread and rolls. The last component was labelled 'health conscious' DP and was positively correlated with the intake of white milk, breakfast cereals, fruit, starch roots, potatoes and milk products, and negatively with beer, wine and other alcoholic beverages.

Association between sedentary behaviours and DPs

Tables 3 and 4 show the relationship between the sedentary behaviour indicators and DPs stratified by gender. Figure 1 presents graphically the relationship (standardized regression β-coefficients and 95% CI) between each of the categories denoting higher time spent in sedentary behaviours (>4 h/day) and DPs, separately for weekdays and weekend days. Each sedentary behaviour is presented individually (TV, computer, video games, internet for recreational reason, internet for study and study) for each DP and separately for boys and girls. In boys, higher TV viewing, computer, video games and internet use for recreational reasons, both during weekdays and weekend days, were associated with lower adherence to the 'plant based', 'breakfast' and 'health conscious' DPs (Figure 1). Boys who spend watching TV >4 h/day had lower adherence to the 'plant based' DP ($\beta = -0.08$, CI: −0.14, −0.01; $\beta = -0.05$, CI: −0.10, −0.01, during weekdays and weekend days, respectively), the 'breakfast' DP ($\beta = -0.11$,CI: −0.19, −0.03; $\beta = -0.08$, CI: −0.13, −0.03, during weekdays and weekend days, respectively) and the 'health conscious' DP ($\beta = -0.09$, CI: −0.13, −0.01; $\beta = s-0.07$, CI: −0.12, −0.02, during weekdays and weekend days, respectively), and higher adherence to the 'snacking' DP ($\beta = 0.11$, CI: 0.05, 0.17; $\beta = 0.09$, CI: 0.04, 0.13, during weekdays and weekend days, respectively) (Table 3). In addition, higher computer use ($\beta = 0.12$, CI: 0.05, 0.19; $\beta = 0.11$, CI: 0.06, 0.15, during weekdays and weekend days, respectively) and internet use for recreational reason ($\beta = 0.11$, CI: 0.04, 0.18; $\beta =$ 0.11, CI: 0.05, 0.16, during weekdays and weekend days, respectively) were associated with higher adherence to the 'snacking' DP (Table 3).

In girls, TV viewing >4 h/day were associated with higher adherence to the 'confectionary and snacking' DP ($\beta = 0.13$, CI: 0.06, 0.19; $\beta = 0.09$, CI: 0.05, 0.14, during weekdays and weekend days, respectively) and less to the 'health conscious' DP ($\beta = -0.15$, CI: −0.23, −0.08; $\beta = -0.08$, CI: −0.13, −0.03, during weekdays and weekend days, respectively) (Table 4). Also, girls who spend >4 h/day using internet for recreational reasons had higher adherence to the 'confectionary and snacking' DP ($\beta = 0.08$, CI: 0.00, 0.13; $\beta = 0.09$, CI: 0.05, 0.14, during weekdays and weekend days, respectively) and lower to the 'health conscious' DP ($\beta = -0.14$, CI: −0.22, −0.06; $\beta = -0.14$, CI: −0.19, −0.09, during weekdays and weekend days, respectively) (Table 4). Those girls who studied between 2 and 4 h during weekend days were associated with lower adherence to the 'snacking' DP ($\beta = 0.06$, CI: 0.01, 0.12) and with higher adherence to the 'plant based' ($\beta = -0.06$, CI: −0.11, −0.01) and 'breakfast' DPs ($\beta = 0.07$, CI: 0.01, 0.13) (Table 4).



DP: dietary patterns
* Significant differences were found between each category (>4h/day) compared with the reference category (<2h/day) (p<0.05)
■ TV, Computer, Video games, Internet, Internet for study and Study respectively, during weekdays (>4h/day)
□ TV, Computer, Video games, Internet, Internet for study and Study respectively, during weekend days (>4h/day)

Figure 1. Standardized regression β-coefficients between individual sedentary behaviours during weekdays and weekend days, and mean scores of DPs in boys and girls. *Significant differences were found between each category (>4 h/day) compared with the reference category (<2 h/day) ($P<0.05$). ■TV, computer, video games, internet, internet for study and Study, respectively, during weekdays (>4 h/day). □TV, computer, video games, internet, internet for study and study, respectively, during weekend days (>4 h/day).

DISCUSSION

The identification of DPs in a European sample and their relation to several indicators of sedentary behaviour has rarely been examined. The present population-based study identified the association between several sedentary behaviours and DPs. In boys, the time spent watching TV, playing computer or video games and using internet due to recreational reasons were positively associated with the 'snacking' pattern, and negatively with the 'plant based', 'breakfast' and 'health conscious' patterns. In girls, watching TV and using internet for recreational reasons were positively associated with the 'confectionary and snacking' patterns, and negatively with the 'health conscious' pattern.

In the HELENA study, several screen-based behaviours have been positively associated with unhealthy DP and negatively with healthy DP; the size of the relations was higher for playing video games, internet for study and study during weekdays and the 'plant based' and 'breakfast' DPs in boys, and TV viewing, computer playing and internet for recreational reasons during weekdays and the 'health conscious' DP in girls (based on β-coefficients $\geqslant 0.14$). A recent study carried out in German adolescents with the same age-group, showed that among girls, a high adherence to the 'traditional' and 'western dietary' patterns was associated with more hours of TV watching per day.[27] Another study of Dutch adolescents aged 12–16 years suggested that sedentary behaviours (TV watching and PC use) were associated with high consumption of soft drinks.[29] Among Spanish adolescents aged 14–24 years, a 'snacky' DP was positively associated with time spent watching TV[30] and in another participants spending more than 4 h/day on media screen was related to adherence to a 'western' DP characterised by milk products, meat, cereals, pasta, soft drinks, high-fat foods, sweets and chocolates.[31] Also, an association between TV watching >2 h/day and higher consumption of high-fat snacks and high-sugar drinks has been demonstrated in European adolescents from the HELENA study.[5,32] In addition, the consumption of energy-dense foods during TV viewing was analysed in the HELENA sample and findings showed that adolescents who watched TV for >2 h/day were more likely to eat pastry, savoury snacks or sweets.[32] A recent study in Scottish young population aged 5–17 years showed that 'healthier' DP was consistently associated with less time spent in front of a screen for all age and both boys and girls, whereas an 'unhealthy' DP was associated with more time spent in front of a screen in girls aged 5–11 years.[2] In children, TV viewing has been found to be associated with less healthy dietary habits from early age. For instance, a Dutch study of toddlers aged 14 months showed that TV viewing was an important predictor of adherence to a 'western-like' DP.[33] A Portuguese study in children aged 5–10 years observed that those who watched TV more than 2 h/day were positively associated with a DP that included food rich in fat and added sugar, which was a predictor of fast-foods, sugar-sweetened beverages and pastry consumption.[34]

Our study provides a novel finding regarding the relation between DP and time spent for school studying reasons. A positive association has been observed in both genders between those who studied >2 h per day and the 'breakfast' DP, and also in girls with the 'plant based' DP. In addition, a negative association has been observed in girls who study between 2 and 4 h during weekdays and the 'confectionary and snacking' DP. No comparable information has been observed in other population groups, which hamper further comparisons.

Recent findings suggest increased risk of overweight for children with high scores of eating patterns characterised by the frequent intake of unhealthy food items. For instance, the DONALD study[35] indicated a small but positive association between consumption of high-energy foods and body weight among boys ($\beta = 0.104$, $P = 0.0098$). Another Japanese study[36] observed a lower BMI among those adolescents with a 'healthier' DP and a higher BMI among those with 'western' DP. However, no association between DPs scores and overweight has been found in other studies.[2,27]

Table 3. Unstandardised regression β-coefficients (95% CI) between individual sedentary behaviours and mean scores of dietary patterns in boys

	'Plant based'	*Snacking*	*Breakfast*	*Health conscious*
	Unstandardised β-coefficients (IC)	*Unstandardised β-coefficients (IC)*	*Unstandardised β-coefficients (IC)*	*Unstandardised β-coefficients (IC)*
TV, week days				
2–4 h[a]	**−0.07 (−0.12, −0.1)**	**0.10 (0.05,0.15)**	**−0.02 (−0.21, −0.09)**	**−0.07 (−0.13, −0.01)**
>4 h[a]	**−0.08 (−0.14, −0.01)**	**0.11 (0.05,0.17)**	**−0.11 (−0.19, −0.03)**	**−0.09 (−0.13, −0.01)**
TV, weekends				
2–4 h[a]	−0.01 (−0.06,0.04)	0.03 (−0.02,0.08)	−0.02 (−0.08,0.04)	**−0.07 (−0.12, −0.01)**
>4 h[a]	**−0.05 (−0.10, −0.01)**	**0.09 (0.04,0.13)**	**−0.08 (−0.13, −0.03)**	**−0.07 (−0.12, −0.02)**
Computer, weekdays				
2–4 h[a]	−0.05 (−0.11,0.02)	**0.08 (0.02,0.14)**	**−0.11 (−0.19, −0.04)**	−0.04 (−0.12,0.04)
>4 h[a]	**−0.09 (−0.17, −0.02)**	**0.12 (0.05,0.19)**	−0.01 (−0.10,0.08)	**−0.16 (−0.24, −0.07)**
Computer, weekends				
2–4 h[a]	−0.02 (−0.07,0.04)	0.03 (−0.03,0.08)	−0.04 (−0.10,0.03)	−0.02 (−0.09,0.04)
>4 h[a]	−0.03 (−0.08,0.01)	**0.11 (0.06,0.15)**	**−0.08 (−0.13, −0.03)**	**−0.08 (−0.13, −0.03)**
Video games, weekdays				
2–4 h[a]	**−0.14 (−0.23, −0.04)**	**0.15 (0.06,0.24)**	**−0.18 (−0.29, −0.07)**	−0.09 (−0.19,0.02)
>4 h[a]	**−0.10 (−0.19,0.00)**	0.09 (0.00,0.18)	−0.09 (−0.20,0.03)	−0.19 (−0.31,0.08)
Video games, weekends				
2–4 h[a]	−0.05 (−0.12,0.01)	0.05 (−0.01,0.11)	**−0.12 (−0.19, −0.04)**	−0.05 (−0.12,0.03)
>4 h[a]	**−0.07 (−0.13, −0.01)**	**0.11 (0.05,0.17)**	**−0.13 (−0.20, −0.06)**	−0.06 (−0.13,0.01)
Internet[b]*, weekdays*				
2–4 h[a]	−0.04 (−0.11,0.04)	0.06 (−0.01,0.14)	−0.08 (−0.17,0.01)	−0.08 (−0.17,0.00)
>4 h[a]	**−0.10 (−0.17, −0.03)**	**0.11 (0.04,0.18)**	**−0.11 (−0.19, −0.02)**	**−0.13 (−0.21, −0.05)**
Internet[b]*, weekends*				
2–4[a]	−0.02 (−0.08,0.04)	**0.08 (0.02,0.13)**	−0.05 (−0.12,0.02)	**−0.09 (−0.16, −0.02)**
>4 h[a]	**−0.08 (−0.13, −0.02)**	**0.11 (0.05,0.16)**	**−0.10 (−0.16, −0.03)**	**−0.08 (−0.15, −0.02)**
Internet for study, week days				
2–4 h[a]	−0.05 (−0.19,0.10)	0.03 (−0.11,0.17)	0.05 (−0.13,0.23)	−0.07 (−0.24,0.10)
>4 h[a]	**−0.17 (−0.34, −0.01)**	0.03 (−0.13,0.19)	0.05 (−0.16,0.25)	−0.02 (−0.22,0.17)
Internet for study, weekends				
2–4[a]	−0.09 (−0.22,0.05)	0.10 (−0.03,0.23)	−0.07 (−0.22,0.09)	−0.09 (−0.25,0.06)
>4 h[a]	−0.04 (−0.20,0.12)	0.05 (−0.10,0.21)	−0.23 (−0.21,0.17)	−0.06 (−0.25,0.12)
Study, weekdays				
2–4 h[a]	0.05 (−0.03,0.13)	−0.06 (−0.13.0.02)	**0.11 (0.01,0.20)**	0.08 (−0.01,0.17)
>4 h[a]	−0.02 (−0.11,0.07)	−0.03 (−0.12,0.06)	**0.19 (0.08,0.29)**	0.02 (−0.08,0.13)
Study, weekends				
2–4 h[a]	0.04 (−0.02,0.11)	−0.05 (−0.11,0.02)	0.07 (−0.01,0.15)	0.04 (−0.04,0.11)
>4 h[a]	0.05 (−0.03,0.13)	0.01 (−0.07,0.09)	0.09 (−0.01,0.18)	0.04 (−0.05,0.14)

Abbreviation: CI, confidence interval. [a]The first category (<2 h) was the reference category. [b]Internet use for recreational reasons. Differences marked in bold are statistically significant at the 95% confidence level.

Our study has limitations. Factor analysis, as a statistical technique, requires some arbitrary decisions on the extraction and interpretation of factors. In addition, food consumption and sedentary behaviours data are based on self-reported questionnaires where errors in reporting are possible; nevertheless, questionnaire use is the most common method due to low-cost and ease of administration in a large European sample, and both questionnaires have been tested and validated indicating acceptable accuracy.[20,25] In addition, food accessibility at home setting is not been addressed in the HELENA study.

Strengths of the study include a large and culturally diverse sample of European adolescents. The highly standardized procedures used within the HELENA study are also an important strength,[12,13] and the large pool of sedentary indicators that has been measured in this population group. In addition, the use of multiple 24 H-DR interviews in estimating dietary behaviours combined with sedentary behaviours is a relatively new approach.

Using PCA to generate DPs shows which foods tend to be consumed together, and relating these patterns to other factors such as demographics, lifestyle and health helps to tailor and set priorities for health promotion and also to better understand the role of diet in relation to disease risk. In addition, the use of DPs takes into account interactions across the food matrix which is not possible using the single nutrient approach.

The present study found significant linear relationships between DPs and sedentary behaviours. Our study suggests that

Table 4. Unstandardised regression β-coefficients (95% CI) between individual sedentary behaviours and mean scores of dietary patterns in girls

	Confectionary and snacking	*Plant based*	*Breakfast*	*Animal protein*	*Health conscious*
	Unstandardised β-coefficients (IC)	*Unstandardised β-coefficients (IC)*	*Unstandardised β-coefficients (IC)*	*Unstandardised β-coefficients (IC)*	*Unstandardised β-coefficients (IC)*
TV, weekdays					
2–4 h[a]	**0.06 (0.01,0.10)**	−0.04 (−0.09,0.10)	−0.03 (−0.09,0.02)	−0.01 (−0.06,0.05)	−0.03 (−0.08,0.03)
>4 h[a]	**0.13 (0.06,0.19)**	**−0.09 (−0.17, −0.02)**	−0.05 (−0.13,0.02)	−0.03 (−0.10,0.04)	**−0.15 (−0.23, −0.08)**
TV, weekends					
2–4 h[a]	**0.06 (0.01,0.10)**	**−0.07 (−0.12, −0.02)**	−0.05 (−0.10,0.00)	0.04 (−0.01,0.09)	−0.01 (−0.06,0.05)
>4 h[a]	**0.09 (0.05,0.14)**	**−0.06 (−0.11, −0.01)**	**−0.06 (−0.11, −0.01)**	−0.01 (−0.06,0.04)	**−0.08 (−0.13, −0.03)**
Computer, weekdays					
2–4 h[a]	0.07 (−0.01,0.16)	0.00 (−010.0.10)	0.00 (−0.10,0.10)	0.030 (−0.07,0.13)	**−0.19 (−0.29, −0.09)**
>4 h[a]	0.08 (−0.02,0.18)	−0.10 (−0.21,0.02)	−0.09 (−0.20,0.03)	−0.05 (−0.16,0.07)	**−0.24 (−0.35, −0.12)**
Computer, weekends					
2–4 h[a]	**0.10 (0.03,0.16)**	−0.02 (−0.09,0.06)	−0.01 (−0.08,0.07)	−0.01 (−0.08,0.07)	−0.03 (−0.11,0.05)
>4 h[a]	**0.09 (0.03,0.15)**	−0.04 (−0.10,0.03)	−0.02 (−0.09,0.05)	−0.02 (−0.08,0.05)	**−0.18 (−0.25, −0.11)**
Video Games, weekdays					
2–4 h[a]	0.08 (−0.12,0.28)	−0.01 (−0.23,0.22)	−0.13 (−0.36,0.10)	−0.12 (−0.34,0.11)	−0.11 (−0.34,0.13)
>4 h[a]	−0.05 (−0.38,0.29)	−0.28 (−0.66,0.10)	−0.07 (−0.46,0.32)	0.29 (−0.09,0.67)	0.03 (−0.36,0.43)
Video games, weekends					
2–4 h[a]	−0.01 (−0.13,0.11)	−0.01 (−0.14,0.12)	−0.12 (−0.26,0.01)	0.04 (−0.09,0.17)	−0.09 (−0.23,0.04)
>4 h[a]	0.09 (−0.06,0.24)	−0.09 (−0.26,0.08)	−0.03 (−0.21,0.14)	0.03 (−0.14,0.20)	0.02 (−0.16,0.20)
Internet,[b] weekdays					
2–4 h[a]	**0.07 (0.01,0.13)**	−0.01 (−0.08,0.06)	−0.06 (−0.16,0.03)	−0.04 (−0.11,0.04)	**−0.15 (−0.22, −0.08)**
>4 h[a]	**0.08 (0.00,0.13)**	−0.04 (−0.12,0.03)	−0.01 (−0.09,0.06)	−0.03 (−0.11,0.04)	**−0.14 (−0.22, −0.06)**
Interne[b] weekends					
2–4[a]	**0.08 (0.02,0.13)**	0.01 (−0.05,0.07)	0.02 (−0.04,0.08)	−0.01 (−0.07,0.05)	**−0.13 (−0.19, −0.06)**
>4 h[a]	**0.09 (0.05,0.14)**	−0.03 (−0.08,0.03)	0.00 (−0.05,0.05)	−0.03 (−0.09,0.02)	**−0.14 (−0.19, −0.09)**
Internet for study, week days					
2–4 h[a]	−0.08 (−0.21,0.04)	0.11 (−0.03,0.25)	−0.05 (−0.19,0.09)	−0.06 (−0.20,0.08)	0.06 (−0.09,0.20)
>4 h[a]	0.13 (−0.11,037)	0.02 (−0.24,0.29)	−0.01 (−0.28,0.27)	−0.04 (−0.31,0.23)	0.05 (−0.24,0.33)
Internet for study, weekends					
2–4[a]	0.05 (−0.60,0.17)	0.04 (−0.08,0.17)	0.01 (−0.12,0.14)	**−0.13 (−0.25,0.00)**	0.04 (−0.09,0.17)
>4 h[a]	0.04 (−0.20,0.28)	−0.03 (−0.29,0.24)	−0.13 (−0.40,0.14)	−0.15 (−0.42,0.11)	0.16 (−0.12,0.44)
Study, weekdays					
2–4 h[a]	−0.01 (−0.07,0.05)	0.06 (−0.01,0.12)	0.04 (−0.03,0.11)	−0.02 (−0.08,0.05)	−0.01 (−0.08,0.06)
>4 h[a]	−0.01 (−0.08,0.06)	**0.10 (0.02,0.17)**	0.06 (−0.02,0.14)	−0.06 (−0.14,0.02)	−0.01 (−0.09,0.08)
Study, weekends					
2–4 h[a]	**−0.06 (−0.11, −0.01)**	**0.06 (0.01,0.12)**	**0.07 (0.01,0.13)**	0.00 (−0.05,0.06)	0.05 (−0.01,0.11)
>4 h[a]	−0.01 (−0.07,0.06)	0.04 (−0.03,0.11)	0.03 (−0.04,0.10)	−0.05 (−0.12,0.03)	−0.04 (−0.11,0.04)

Abbreviations: BMI, body mass index; CI, confidence interval; IC, incidence of coincidence. Covariates: socioeconomic status, age, country, energy intake (kcal/day) and crude BMI. [a]The first category (<2 h) was the reference category. [b]Internet use for recreational reasons. Differences marked in bold are statistically significant at the 95% confidence level.

adolescents' dietary intake is related to the time spent in several sedentary behaviours. In the same line, the results of a recent meta-analysis indicated that sedentary behaviours (TV watching) contribute to obesity by encouraging excessive eating.[37] Overall, DPs are important in identifying relationships with several sedentary behaviours. These findings may also help to generate new hypotheses for future research and interventions in adolescent populations, focusing on decreasing unhealthy DPs and sedentary behaviours. This may have important implications for targeting health promotion messages, highlighting the importance of being physically active and decreasing sedentary behaviours. Further longitudinal studies are needed to confirm our findings.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1 Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol* 2002; **13**: 3–9.
2 Craig LC, McNeill G, Macdiarmid JI, Masson LF, Holmes BA. Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity. *Br J Nutr* 2010; **103**: 319–334.
3 Chaput JP, Klingenberg L, Astrup A, Sjodin AM. Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obes Rev* 2010; **12**: e12–e20.
4 Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. *Best Pract Res Clin Endocrinol Metab* 2005; **19**: 343–358.
5 Santaliestra-Pasías AM, Mouratidou T, Verbestel V, Huybrechts I, Gottrand F, Le Donne C *et al.* Food consumption and screen-based sedentary behaviors in european adolescents: The helena study. *Arch Pediatr Adoles Med* 2012; **166**: 1–11.
6 Biddle SJ, O'Connell S, Braithwaite RE. Sedentary behaviour interventions in young people: a meta-analysis. *Br J Sports Med* 2011; **45**: 937–942.
7 Global Strategy on diet and Physical Activity. *World Health Assembly 5717*. World Health Organization: Geneva, 2004.
8 Rey-Lopez JP, Vicente-Rodriguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. *Nutr Metab Cardiovasc Dis* 2008; **18**: 242–251.
9 Moreno LA, Rodriguez G. Dietary risk factors for development of childhood obesity. *Curr Opin Clin Nutr Metab Care* 2007; **10**: 336–341.
10 Ottevaere C, Huybrechts I, Benser J, De Bourdeaudhuij I, Cuenca-Garcia M, Dallongeville J *et al.* Clustering patterns of physical activity, sedentary and dietary behavior among European adolescents: The HELENA study. *BMC Public Health* 2011; **11**: 328.
11 Newby PK, Tucker KL. Empirically derived eating patterns using factor or cluster analysis: a review. *Nutr Rev* 2004; **62**: 177–203.
12 Moreno LA, Gonzalez-Gross M, Kersting M, Molnar D, de Henauw S, Beghin L *et al.* Assessing, understanding and modifying nutritional status, eating habits and physical activity in European adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr* 2008; **11**: 288–299.
13 Moreno LA, De Henauw S, Gonzalez-Gross M, Kersting M, Molnar D, Gottrand F *et al.* Design and implementation of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study. *Int J Obes (Lond)* 2008; **32**(Suppl 5): S4–S11.
14 Beghin L, Huybrechts I, Vicente-Rodriguez G, DEH S, Gottrand F, Gonzales-Gross M *et al.* Mains characteristics and participation rate of European adolescents included in the HELENA study. *Arch Public Health* 2012; **70**: 14.
15 Beghin L, Castera M, Manios Y, Gilbert CC, Kersting M, De Henauw S *et al.* Quality assurance of ethical issues and regulatory aspects relating to good clinical practices in the HELENA Cross-Sectional Study. *Int J Obes (Lond)* 2008; **32**(Suppl 5): S12–S18.
16 Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med* 2008; **66**: 1429–1436.
17 Nagy E, Vicente-Rodriguez G, Manios Y, Beghin L, Iliescu C, Censi L *et al.* Harmonization process and reliability assessment of anthropometric measurements in a multicenter study in adolescents. *Int J Obes (Lond)* 2008; **32**(Suppl 5): S58–S65.
18 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**: 1240–1243.
19 Tanner JM, Whitehouse RH. Clinical longitudinal standards for height, weight, height velocity, weight velocity, and stages of puberty. *Arch Dis Child* 1976; **51**: 170–179.
20 Vereecken CA, Covents M, Sichert-Hellert W, Alvira JM, Le Donne C, De Henauw S *et al.* Development and evaluation of a self-administered computerized 24-h dietary recall method for adolescents in Europe. *Int J Obes (Lond)* 2008; **32** (Suppl 5): S26–S34.
21 Harttig U, Haubrock J, Knuppel S, Boeing H. The MSM program: web-based statistics package for estimating usual dietary intake using the Multiple Source Method. *Eur J Clin Nutr* 2011; **65**(Suppl 1): S87–S91.
22 Brussaard JH, Lowik MR, Steingrimsdottir L, Moller A, Kearney J, De Henauw S *et al.* A European food consumption survey method--conclusions and recommendations. *Eur J Clin Nutr* 2002; **56**(Suppl 2): S89–S94.
23 Rey-Lopez JP, Vicente-Rodriguez G, Ortega FB, Ruiz JR, Martinez-Gomez D, De Henauw S *et al.* Sedentary patterns and media availability in European adolescents: The HELENA study. *Prev Med* 2010; **51**: 50–55.
24 American Academy of Pediatrics. Children, adolescents, and television. *Pediatrics* 2001; **107**: 423–426.
25 Rey-Lopez JP, Ruiz JR, Ortega FB, Verloigne M, Vicente-Rodriguez G, Gracia-Marco L *et al.* Reliability and validity of a screen time-based sedentary behaviour questionnaire for adolescents: The HELENA study. *Eur J Public Health* 2011; **22**: 373–377.
26 Deshmukh-Taskar PR, O'Neil CE, Nicklas TA, Yang SJ, Liu Y, Gustat J *et al.* Dietary patterns associated with metabolic syndrome, sociodemographic and lifestyle factors in young adults: the Bogalusa Heart Study. *Public Health Nutr* 2009; **12**: 2493–2503.
27 Richter A, Heidemann C, Schulze MB, Roosen J, Thiele S, Mensink GB. Dietary patterns of adolescents in Germany - Associations with nutrient intake and other health related lifestyle characteristics. *BMC Pediatr* 2012; **12**: 35.
28 Charreire H, Kesse-Guyot E, Bertrais S, Simon C, Chaix B, Weber C *et al.* Associations between dietary patterns, physical activity (leisure-time and occupational) and television viewing in middle-aged French adults. *Br J Nutr* 2011; **105**: 902–910.
29 van Kooten M, de Ridder D, Vollebergh W, van Dorsselaer S. What's so special about eating? Examining unhealthy diet of adolescents in the context of other health-related behaviours and emotional distress. *Appetite* 2007; **48**: 325–332.
30 Aranceta J, Perez-Rodrigo C, Ribas L, Serra-Majem L. Sociodemographic and lifestyle determinants of food patterns in Spanish children and adolescents: the enKid study. *Eur J Clin Nutr* 2003; **57**(Suppl 1): S40–S44.
31 Bibiloni Mdel M, Martinez E, Llull R, Pons A, Tur JA. Western and Mediterranean dietary patterns among Balearic Islands' adolescents: socio-economic and lifestyle determinants. *Public Health Nutr* 2012; **15**: 683–692.
32 Rey-Lopez JP, Vicente-Rodriguez G, Repasy J, Mesana MI, Ruiz JR, Ortega FB *et al.* Food and drink intake during television viewing in adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. *Public Health Nutr* 2011; **14**: 1563–1569.
33 Kiefte-de Jong JC, de Vries JH, Bleeker SE, Jaddoe VW, Hofman A, Raat H *et al.* Socio-demographic and lifestyle determinants of 'Western-like' and 'Health conscious' dietary patterns in toddlers. *Br J Nutr* 2012; **109**: 1–11.
34 Moreira P, Santos S, Padrao P, Cordeiro T, Bessa M, Valente H *et al.* Food patterns according to sociodemographics, physical activity, sleeping and obesity in Portuguese children. *Int J Environ Res Public Health* 2010; **7**: 1121–1138.
35 Alexy U, Libuda L, Mersmann S, Kersting M. Convenience foods in children's diet and association with dietary quality and body weight status. *Eur J Clin Nutr* 2011; **65**: 160–166.
36 Okubo H, Sasaki S, Murakami K, Kim MK, Takahashi Y, Hosoi Y *et al.* Three major dietary patterns are all independently related to the risk of obesity among 3760 Japanese women aged 18-20 years. *Int J Obes (Lond)* 2008; **32**: 541–549.
37 Chapman CD, Benedict C, Brooks SJ, Schioth HB. Lifestyle determinants of the drive to eat: a meta-analysis. *Am J Clin Nutr* 2012; **96**: 492–497.

APPENDIX

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Artículo V [Paper V]

Clustering of lifestyle behaviours and relation to body composition in European children. The IDEFICS study.

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Eur J Clin Nutr (submitted)

Clustering of lifestyle behaviors and relation to body composition in European children. The IDEFICS study.

Abstract

Background: Dietary patterns, physical activity (PA) and sedentary behaviors are acknowledged as major behavioral determinants of obesity, and limited evidence exist examining their synergetic effects of multiple obesity-related behaviors in children.

Methods: Data from the baseline IDEFICS cross-sectional survey. A sample of 11 674 2-to-9-year-old children (50.8% males), from 8 European regions were measured. Children's food consumption (fruit and vegetables (F&V), sweetened beverages (SSB)), physical activity (PA) and sedentary behaviors were assessed with parental questionnaires. Cluster analysis stratified by sex was performed. To identify associations between behavioral clusters and body composition indicators (BCI), analyses of covariance and logistic regressions were calculated.

Results: Six lifestyle clusters were identified (C1 to C6).Clusters characterized by high level of PA (C1 and C3) included a high proportion of older children (6 to 9 years old); clusters characterized by low beverage consumption (C5 and C6) included a high proportion of younger children (2 to 6 years old). High proportion of children with low socioeconomic status characterized the cluster with the highest SSB consumption (C4). Significant associations with BCI were observed only in males; children in the cluster with the highest time spent in sedentary activities and low PA had increased odds of having a Body Mass Index z-score (OR 1.33; 95%CI 1.01,1.74) and a waist circumference z-score (OR 1.41; 95%CI 1.06, 1.86) higher than one.

Conclusion: Clusters characterized by high sedentary behaviors, low F&V and SSB consumption and low PA can be considered as the most obesogenic.

Keywords: cluster analysis, sedentary behavior, television, diet, physical activity, body mass index

Introduction

A multi-factorial approach to obesity prevention requires changes in multiple factors contributing to energy imbalance.[97] Dietary patterns, physical activity (PA) and sedentary behaviors are acknowledged as major behavioral determinants of obesity [54-56] being established at an early age [37]. Such determinants often coexist and interrelate [54]. Limited evidence exist indicating the potential benefits of examining the synergetic effects of multiple obesity-related behaviors, as opposed to single behaviors, which showed to be clustered within individuals and certain subgroups [98]. Such patterns showed to be independently associated with increased obesity in children and adolescents, [99] and their clustering within individuals has also been observed [100].

Several studies have reported clusters of health-related behaviors in adult and adolescent population groups [101-106], but few on obesity-related behaviors in younger age populations. Recent studies in adolescents have shown the relevance of some clusters in relation with body mass index z-scores (BMIz) and higher odds of prevalent and incident obesity in females [98, 100]. It is of interest to note the low proportion of adolescents scoring high in healthy behavior clusters, i.e. only 18% of the total sample of European adolescents from the HELENA study [107]. The IDEFICS (Identification and prevention of Dietary- and lifestyle induced health EFfects In Children and infants) study offers the opportunity to examine clustering patterns selected and their association to body composition in a large sample of young children. Such measures include dietary-related habits (fruit and vegetable (F&V) and sugar sweetened-beverages (SSB) consumption) and activity (PA and sedentary behavior).

The aim of this paper is to examine the association between clustering patterns (dietary, physical activity and sedentary behaviors) and body composition in European children aged 2 to 9 from the IDEFICS study.

Participants and Methods

Design

The IDEFICS study is a setting-based community-oriented intervention study aiming to prevent obesity in children from eight European countries. Findings from the baseline survey of this multi-centre cross-sectional study are the focus of the current paper. All measurements were taken following a highly standardized procedure summarized in a detailed operation manual. Full details on the study procedures are described elsewhere [79, 80, 108].

Participants

Between September 2007 and June 2008, 16 864 children from pre-schools and primary schools of selected regions in Italy, Estonia, Cyprus, Belgium, Sweden, Hungary, Germany and Spain were recruited. Approximately, 96% of the children fulfilled the inclusion criteria: complete information on sex, height and weight. The final sample size comprised 16 223 children. Only those with complete information on diet, PA, sedentary behaviors and body composition were included (n=11 674, 50.8% of males).

The study was approved by the local Ethics Committees in each centre involved. Parents provided written informed consent for all examinations.

Socio-economic factors

Information on socio-demographic factors was collected by means of a standardized self-reported parental questionnaire including sex, age, and parental educational level. Parental educational level was classified according to the International Standard Classification of Education [83], and used as a proxy indicator of socio-economic status (SES).

Measures:

Diet

F&V and SSB consumption were assessed using the proxy-administered food frequency section of the Children's Eating Habits Questionnaire (CEHQ-FFQ) [109, 110]. Parents reported the number of times the child had eaten or drunk these items during a typical week in the previous month. A scale with eight frequency categories was used: (1) never/less than once a week, (2) 1-3 times/ week, (3) 4-6 times/ week, (4) once per day, (5) 2 times/ day, (6) 3 times/ day, (7) 4 or more times per day, and (8) I have no idea. Frequencies were converted into times per week ranging from 0 to 30. The following conversion factors were applied to obtain estimates of weekly consumption: category 1= 0 times/week, 2= 2 times/week, 3= 5 times/week, 4= 7 times/week, 5= 14 times/week, 6= 21 times/week, 7= 30 times/week and 8= missing. From the 43 food groups included in the questionnaire only five were used: cooked vegetables, potatoes, and beans; raw vegetables; fresh fruit; fresh fruits with added sugar, and SSB. According to the purpose of the present analysis, F&V were put together into one group.

Sedentary behaviors

A standardized parental-report questionnaire was used to obtain information on child's PA and sedentary behavior. Parents reported hours of TV/DVD/video viewing separately for weekday and weekends. Response categories included: (0) not at all, (1) ≤ ½ hour/day, (2) ≤ 1 hour/day, (3) between 1-<2 hours/day, (4) between 2-<3 hours/day, (5) ≥ 3 hours/day. Total sedentary minutes per day were estimated as follows: category 0 = 0 min, 1 = 15 min, 2 = 45 min, 3 = 90 min, 4 = 150 min and 5 = 220 min, respectively. Total sedentary weekly time was calculated taking the mean time in the selected category separately for weekdays and weekends and multiplying each mean with the corresponding number of days, divided by seven, i.e.: *[((weekdays * 5) + (weekends·* 2))/60)] / 7.*

Screen-time behavior was used as an indicator of sedentary behavior based on the fact that TV viewing is the dominant sedentary behavior during leisure time in young children [111].

Physical activity

PA was obtained from the time the children participated in sports club activities per week. Proxies reported hours and minutes of participation in sports club activities per week. Total PA weekly time (hours) was calculated applying the following formula: *[Hours+ (Minutes/60)].*

Body composition:

Weight, height and skinfold thickness of the children were measured by trained [84]. Weight was recorded to the nearest 0.1 kg using a digital scale (Type TANITA BC 420 SMA) and height to the nearest 0.1 cm, using a telescopic height measuring instrument (Type SECA 225). Skinfold thicknesses were measured after previous landmarking using skinfold calliper (Type Holtain

Tanner/Whitehouse Lt., Crosswell, UK). Skinfold measurements were taken at the following sites: (1) triceps, halfway between the acromion and the olecranon process at the back of the arm; and (2) subscapular about 20 mm below the tip of the scapula, at an angle of 45º to the lateral side of the body. Only light indoor clothing could be worn. The reliability of the body composition measurements was studied in 298 children (mean age of 5.4 (±1.2) years). Intra and inter- observer reliability was higher than 0.95 and 0.88, respectively [85]. Body mass index (BMI) was calculated thereafter (kg/m^2). In addition, all skinfolds were summed up. Based on these measures, sex- and age-specific BMIz, waist circumference z-scores (WCz) and sum of skinfolds z-scores (SSz) were computed in the sample. Excess of BMI, waist circumference and sum of skinfolds were considered when z-scores were higher than 1.

Statistical analyses

The Predictive Analytics SoftWare (PASW) version 18.0 (SPSS Inc., Chicago, IL, USA) was used to analyze the data. Statistical analyses were stratified by sex. For the creation of behavioral cluster profiles, food and drink consumption, sport participation and TV/DVD/video indicators were considered as standardized continuous variables. The two-steps analysis used a combination of hierarchical and non-hierarchical clustering methods [112]. In the first step, a hierarchical cluster analyses was carried out using the Ward's method based on Euclidean distances. Since the Ward's method is sensitive to the influence of outliers, we decided to omit extreme values from subsequent analyses. We considered values of more than 3 standard deviations (SD) above or below the mean as univariate outliers and individuals with high Mahalanobis values as multivariate outliers. We applied Ward's method to get clusters of a meaningful size.

In the second step, an iterative non-hierarchical K-means clustering procedure was applied in which initial cluster centers based on Ward's hierarchical method were used as non-random starting points. To examine the stability of the found cluster solution, 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 centers of the other half of the sample. These new clusters were then compared for agreement with the originals by means of Cohen's kappa (k). Agreement was excellent (0.985 and 0.983 in males and females) [113].

One-way analysis of variance (ANOVA) was used to compare characteristics between clusters. Differences in z-score body composition indicators (BMIz, WCz and SSz) according to each cluster were analyzed by one-way analysis of covariance (ANCOVA), adjusted for SES and age. Bonferroni correction was used for post hoc multiple comparisons test. Binary logistic regression analyses were performed to estimate the odds ratio (OR) (CI 95%) for each z-score body composition indicator (dichotomization based on >1 SD above the mean) by specified cluster after adjusting for SES and age.

Results

Cluster analysis resulted in a six cluster solution as the most appropriate to define obesity-related indicators in the IDEFICS population in both genders. **Figure 1** describes the six obtained cluster solutions: C1 to C6. Distinguishing characteristics of each cluster by sex were indicated by high or low z-scores.

Differences between main characteristic of each cluster solution in terms of age, SES and crude BMI, and means of each behavior reported in times or hours per week (mean ± SD) are described in **Table 1**. C1 comprised of children with a high level of PA, whereas C2 consists of children with a high level of sedentary activities. Children in Cluster 3 were characterized by high level of PA and sedentary behaviors. Children in Cluster 4 were characterized by high SSB consumption, whereas children in C5 were characterized by low SSB consumption and low level of sedentary activities. High consumption of F&V and low consumption of SSB and low level of sedentary behaviors characterized C6. Those clusters characterized by high level of PA (C1 and C3) included a high proportion of children between 6 to 9 years. In addition, those clusters characterized by low beverage consumption (C5 and C6) included a high proportion of children between 2 to 6 years. A high proportion of children with low SES were found in the cluster with the highest SSB consumption (C4). Clusters by sex-group were significantly different for age, SES and crude BMI.

Table 2 presents the means and standard errors of BMIz, WCz and SSz by each cluster for males and females separately. The children in the clusters with the highest mean sedentary time, namely C2 and C3, had statistically significant higher BMIz, WCz and SSz (in both males and females) ($p<0.05$) compared to children in the remaining clusters (C1, C4-C6).

Table 3 presents the results of the logistic regression analyses estimating the odds of having BMIz, WCz and SSz equal to or higher than 1. None of the cluster obtained positive scores in all the behaviors, for this reason C6 was chosen as the reference cluster because it obtained a positive score in three behaviors. In males, being in the C2 with the highest average of sedentary time increased the odds of being overweight/ obese when considering BMIz as an indicator of body composition (OR 1.33; 95%CI 1.01,1.74) compared to C6. The same trend was observed considering the WCz, for males in the cluster with the highest time spent in sedentary behaviors (C2) (OR 1.41; 95%CI 1.06, 1.86) compared to C6. No significant effect was observed for the z-score indicators in the group of females. In addition, no significant effect was observed in SSz indicators in both genders.

Discussion

This study examined the association between clusters of lifestyle obesity-related behaviors and indicators of body composition in a sample of young children participating in a pan-European study. Such behaviors that are established early during childhood are important determinants of adult health. Despite their acknowledged independent influence, little evidence exists on their synergetic effect in various population groups.

The four behaviors included in the cluster analysis were those considered in the intervention that was conducted later in intervention communities [114]. Adherence to F&V recommendations (5 portions/day) in our sample was low (17% in both sexes) [115]. No recommendations for SSB exists, but the European Society for Pediatric Gastroenterology, Hepatology and Nutrition suggests water as the main source of fluids for children instead of SSB, to avoid the development of obesity in children [116]. During the last years, the consumption of SSB has increased in several developed countries [117-119]. Our results are in line with such findings and suggest that 9% of children usually drink close to one SSB per day. Sedentary time in all clusters remained slightly below the established threshold for media time (2 hours/day) [120]. All

clusters, even those characterized by higher PA, were far from meeting recommendations for moderate to vigorous (M-V) PA (≥1 hour/day) [121].

Six stable clustering patterns were found in both genders, while correlations between the health indexes per se were low (see Table A in the appendix). This confirms the hypothesis that low correlations do not exclude co-occurrence of health-related behavioral indicators within certain groups, i.e. consumption of F&V and SSB, time spent in PA, and time spent in sedentary behaviors. Our study provides the evaluation and assessment of several clusters from early ages, and their relation with body composition determinants such as BMI, waist circumference or skinfolds. To the authors' knowledge this is the first study to report clusters of all four obesity-related behaviors in children aged between 2 to 9 years and addressing the relationship between them and indicators of body composition.

In our study, C6 showed a healthy eating pattern (high F&V consumption and low SSB consumption) and little time spent in sedentary behaviors; however, at the same time, subjects' participation in sport activities was low (17% in both sexes). Sabbe et al. reported that only 18% of their sample was included in the healthy pattern based on M-VPA and two dietary indexes in a sample of Flemish children (mean age of 10 years old) [102]. The same proportion was observed by Ottevaere et al. for a European sample of adolescents [107]. However, Landsberg et al. similar to our findings, did not find a healthy cluster in a longitudinal study with European adolescents [122].

Children being part of the clusters with high PA (C1 and C3) were older, indicating increases in structured activities and PA with age in our group. In line with Landsberg et al. the same behavioral patterns for males and females was found [122]. A high proportion of children in Cluster 4 (high beverage consumption) was allocated to the low SES in contrast to Te Velde et al. [103].

For BMIz scores, significant differences were found among the clusters, showing higher mean BMIz in those clusters with high levels of PA and sedentary behaviors. In our study the cluster characterized by high sedentary activities, low F&V and low SSB consumption (C2) was the only cluster significantly associated with high BMIz and WCz, compared to C6 (high F&V consumption, low SSB consumption, and low sedentary time). Boys in C2 were those with the highest risk to have excess BMIz and WCz. Our findings are in contrast to those of Ottevaere et al. and Sabbe et al. who reported no significant differences among clusters for BMI [102, 107]. Children practicing specific health-related behaviors are not compulsory involved in other specific health-behaviors, i.e. those children in C3 have high levels of PA and sedentary behaviors at the same time, in concordance with previous studies [102, 123].

The importance of examining the joint influence of energy-balance related behaviors is highlighted by a recent study in adolescents showing that sedentary behaviors were related to higher odds of SSB and lower odds of fruit consumption [124]. It is reasonable to assume that having a diet rich in F&V and low sedentary behaviors are components related to a healthier body composition profile. The combined influence of the three behaviors could be the key in formulating further research questions. Similarly to our findings, several studies[103, 122] indicated that sedentary behaviors are not necessarily barriers for PA, and could coexist in the same population (C3 in both genders) [125]. On the other hand, in the logistic regression analysis our results in children did not support the findings of Boone-Heinonen et al. showing that adolescents being in a cluster characterized by participation in school clubs and sports had the

lowest risk of overweight [98]. Regarding potential effects on body composition, findings of a longitudinal study reported that individuals showing the highest levels of TV consumption during childhood had the greatest increase in body fat over time.[125]

Strengths and limitations

This study is not without limitations. Firstly, the cross-sectional nature of the data must be emphasized which means that no causal conclusions can be drawn. It should be taken into consideration that data from diet, PA and sedentary behaviors are based on parental-reported questionnaires. In addition, the assessment of energy balance related behaviors has been shown to be difficult and complex in young children [126]. However the questionnaires used in this study have been tested and validated before [109].

One of the strengths of the IDEFICS study is the broad range of examinations of obesity-related behaviors on a European scale. Cluster analysis is a method valuable for identifying complex and multifactorial behavior patterns that might be useful to develop tailored interventions. In order to address robustness of the cluster solutions, we replicated these clusters in a 50% internal random sample and obtain excellent stability. However, should consider the fact that cluster analysis is more an exploratory method being rather sensitive to changes.

Conclusions

It is important to consider multiple lifestyle-related health factors in classifying individuals. Most children were not included in the healthy clusters. Clusters characterized by high sedentary behaviors can be considered as the most obesogenic in children. In boys, coexistence with low levels of PA and low F&V consumption was the most deleterious association. Promotion of recommended amounts of these behaviors (<2 hours/day of screen time, >60 minutes/day of M-VPA and >5 portions/day of F&V intake) should be promoted in order to avoid the development of obesity. Thus, our research supports the key messages of the primary prevention programme developed in course of the IDEFICS study [114] that focused on lowering sedentary time and increasing PA and F&V consumption as main targets of the intervention.

Conflict of interest

None declared

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Figure 1. Cluster solutions and mean z-scores of obesity- related behaviors in boys and girls

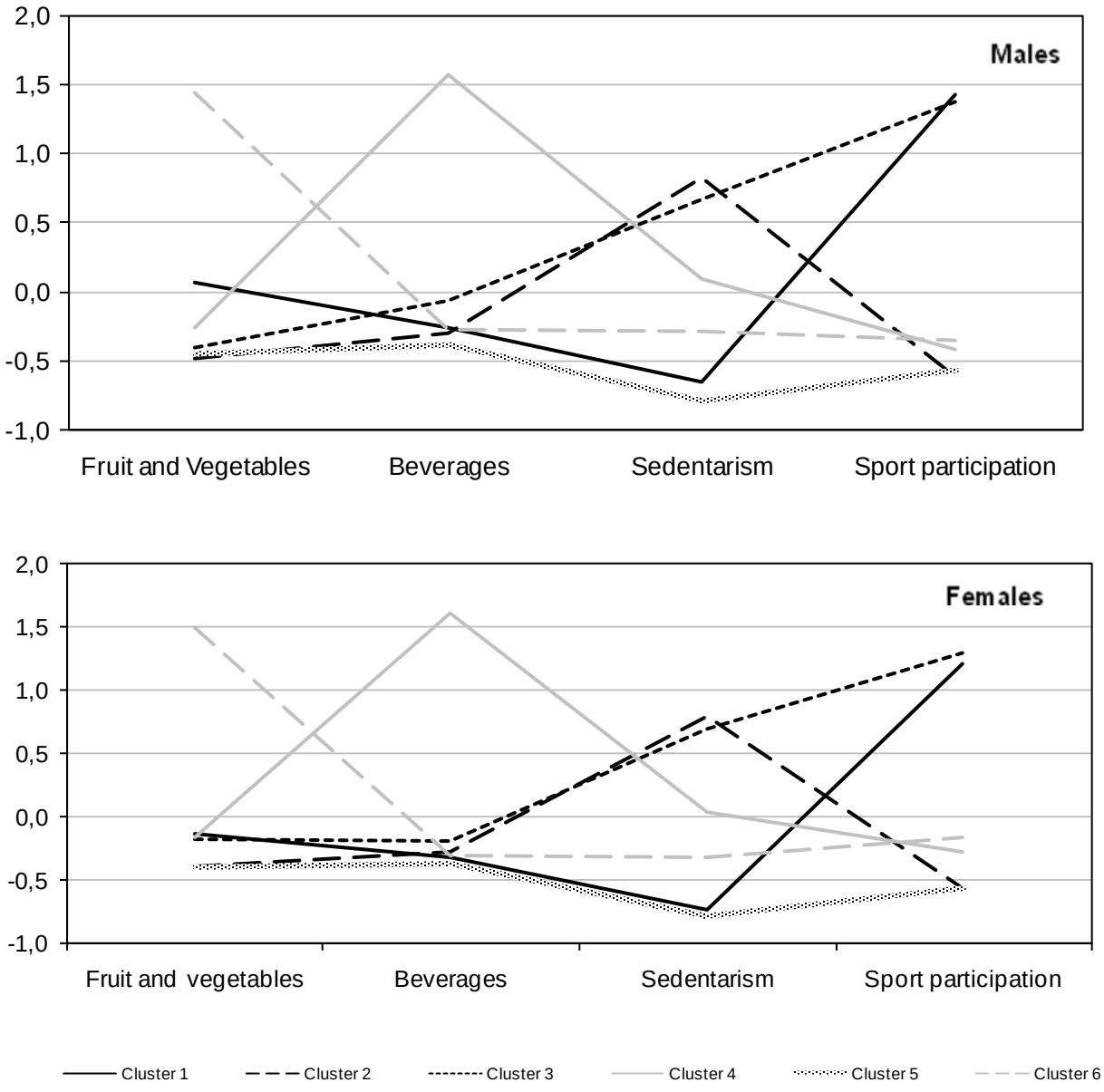

Table 1. Description of socio-demographic and behavioral factors within the clusters

Girls (n=5 932)		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	P value (cluster differences)
N (%)		819 (14)	1307(22)	746(13)	529(9)	1 523(25)	1 008(17)	
Age	*X ±SD*	6.98 (1.29)	5.57 (1.73)	7.24 (1.15)	5.92 (1.78)	5.15 (1.78)	5.46 (1.79)	<0.001††
	Groups: 2-<6 years/6-9 years(%)	19/81	58/42	14/86	46/54	66/34	59/41	<0.001†
SES	*Low/ medium/ high(%)*	6/48/46	11/55/34	7/53/40	19/53/29	9/47/44	10/45/45	<0.001†
BMI	*X ±SD (kg/m2)*	16.60 (2.56)	16.55 (2.55)	17.06 (2.83)	16.37 (2.43)	16.11 (2.13)	16.21 (2.26)	<0.001††
Fruit &Vegetables consumption								**F**
	X ± SD (times/week)	31.50 (13.87)^{abcde}	22.15 (10.13)^{agi}	23.54(11.84)^{bjl}	25.86 (12.30)^{cgjmn}	22.73 (9.27) ^{dmo}	54.84 (10.97) ^{eilno}	1342.01*
Beverages consumption								
	X ± SD (times/week)	0.86 (1.50) ^{bcd}	0.74 (1.05)^{fgh}	1.44 (1.84)^{bjl}	6.13 (0.99)^{cgjmn}	0.54 (0.89)^{dmo}	0.84 (1.36)^{eilno}	1772.03*
Sedentary time								
	X ± SD (hours/week)	5.95 (2.31)^{bcd}	13.60 (3.20)^{fgh}	12.84 (3.03)^{bfjkl}	9.80 (4.26)^{cgjmn}	5.32 (2.29)^{dhkmo}	7.87 (3.94)^{lno}	1404.58*
Sport participation								
	X ± SD (hours/week)	2.77 (0.83)^{acde}	0.12 (0.34)^{afgi}	2.71 (0.84)^{fjkl}	0.37 (0.72)^{cgjm}	0.18 (0.40)^{dkmo}	0.46 (0.77)^{eilo}	3626.83*
Boys (n=5 742)		**Cluster 1**	**Cluster 2**	**Cluster 3**	**Cluster 4**	**Cluster 5**	**Cluster 6**	**P value (cluster differences)**
N (%)		775 (14)	1 228 (21)	580 (10)	529 (9)	1 678 (29)	952 (17)	
Age	*X ±SD*	6.78 (1.42)	5.85 (1.79)	7.00 (1.36)	6.15 (1.75)	5.38 (1.84)	5.71 (1.84)	<0.001††
	Groups:2-<6 years/6-9 years(%)	25/75	50/50	21/79	43/57	60/40	51/49	<0.001†
SES	*Low/medium/high(%)*	7/48/45	11/55/34	7/55/38	16/58/26	8/47/45	8/48/44	<0.001†
BMI	*X ±SD (kg/m2)*	16.5 (2.56)	16.50 (2.52)	17.00 (2.84)	16.44 (2.49)	16.10 (2.23)	16.30 (2.33)	<0.001††
Fruit &Vegetables consumption								**F**
	X ± SD (times/week)	27.98 (11.93)^{ade}	23.36 (10.55)^{afgi}	27.27 (13.62)^{fk}	27.54 (12.95)^{gmn}	23.55 (9.52)^{dkmo}	55.84 (10.40)^{eilno}	1266.27*
Beverages consumption								
	X ± SD (times/week)	0.66 (1.17)^{bc}	0.76 (1.04)^{fgh}	1.06 (1.51)^{bfjkl}	6.22 (0.98)^{cgjmn}	0.55 (0.92)^{hkmo}	0.73 (1.22)^{lno}	2385.89*
Sedentary time								
	X ± SD (hours/week)	5.53 (2.09)^{abce}	13.39 (3.02)^{afghi}	12.93 (2.73)^{bfjkl}	9.52 (4.18)^{cgjmn}	5.29 (2.33)^{hkmo}	7.66 (3.73)^{eilno}	1498.75*
Sport participation								
	X ± SD (hours/week)	2.48 (0.80)^{acde}	0.17 (0.38)^{afgi}	2.59 (0.84)^{fjkl}	0.55 (0.84)^{cgjmn}	0.17 (0.37)^{dkmo}	0.69 (0.90)^{dhkmo}	2437.26*

Differences in specified characteristics across clusters using Pearson chi-squared test for categorized variables (†) and t-test for continuous variables(††) * p<0.001. a to o Cluster significant differences (p<0.05) using ANOVAS and Bonferroni post-hoc test.

[a] Significant difference between C1 and C2
[b] Significant difference between C1 and C3
[c] Significant difference between C1 and C4
[d] Significant difference between C1 and C5
[e] Significant difference between C1 and C6
[f] Significant difference between C2 and C3
[g] Significant difference between C2 and C4
[h] Significant difference between C2 and C5
[i] Significant difference between C2 and C6
[j] Significant difference between C3 and C4
[k] Significant difference between C3 and C5
[l] Significant difference between C3 and C6
[m] Significant difference between C4 and C5
[n] Significant difference between C4 and C6
[o] Significant difference between C5 and C6

Table 2. Body composition (BMI, Waist circumference, and Sum skinfolds) z-score according to six-cluster solution.

Clusters	*BMI z-score*		*Waist circumference z-score*		*Sum of skinfolds z-score*	
	Mean	Standard Error	Mean	Standard Error	Mean	Standard Error
Boys						
Cluster 1	-0.041[b]	0.035	-0.095[a]	0.035	-0.056[a]	0.036
Cluster 2	0.053[d]	0.027	0.093[acde]	0.028	0.081[a]	0.029
Cluster 3	0.119[bfgh]	0.037	0.051[f]	0.037	0.034	0.038
Cluster 4	-0.076[f]	0.043	-0.137[cf]	0.043	-0.063	0.045
Cluster 5	-0.059[dg]	0.026	-0.057[d]	0.026	-0.031	0.027
Cluster 6	-0.047[h]	0.031	-0.052[e]	0.031	-0.025	0.032
Girls						
Cluster 1	-0.037[b]	0.036	-0.089[a]	0.036	-0.004	0.037
Cluster 2	0.044	0.028	0.085[acd]	0.028	0.084	0.030
Cluster 3	0.136[bfg]	0.041	0.074	0.041	0.136	0.043
Cluster 4	-0.047[f]	0.043	-0.083[c]	0.043	-0.045	0.045
Cluster 5	-0.038[g]	0.024	-0.066[d]	0.024	-0.011	0.026
Cluster 6	0.007	0.032	0.001	0.032	0.011	0.034

Covariates: Socioeconomic status and age.
[a] Significant difference between 1st and 2nd cluster
[b] Significant difference between 1st and 3rd cluster
[c] Significant difference between 2nd and 4th cluster
[d] Significant difference between 2nd and 5st cluster
[e] Significant difference between 2nd and 6th cluster
[f] Significant difference between 3rd and 4th cluster
[g] Significant difference between 3rd and 5th cluster
[h] Significant difference between 3rd and 6th cluster

Table* 3. Binary logistic regression analyses between clusters of obesity-related behaviors and excessive BMI,* abdominal adiposity** and fat**

Clusters	*BMI z-score*	*Waist circumference z-score*	*Sum of skinfolds z-score*)
	OR (95%IC)	**OR (95%IC)**	**OR (95%IC)**
Boys			
Cluster 1	1.04(0.76,1.41)	0.95(0.70,1.30)	1.05(0.75,1.45)
Cluster 2	**1.33(1.01,1.74)**	**1.41(1.06,1.86)**	1.31(0.97,1.78)
Cluster 3	1.22(0.90,1.65)	1.09(0.80,1.49)	1.11(0.80,1.54)
Cluster 4	0.95(0.67,1.35)	0.72(0.49,1.06)	0.79(0.53,1.17)
Cluster 5	0.98(0.74,1.30)	0.93(0.69,1.24)	0.99(0.72,1.36)
Cluster 6	*Ref*	*Ref*	*Ref*
Girls			
Cluster 1	0.85(0.63,1.13)	0.79(0.59,1.07)	0.85(0.63,1.16)
Cluster 2	1.03(0.80,1.33)	1.25(0.96,1.62)	1.08(0.83,1.42)
Cluster 3	1.13(0.84,1.51)	0.96(0.70,1.30)	1.22(0.90,1.65)
Cluster 4	0.88(0.64,1.21)	0.78(0.55,1.10)	0.82(0.58,1.15)
Cluster 5	0.85(0.66,1.10)	0.85(0.65,1.11)	0.85(0.65,1.12)
Cluster 6	*Ref*	*Ref*	*Ref*

OR: Odds Ratio. CI: Confidence Interval. Covariates: Socioeconomic status and age.
*Excess of BMI was based on BMI (equal or higher to one SD above the mean). **Excess of abdominal adiposity was based on waist circumference > 1 SD. ***Excess of fat was based on sum of skinfolds > 1 SD

Supplementary Material

Table A. Spearman rank correlation coefficients of obesity-related risk behaviors among males (in bold) and females participating in the IDEFICS study.

	Fruit& vegetables consumption (times/week)	Beverages consumption (times/ week)	Sedentary time (h/week)	Sport participation (h/week)
Fruit & vegetables consumption (times/week)	-	0.026*	-0.092**	0.055**
Beverages consumption (times/ week)	0.031**	-	0.145**	0.022
Sedentary time (h/week)	-0.064**	0.150**	-	-0.009
Sport participation (h/week)	0.082**	-0.020**	-0.014	-

* significant at the 0.05 level (2-tailed)

** significant at the 0.01 level (2-tailed)

References

1. NIH. Strategic plan for National Institutes of Health obesity research: a report of the NHI Obesity Task Force. 2011.
2. Global Strategy on diet and Physical Activity. World Health Assembly 5717. Geneva: World Health Organization; 2004.
3. Rey-Lopez JP, Vicente-Rodriguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. Nutr Metab Cardiovasc Dis2008 Mar;18(3):242-51.
4. Moreno LA, Rodriguez G. Dietary risk factors for development of childhood obesity. Curr Opin Clin Nutr Metab Care2007 May;10(3):336-41.
5. Janz KF, Burns TL, Levy SM. Tracking of activity and sedentary behaviors in childhood: the Iowa Bone Development Study. Am J Prev Med2005 Oct;29(3):171-8.
6. Boone-Heinonen J, Gordon-Larsen P, Adair LS. Obesogenic clusters: multidimensional adolescent obesity-related behaviors in the U.S. Ann Behav Med2008 Dec;36(3):217-30.
7. Maffeis C. Aetiology of overweight and obesity in children and adolescents. Eur J Pediatr2000 Sep;159 Suppl 1:S35-44.
8. Cameron AJ, Crawford DA, Salmon J, Campbell K, McNaughton SA, Mishra GD, et al. Clustering of obesity-related risk behaviors in children and their mothers. Ann Epidemiol2011 Feb;21(2):95-102.
9. French S, Rosenberg M, Knuiman M. The clustering of health risk behaviours in a Western Australian adult population. Health Promot J Austr2008 Dec;19(3):203-9.
10. Sabbe D, De Bourdeaudhuij I, Legiest E, Maes L. A cluster-analytical approach towards physical activity and eating habits among 10-year-old children. Health Educ Res2008 Oct;23(5):753-62.
11. te Velde SJ, De Bourdeaudhuij I, Thorsdottir I, Rasmussen M, Hagstromer M, Klepp KI, et al. Patterns in sedentary and exercise behaviors and associations with overweight in 9-14-year-old boys and girls--a cross-sectional study. BMC Public Health2007;7:16.
12. Vries Hd, Kremers S, Smeets T, Reubsaet A. Clustering of diet, physical activity and smoking and a general willingness to change. Psychology & Health2008 2011/09/01;23(3):265-78.
13. De Vries H, van 't Riet J, Spigt M, Metsemakers J, van den Akker M, Vermunt JK, et al. Clusters of lifestyle behaviors: Results from the Dutch SMILE study. Preventive Medicine2008;46(3):203-8.
14. Bel-Serrat S, Mouratidou T, Santaliestra-Pasias AM, Iacoviello L, Kourides YA, Marild S, et al. Clustering of multiple lifestyle behaviours and its association to cardiovascular risk factors in children: the IDEFICS study. Eur J Clin Nutr2013 Aug;67(8):848-54.
15. Ottevaere C, Huybrechts I, Benser J, De Bourdeaudhuij I, Cuenca-Garcia M, Dallongeville J, et al. Clustering patterns of physical activity, sedentary and dietary behavior among European adolescents: The HELENA study. BMC Public Health2011;11:328.
16. Ahrens W, Bammann K, de Henauw S, Halford J, Palou A, Pigeot I, et al. Understanding and preventing childhood obesity and related disorders--IDEFICS: A European multilevel epidemiological approach. Nutrition, Metabolism and Cardiovascular Diseases2006;16(4):302-8.
17. Ahrens W, Bammann K, Siani A, Buchecker K, De Henauw S, Iacoviello L, et al. The IDEFICS cohort: design, characteristics and participation in the baseline survey. Int J Obes (Lond)2011 Apr;35 (Suppl 1):S3-15.
18. Bammann K, Peplies J, Sjöström M, Lissner L, De Henauw S, Galli C, et al. Assessment of diet, physical activity and biological, social and environmental factors in a multi-centre European project on diet- and lifestyle-related disorders in children (IDEFICS). Journal of Public Health2006;14(5):279-89.

19. UNESCO. United Nations Educational Scientific and Cultural Organization. International Standard Classitication of Education. 2010 [April 2012]; Available from: http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx.
20. Lanfer A, Hebestreit A, Ahrens W, Krogh V, Sieri S, Lissner L, et al. Reproducibility of food consumption frequencies derived from the Children's Eating Habits Questionnaire used in the IDEFICS study. Int J Obes (Lond)2011 Apr;35 Suppl 1:S61-8.
21. Huybrechts I, Bornhorst C, Pala V, Moreno LA, Barba G, Lissner L, et al. Evaluation of the Children's Eating Habits Questionnaire used in the IDEFICS study by relating urinary calcium and potassium to milk consumption frequencies among European children. Int J Obes (Lond)2011 Apr;35 Suppl 1:S69-78.
22. Kaiser Family Foundation. Generation M: media in the lives of 8-18-year-olds. The Henry J. Kaser Family Foundation; 2010; Available from: http://kff.org/entmedia/mh012010pkg.cfm.
23. Bammann K, Sioen I, Huybrechts I, Casajus JA, Vicente-Rodriguez G, Cuthill R, et al. The IDEFICS validation study on field methods for assessing physical activity and body composition in children: design and data collection. Int J Obes (Lond)2011 Apr;35 Suppl 1:S79-87.
24. Stomfai S, Ahrens W, Bammann K, Kovacs E, Marild S, Michels N, et al. Intra- and inter-observer reliability in anthropometric measurements in children. Int J Obes (Lond)2011 Apr;35 Suppl 1:S45-51.
25. Gore PA. Cluster analysis. In: Brown HEATaSD, editor. Handbook of appied multivariate statistics and mathematical modeling. San Diego, CA: Academic Press; 2000. p. 297-321.
26. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. Fam Med2005 May;37(5):360-3.
27. De Henauw S, Verbestel V, Marild S, Barba G, Bammann K, Eiben G, et al. The IDEFICS community-oriented intervention programme: a new model for childhood obesity prevention in Europe? Int J Obes (Lond)2011 Apr;35 Suppl 1:S16-23.
28. Fruit and Vegetable promotion Initiative - report of the meeting. Geneva World Health Organization 2003.
29. Agostoni C, Braegger C, Decsi T, Kolacek S, Koletzko B, Mihatsch W, et al. Role of dietary factors and food habits in the development of childhood obesity: a commentary by the ESPGHAN Committee on Nutrition. J Pediatr Gastroenterol Nutr2011 Jun;52(6):662-9.
30. Naska A, Bountziouka V, Trichopoulou A. Soft drinks: time trends and correlates in twenty-four European countries. A cross-national study using the DAFNE (Data Food Networking) databank. Public Health Nutr2010 Sep;13(9):1346-55.
31. Popkin BM. Patterns of beverage use across the lifecycle. Physiol Behav2010 Apr 26;100(1):4-9.
32. Duffey KJ, Huybrechts I, Mouratidou T, Libuda L, Kersting M, De Vriendt T, et al. Beverage consumption among European adolescents in the HELENA study. Eur J Clin Nutr2011 Feb;66(2):244-52.
33. American Academy of Pediatrics. Children, adolescents, and television. Pediatrics. 2001/02/07 ed2001. p. 423-6.
34. Physical Activity Guidelines for Americans. In: (US) DoHHS, editor.2008.
35. Landsberg B, Plachta-Danielzik S, Lange D, Johannsen M, Seiberl J, Muller MJ. Clustering of lifestyle factors and association with overweight in adolescents of the Kiel Obesity Prevention Study. Public Health Nutr2010 Oct;13(10A):1708-15.
36. De Bourdeaudhuij I, van Oost P. A cluster-analytical approach toward physical activity and other health related behaviors. Med Sci Sports Exerc1999 Apr;31(4):605-12.
37. Santaliestra-Pasías AM, Mouratidou T, Verbestel V, Huybrechts I, Gottrand F, Le Donne C, et al. Food consumption and screen-based sedentary behaviors in European adolescents. The HELENA study. Arch Pediatr Adolesc Med2012;in press.

38. Proctor MH, Moore LL, Gao D, Cupples LA, Bradlee ML, Hood MY, et al. Television viewing and change in body fat from preschool to early adolescence: The Framingham Children's Study. Int J Obes Relat Metab Disord2003 Jul;27(7):827-33.

39. Mouratidou T, Mesana MI, Manios Y, Koletzko B, Chinapaw MJ, De Bourdeaudhuij I, et al. Assessment tools of energy balance-related behaviours used in European obesity prevention strategies: review of studies during preschool. Obes Rev2012 Mar;13 Suppl 1:42-55.

8. Discusión [Discussion]

8.1 Prevalencia de comportamientos sedentarios y relación entre ellos

Los estilos de vida se han modificado a lo largo de las últimas décadas, incrementándose las actividades recreativas basadas en tecnologías y medios electrónicos, en detrimento del tiempo dedicado a realiza la AF. Además todas aquellas actividades que requieren un bajo gasto energético están aumentado en población infantil y adulta, incluyendo el tiempo dedicado a ver la televisión, utilizar el ordenador, el tiempo de colegio/ instituto, leer o escuchar música. Entre todos los comportamientos sedentarios, el tiempo total de pantalla es el más prevalente, dado que incluye todas las actividades realizadas en frente de una pantalla (televisión, ordenadores, vídeos y videoconsolas).

Se han asociado los comportamientos sedentarios a diversos problemas de salud como es el caso de la obesidad. Ésta tiene una causa multifactorial, pero se considera que entre los factores causales, podría estar el vínculo de los comportamientos sedentarios, debido a diferentes aspectos: (1) el tiempo dedicado a ver la televisión desplaza la práctica de AF [127]; (2) publicidad de alimentos poco saludables en medios de difusión como la televisión; (3) consumir alimentos de forma inconsciente y automática mientras se ve la televisión, o los anuncios de la misma, incluso en ausencia de sensación de hambre,[128] provocando una ingesta de energía superior; (4) ser un medio de distracción, que origina un mayor consumo de alimentos si se come enfrente de la televisión[129]; (5) estar asociados con hábitos alimentarios menos saludables, por ejemplo, con un consumo de alimentos de elevada densidad energética,[130] con un mayor consume de dulces, snacks y refrescos, y menor de frutas y vegetales.[131, 132]

Tras evaluar los principales factores ligados a los comportamientos sedentarios, se ha considerado esencial describir y comparar la información relativa a los mismos, así como a la AF entre los diferentes países europeos. La descripción en base a las recomendaciones internacionales para el tiempo total de pantalla se ha utilizado para valorar la adecuación de las mismas en los diferentes países. De forma global, un 29% (33% en los niños y 25% en las niñas) no cumplen con las recomendaciones de tiempo total de pantalla (<2horas/día), especialmente en los días de fines de semana. Así mismo, es importante destacar que los niños de mayor edad (6-8 años) exceden las recomendaciones en una mayor proporción (43% en los niños y 31% en las niñas), incrementándose especialmente durante los fines de semana (71% en los niños, y 57% en las niñas). En la misma línea que los resultados encontrados se ha observado, en una muestra de niños en edad escolar españoles, que cuando son más mayores, más tiempo dedican a actividades sedentarias.[133] En el estudio IDEFICS se ha observado una

mayor proporción de tiempo dedicado a ver la televisión en los niños y niñas más mayores (de 6 a 8 años), comparado con los más jóvenes (de 2 a 5.99 años); en otros estudios no se han observado diferencias entre el tiempo dedicado a diversas conductas sedentarias y la edad de los participantesos grupos dela participación.[19, 39, 134] Por otro lado, se han observado diferencias de género en el tiempo dedicado a diversos comportamientos sedentarios, lo cual está en concordancia con resultados observados en diferentes países.[3]

En relación a la práctica deportiva, se ha observado que la práctica de dichas actividades en clubs deportivos o actividades organizadas, es del 43% (42% en niños y 44% en niñas). Se ha observado una baja adherencia a realizar actividades deportivas en clubs deportivos.[2, 135, 136] Así mismo, es mayor la participación en este tipo de actividades de los niños de mayor edad (6-8 años). La edad temprana es un factor importante en la adquisición de hábitos, y los presentes resultados podrían sugerir que adquirir un comportamiento de AF saludable a edades tempranas podría ser un factor clave en el desarrollo de intervenciones que pretendan prevenir el desarrollo de sobrepeso y obesidad en la edad infantil. La práctica de AF y su relación con la composición corporal es una de las vías potenciales de estudio en el futuro que se deben tener en cuenta, especialmente en edad escolar, como otro de los ejes relacionados con la prevención de diversa enfermedades crónicas. Nuestro estudio Además, en cuanto a la realización de AF, se ha evaluado el medio de trasporte entre los hogares familiares y el colegio, destacando el transporte pasivo (coche o autobús) en la mayoría de los países. En la misma línea en el estudio de Fainardi y cols.,[137] se observó una mayor proporción de niños que utilizan el transporte pasivo como medio habitual observándose una mayor proporción del transporte activo en jóvenes de bajo nivel socioeconómico.[136]

En consistencia con la evidencia existente, tener la televisión en el espacio personal de los niños se ha asociado con un mayor riesgo de superar las recomendaciones de tiempo total de pantalla.[31, 138] No obstante, en poblaciones infantiles, una revisión reciente muestra asociaciones poco claras entre ambos factores.[139] Por otro lado no se han observado relaciones entre la práctica de AF y el tiempo de pantalla, igual que se ha observado en otros estudios que han utilizado mediciones objetivas de AF (acelerometría).[2, 140] En contraposición, en un estudio longitudinal realizado en niños con edades comprendidas entre los 10 y 15 años, se ha observado que no hay relación entre el tiempo de pantalla y la práctica de AF de elevada intensidad en el tiempo libre.[141] Así mismo, tampoco se ha encontrado asociación con la práctica deportiva en adolescentes brasileños.[135] En relación al transporte entre el hogar y el colegio, el transporte pasivo se ha asociado con un menor tiempo total de pantalla, aunque en un estudio previo no se había encontrado ninguna relación.[142]

8.2 Dieta y comportamientos sedentarios

La presente Tesis Doctoral incluye un tercer y cuarto artículo en el que se ha investigado sobre las asociaciones entre los comportamientos sedentarios y la alimentación en jóvenes europeos. En primer lugar se evaluó la relación entre diferentes comportamientos sedentarios y el consumo de diversos grupos de alimentos, reconocidos por su importancia en la asociación con la obesidad infantil.[58] Evaluar el consumo de los mismos, en función de diferentes comportamientos, así como valorar en función de diferentes puntos de corte en función de las recomendaciones establecidas para el tiempo de pantalla total, es el origen para poder determinar si existen diferencias entre los mismos y así poder desarrollar intervenciones efectivas para la prevención de la obesidad infanto-juvenil. Es por ello que se seleccionaron algunos de los grupos alimentarios de mayor relevancia ((1) tartas, pasteles y galletas, (2) aperitivos salados, (3) vegetales, (4) frutas, (5) zumos de frutas y vegetales, (6) refrescos azucarados, (7) leche y (8) postres y pudding derivados de la leche). Además se recogió información de diferentes comportamientos sedentarios (ver televisión, jugar juegos de ordenador, jugar juegos de videoconsola, surfear en internet por motivos de ocio, surfear en internet por motivos escolares y tiempo dedicado al estudio) y se categorizó cada uno de los mismos en <2h/día, 2-4h/día y >4h/día.

Algunos estudios previos habían analizado asociaciones similares, pero focalizadas en un solo comportamiento sedentario, generalmente televisión, y otros solamente se habían centrado en grupos específicos de comida, por ejemplo refrescos,[143] o fruta y vegetales.[48] El presente estudio destaca por la incorporación de diversos comportamientos sedentarios, así como por un análisis detallado de la dieta, incluyendo múltiples grupos alimentarios, lo que permite valorar la alimentación de forma más global.

Los resultados del presente artículo indican que aquellos adolescentes que dedican más tiempo a actividades sedentarias, principalmente televisión, juegos de ordenador y utilizando internet durante su tiempo libre, consumen más refrescos y snacks, así como tienen un menor consumo de frutas.

La influencia paterna y del hogar familiar tiene un impacto esencial en la adquisición de comportamientos saludables.[53, 144] Por ejemplo, consumir más alimentos poco sanos es más frecuente después del horario de colegio, y éste está relacionado a su vez con la libre disposición de alimentos en casa. Así mismo, aquellos adolescentes que no tienen limitaciones para realizar distintas actividades sedentarias, pueden ser aquellos que tampoco tengan limitaciones para el consumo de refrescos y snacks. En la misma línea que nuestros resultados, se ha observado en un grupo de pre-adolescentes que

ver durante 3.5 horas o más al día la televisión se ha relacionado con una odds mayor de consumo de refrescos.[47] Paralelamente, lo adolescentes del estudio HELENA, que dedican más tiempo a ver la televisión o utilizar el ordenador consumen menos frutas. Nuestros resultados están en concordancia con otros estudios realizados en poblaciones infanto-juveniles.[52, 131, 145]

En general el tiempo total de pantalla, y en particular el tiempo dedicado a ver la televisión, se han asociado con prácticas dietéticas insanas [51, 146, 147] lo cual puede explicar parcialmente la relación entre los comportamientos sedentarios y la obesidad.[148] De esta estrecha relación surge el desarrollo del cuarto artículo de la presente Tesis Doctoral. Debido a que los alimentos no se consumen de forma aislada, se pretende evaluar su consumo de forma conjunta, y de esta forma evaluar su asociación con los comportamientos sedentarios recogidos en el estudio HELENA.

La identificación de patrones dietéticos (*dietary patterns*, DP) identifica aquellos alimentos que se tienden a consumir juntos, lo cual permite relacionar estos hábitos alimentarios con otros factores como sería socio-demográficos, de estilos de vida y de salud en general. Así mismo, utilizar los patrones dietéticos es una herramienta que permite valorar al mismo tiempo las posibles interacciones entre los alimentos que se consumen juntos.

En el presente estudio se han identificado 4 DP en los chicos (consumo basado en (1) alimentos vegetales o "plant based", (2) alimentos de picoteo o "snacking", (3) alimentos típicos del desayuno o "breakfast", y (4) alimentos saludables o "health conscious"), y 5 DP en las chicas (consumo basado en (1) alimentos de picoteo dulces y saltados o "confectionary and snacking", (2) alimentos vegetales o "plant based", (3) alimentos típicos del desayuno o "breakfast", (4) alimentos basados en proteínas animales o "animal protein", y (5) alimentos saludables o "health conscious"); el tiempo que los chicos dedican a ver la TV, jugar al ordenador o videoconsolas, y utilizar internet en su tiempo de ocio, se ha asociado positivamente con el DP basado en el picoteo y negativamente con los DP basados en el consumo de alimentos de origen vegetal, en alimentos típicos del desayuno y basado en alimentos saludables. El tiempo que dedican las chicas a ver la televisión y a utilizar internet en su tiempo de ocio se ha asociado positivamente con el DP basado en el picoteo de alimentos dulces y salados, y negativamente con el basado en alimentos saludables.

Un estudio reciente realizado en adolescentes alemanes mostró que las chicas que ven más horas la televisión, tienen una mayor adherencia a los patrones dietéticos tradicionales y occidentales.[149] En la misma línea se ha asociado un mayor tiempo dedicado a ver la televisión y ordenadores con un mayor consumo de refrescos en adolescentes holandeses [150] y con una mayor adherencia al patrón basado en

alimentos de picoteo[151] y al patrón basado en alimentos occidentales[50] en sendos estudios realizados con jóvenes españoles. Así mismo en otro estudio en el que se incluían jóvenes entre los 5 y 17 años, se observó que un patrón dietético más sano estaba asociado con un menor tiempo de pantalla, mientras que al incrementarse éste, se asociaba con un patrón dietético menos saludable.[152] La misma tendencia se ha encontrado en niños en edad preescolar, en los que el tiempo de televisión es un factor predictor de la adherencia al patrón de alimentación occidental,[153] o bien con patrones dietéticos que contienen alimentos ricos en grasas y azúcares añadidos.[154]

Nuestro estudio presenta resultados novedosos relacionando diferentes DP y el tiempo que dedican los adolescentes al estudio. Se ha encontrado una relación positiva en ambos géneros entre los que estudian más de 2 horas al día y una mayor adherencia al patrón de desayuno, así como también al de alimentos de origen vegetal en chicas. Por el contrario, en las chicas, estudiar entre 2 y 4 horas al día, entre semana, se ha asociado negativamente con el DP de picoteo de alimentos dulces y salados. Debido a la novedad de los resultados encontrados, no se ha encontrado información comparable con estudios que vinculen patrones dietéticos y tiempo dedicado al estudio.

Además, en el presente estudio se han encontrado relaciones lineales significativas entre los DP y los comportamientos sedentarios. Nuestros resultados están en la línea de un meta-análisis recientemente publicado, en el que se indican que los comportamientos sedentarios contribuyen a la obesidad debido a que favorecen un consumo excesivo de alimentos.[155] En general, la identificación de DP puede ayudar a generar nuevas hipótesis de trabajo para futuros estudios y/o intervenciones focalizadas en disminuir los DP menos saludables vinculados con los comportamientos sedentarios.

8.3 Estilos de vida y su relación con la composición corporal

Debido a la etiología multifactorial de la obesidad, y teniendo en cuenta los estilos de vida relacionados con la misma se ha incluido en la presente Tesis Doctoral un artículo que agrupa los estilos de vida basados en los tres principales determinantes relacionados con la obesidad como son la alimentación, la AF y los comportamientos sedentarios. Las interacciones entre los diferentes componentes dan como resultado agrupaciones de comportamientos que caracterizan el estilo de vida de los niños. Las agrupaciones de los diferentes comportamientos se han relacionado con indicadores de composición corporal (IMC, perímetro de cintura y sumatorio de pliegues).

En diferentes grupos poblacionales se ha estudiado su efecto de forma aislada, pero en raras ocasiones se ha evaluado su efecto conjunto en relación a indicadores de

composición corporal. Además, la elección de los presentes comportamientos se ha basado en que son conductas que se adquieren en la niñez, y que son importantes determinantes de salud en la edad adulta.

De forma individualizada la adherencia a las recomendaciones internacionales para el consume de frutas y verduras (5 porciones/día) es muy baja en los niños europeos (17% en ambos géneros).[115] En relación al consumo de refrescos no se han establecido recomendaciones internacionales, pero durante los últimos años, se ha incrementado el consumo de refrescos en países desarrollados.[117-119] Un 9% de los niños del presente estudio consumen cerca de un refresco al día, mientras que la Sociedad Europea de Gastronterología, Hepatología y Nutrición Pediátrica *(European Society for Pediatric Gastroenterology, Hepatology and Nutrition* EPSGHAN) recomienda el consumo de agua como la principal fuente de líquiedos para los niños en lugar de los refrescos azucarados como medida preventiva del desarrollo de obesidad en los niños.[116]

En cuanto a las recomendaciones para los comportamientos sedentarios, todos los agrupamientos se mantienen por debajo de las recomendaciones establecidas (2 horas/día).[120] Contrariamente, todos los agrupamientos, incluso aquellos caracterizados por elevados niveles de AF se encuentran lejos de cumplir con las recomendaciones de AF de intensidad moderada-intensa (≥1 hora/día).[121]

En el estudio IDEFICS no se ha encontrado un grupo de niños /as que se caracterice por presentar los cuatro comportamientos saludables (bajo consumo de refrescos, alto consumo de frutas y verduras, bajo tiempo dedicado a conductas sedentarias, y elevado tiempo dedicado a la práctica de AF). El agrupamiento o cluster más saludable se caracterizas por una alimentación saludable (consumo elevado de frutas y verduras, y bajo consume de refrescos) y bajo tiempo dedicado a las actividades sedentarias, pero presentan al mismo tiempo una baja participación en actividades deportivas. En concordancia con nuestros resultados, Landsberg y cols. no encontraron un cluster caracterizado por conductas saludables en todos los determinantes incluidos en un estudio realizado con adolescentes Europeos.[122] Por otro lado, en un estudio realizado en jóvenes belgas de 10 años de edad,[102] se observó que el 17% de los participantes formaba parte del cluster caracterizado por conductas más saludables, aunque los clusters fueron realizados basados en dos índices alimentarios y la AF. La misma proporción la observó Ottevaere y cols. en el estudio HELENA,[107] basando la realización de los clusters en un índice de calidad dietética, la AF y el tiempo sedentario.

Por otro lado, la práctica de una determinada conducta saludable no implica de forma obligatoria la práctica de otra conducta saludable. Nuestros resultados están en la línea de Sabbe y cols.[48] y De Bourdeaudhuij y cols.[123] dado que por ejemplo se han

encontrado en el estudio IDEFICS agrupaciones de comportamientos caracterizadas por elevados niveles de AF así como de conductas sedentarias.

Valorando las características socio-demográficas de los clusters, se ha observado que aquellos agrupamientos caracterizados por elevada AF son los que incluyen los niños más mayores, lo cual indica que las actividades estructuradas aumentan con la edad. En relación a la AF se han encontrado los mismos patrones de comportamiento en ambos géneros, en concordancia con estudios previos.[122] En cuanto al nivel socio-económico, se ha encontrado una mayor proporción de niños de bajo nivel socioeconómico en los clusters caracterizados por un consumo elevado de refrescos.

Relacionar los agrupamientos de conductas con las variables de composición corporal han sido uno de los objetivo, encontrandose diferencias en los valores estandarizados de IMC, mostrando un mayor valor en aquellos agrupamientos caracterizados por elevados niveles de AF y comportamientos sedentarios. Valorando el riesgo de tener un exceso de IMC, perímetro de cintura o sumatorio de pliegues, se encontró que aquellos clusters de chicos caracterizados por elevadas conductas sedentarias, bajo consumo de frutas y verduras y bajo consumo de refrescos (C2) se caracterizó por tener un mayor IMC y perímetro de cintura comparando con el cluster más saludables (elevado consumo de frutas y verduras, bajo consumo de refrescos y bajo tiempo dedicado a conductas sedentarias). Solamente los chicos procedentes del C2 se asociaron con un exceso de IMC y perímetro de cintura. Nuestros resultados discrepan de los observados por Ottevaere y cols. y Sabbe y cols; en ambos estudios no se encontraron diferencias en términos de IMC entre los cluster.[102, 107]

De los resultados obtenidos es razonable deducir que tener una alimentación rica en frutas y verduras combinada con un bajo tiempo dedicado a actividades sedentarias, son características relacionadas con un perfil más saludable en términos de composición corporal. La combinación de las tres conductas relacionadas con el balance energético (alimentación, AF y conductas sedentarias) puede ser la clave para formular futuras investigaciones. Nuestros resultados indican que las conductas sedentarias no son barreras para la práctica deportiva y pueden coexistir en el mismo grupo de jóvenes, igual que lo observado por Proctor y cols.[125] Por otro lado, nuestros resultados no apoyan los encontrados por Boone-Heinonen y cols.[98] que encontraron que aquellos clusters caracterizados por elevada participación en clubs deportivos tenían el menor riesgo de sobrepeso.

Por todo ello, es importante considerar el efecto múltiple de los estilos de vida a la hora de clasificar a los individuos, siendo importante destacar que la mayoría de los niños del presente estudio no presentan conductas saludables en los indicadores evaluados. En niños, las agrupaciones caracterizadas por elevado tiempo dedicado a

conductas sedentarias (televisión) pueden considerarse los más obesogénicos; si bien es cierto que la coexistencia junto con bajos niveles de AF, así como un bajo consumo de frutas y verduras presenta el efecto más perjudicial en población infantil.

Aunar esfuerzos en promocionar las cantidades recomendadas de las conductas relacionadas con el balance energético (<2h/día de tiempo total de pantalla, > 60 minutos/día de AF moderada-intensa y >5 porciones/día de frutas y verduras) son la base para prevenir el desarrollo de obesidad.

8.4 Implicaciones para la salud pública

Los resultados obtenidos en la presente Tesis Doctoral, forman parte de la base para promover estilos de vida saludables en niños y adolescentes europeos. El incremento de estilos de vida inactivos, en los que predominan las actividades sedentarias y que se asocian con una alimentación menos saludable, es uno de los puntos clave valorado en la presente Tesis Doctoral. Los datos obtenidos son herramientas útiles para el diseño de estrategias que fomenten estilos de vida saludables y prevengan de enfermedades crónicas como es el caso de la obesidad.

Evaluar el conocimiento actual de las implicaciones que tienen las conductas sedentarias en la salud (Artículo I) es la base para intervenir sobre aspectos clave que permitan disminuir factores directamente relacionados con enfermedades derivadas de los estilos de vida (obesidad, síndrome metabólico, diabetes tipo 2, enfermedades cardiovasculares). Es esencial conocer aquellos factores causales que desencadenan un aumento de las conductas sedentarias, principalmente en población infanto juvenil, para así poder desarrollar intervenciones específicas y programas de promoción de la salud que reduzcan efectivamente el tiempo dedicado a conductas sedentarias y pasivas.

Por otro lado, las diferencias socio demográficas, culturales y ambientales entre las diferentes regiones de Europa originan a su vez diferentes estilos de vida. Por esa razón, la evaluación de las conductas sedentarias y de AF por países (Artículo II) facilita la comprensión y permite valorar las diferencias entre ellos, aportando información específica según país de procedencia, género y grupo de edad. Al segmentar la información se pueden observar las diferentes conductas de actividad en los niños europeos, de manera que se pueden desarrollar estrategias adaptadas según el país de procedencia y valorando el comportamiento o actividad sobre el que es necesario un mayor esfuerzo.

Además, nuestros resultados (Artículo II) estarían de acuerdo con la recomendación de retirar los aparatos electrónicos de los espacios personales de los niños, debido a su relación con el incremento del tiempo de pantalla total.

En relación con la asociación entre los comportamientos sedentarios y la alimentación (Artículos III y IV) cabe destacar la importancia de los resultados obtenidos como aportación al conocimiento actual. Las conductas relacionadas con el balance energético como son la alimentación, la AF y los comportamientos sedentarios son factores clave en su relación con el sobrepeso y la obesidad en la sociedad actual. Es por ello que analizar la relación entre dos de los factores clave, como son la alimentación y las diversas conductas sedentarias son pieza clave a la hora de establecer las relaciones y asociaciones entre los mismos. En la presente Tesis Doctoral, se han observado asociaciones entre el consumo de diferentes grupos de alimentos y diversas conductas sedentarias. Previamente a nuestro estudio se habían analizado de forma aislada tanto diferentes grupos alimentarios como comportamientos, pero presentar de forma conjunta un compendio de los mismos es una fortaleza del presente estudio. No solamente se ha observado que las conductas más ampliamente estudiadas (tiempo dedicado a ver la televisión y a jugar con los ordenadores) están asociadas con perfiles alimentarios menos saludables, sino que gracias a los presentes resultados se han incorporado actividades más novedosas como es el tiempo dedicado a utilizar internet en el tiempo libre o el tiempo de estudio. Es esencial tener en cuenta que la tendencia de la sociedad actual es tener un estilo de vida más sedentario, que puede modificarse con la práctica deportiva, pero en el día a día se emplea una gran proporción del tiempo en actividades pasivas. Por ello, valorar diferentes actividades sedentarias y su vinculación con la alimentación es esencial, para promover estilo de vida activos, así como para dirigir intervenciones focalizadas en conductas específicas. La inclusión de variables más novedosas como es el caso del uso de internet, que se incrementa día a día en nuestra sociedad, principalmente entre los jóvenes, así como del tiempo de estudio, aporta resultados importantes al conocimiento científico actual, así como a su vinculación con la alimentación. La utilización del tiempo libre dedicado a actividades sedentarias se ha asociado con un patrón alimentario menos saludable, tanto en jóvenes como en adultos, y nuestros resultados están en concordancia con los diferentes resultados que se han publicado al respecto, mostrando la misma tendencia, pero incorporando diferentes grupos alimentarios y conductas sedentarias (Artículo II). Al mismo tiempo, al evaluar la alimentación de forma conjunta valorando aquellos alimentos que tienden a consumirse juntos, en relación a todas las conductas sedentarias (Artículo IV), se ha observado la misma tendencia. Es por ello que los resultados obtenidos apoyan la hipótesis de que tanto las conductas sedentarias más tradicionales (consumo de televisión, juegos de ordenadores y videoconsolas) como las más novedosas (consumo de internet) están asociadas a patrones alimentarios menos saludables. Así mismo, la

valoración del tiempo de estudio en los adolescentes se ha asociado con un patrón alimentario más saludable.

Así mismo, teniendo en cuenta todos los componentes relacionados con el balance energético (alimentación, AF y comportamientos sedentarios) y su asociación con indicadores de composición coporal (Artículo V), se puede concluir en la importancia de evaluar los distintos comportamienos de manera conjunta. Cabe destacar que es esencial valorar la interacción entre diversos comportamientos para poder realizar estrategias efectivas de prevención de obesidad, principalmente en poblaciones infantiles. Los estudios indican que tener un comportamiento saludable en alguno de estos indicadores (alimentación, AF y comportamientos sedentarios), no implica a su vez que se extrapole a otro de los mismos. A través de los resultados de la presente Tesis Doctotal, se ha observado que existen grupos de niños y niñas que emplean una gran parte del tiempo en actividades sedentarias (ver la televisión) y que al mismo tiempo realizan más AF.

Al tratar de vincular las conductas sedentarias con los indicadores de composición corporal y por ende con indicadores de obesidad, hay que tener en cuenta que es una enfermedad de causa multifactorial. Tanto los factores genéticos como ambientales condicionan el desarrollo de esta enfermedad, siendo esencial poder trabajar de forma conjunta en todos aquellos que son modificables. Se ha incorporado la evaluación conjunta de las variables de alimentación, AF y comportamientos sedentarios puesto que son tres de los ejes fundamentales del balance energético. La selección de las variables que representan la alimentación está fundamentada por una parte en la importancia de consumir una adecuada cantidad de alimentos de origen vegetal, así como por los bajos consumos de frutas y vegetales observados en población infanto-juvenil, que se encuentran por debajo de las recomendaciones diarias.[77] Así mismo los grupos aliemntarios seleccionados son aquellos sobre los que existe una mayor evidencia científica en relación a los problemas de obesidad en población infantil. Además, la incorporación de los refrescos azucarados se ha basado en que durante los últimos años, se ha incrementado su consumo,[51] y éstos emergen como el factor dietético más importante asociado con el incremento de peso corporal y grasa corporal, y asociado a la epidemia de obesidad.[53, 55, 156] Igualmente, la incorporación de variables de actividad física y comportamientos sedentarios son dos ejes componentes fundamentales del gasto energético. La selección de la variable “tiempo dedicado a ver la televisión”, se eligió en base a ser la conducta predominante en población joven, y el tiempo dedicado a realizar ejercicio físico en los clubs deportivos debido a ser la variable que se correlacionaba con la actividad física valorada mediante acelerometría.

De forma global y al relacionar estas conductas con los indicadores de composición coporal se observó que el consumo excesivo de tiempo viendo la televisión, junto con los bajos niveles de AF y el bajo consumo de frutas y vegetales presentan la asociación

más fuerte, siendo además los agrupamientos caracterizados por elevado sedentarismo los más obesogénicos. Los resultados destacan la importancia de combinar conductas saludables tanto en términos de alimentación como de actividad, por lo que las implicaciones para promover mensajes saludables deberían destacar la importancia de ser físicametne activos y disminuir las actividades sedentarias. Es imprescindile identificar los mecanismos que sustentan el rol de las conductas sedentarias en el incremento de la epidemia de obesidad.

Promover una alimentación saludable, así como provomer la reducción de las actividades sedentarias con alternativas saludables parece ser la clave a corto y largo plazo para lograr un mejor estado de salud y prevenir el desarrollo de obesidad. Así mismo los padres también deben adoptar los comportamientos más saludales presentandose como modelos positivos para crear ambientes saludables, tanto en materia de alimentación como de actividad física.

9. Aportaciones principales de la Tesis Doctoral

Artículo I. La obesidad es una enfermedad de causa multifactorial motivada entre otras causas por desequilibrio del balance energético. Los comportamientos sedentarios son algunos de los factores involucrados en este desequilibrio. Se ha revisado la evidencia científica actual y se ha observado que disminuir el tiempo sedentario es esencial para obtener beneficios para la salud, y es primordial focalizar los esfuerzos en población en edad preescolar. Es necesario seguir las recomendaciones internacionales para prevenir el desarrollo de sobrepeso y obesidad en niños y adolescentes.

Artículo II. Existen estudios que evaluán la frecuencia de distintos comportamientos sedentarios, pero localizados en determinadas regiones o países. En este estudio se ha valorado 15.330 niños Europeos y se ha realizado una descripción detallada de los comportamientos sedentarios y de actividad física por edad, género y país de procedencia. Se ha observado que existen diferencias de comportamientos entre los participantes del estudio, y que los niños europeos exceden las recomendaciones internacionales sobre el tiempo de pantalla total. La presencia de televisión en el espacio personal de los niños se asocia con un mayor tiempo de pantalla total.

Artículo III. El conocimiento científico actual permite afirmar que los comportamientos sedentarios están involucrados en el desarrollo de la obesidad, pero los mecanismos por los cuales se produce la asociación entre ellos no son bien conocidos. Uno de los mecanismos propuestos es la ingesta de alimentos poco saludables asociados a los comportamientos sedentarios. La valoración conjunta de múltiples comportamientos sedentarios y la ingesta de un número impotante de grupos alimentarios permite ampliar el conocimiento científico. En una muestra de 2.202 adolescentes europeos se ha observado que el tiempo dedicado a ver la televisión, jugar a los ordenadores y utilizar internet se asocia con un mayor consumo de refrescos azucarados y con un menor consumo de frutas.

Artículo IV. Existen diferentes estudios sobre comportamientos sedentarios y su impacto en los patrones de consumo de alimentos, pero bajo la perspectiva de valorar alimentos y conductas sedentarias de forma individual. En una muestra de 2.202 adolescentes procedentes de ocho ciudades europeas se ha observado que un mayor consumo de actividades sedentarias como ver la televisión, jugar a los ordenadores y utilizar internet para uso personal se asocia en los adolescentes europeos con una baja adherencia hacia patrones de alimentación más sanos y aquellos caracterizados por alimentos típicos del desayuno; y con una elevada adherencia hacia patrones de alimentación con elevado consumo de aperitivos. Las adolescentes que ven la televisión o utilizan internet para uso personal presentan con una mayor adherencia a

patrones dietéticos de picoteo y una menor adherencia a patrones de alimentación más sanos. Así mismo, cuanto mayor tiempo dedican al estudio existe una menor adherencia al patrón de picoteo y una mayor adherencia a los patrones alimentarios caracterizados por un consumo elevado de alimentos vegetales y por alimentos típicos de desayuno.

Artículo V. La mayoría de los estudios que tratan de entender los factores que influyen en el desarrollo de obesidad, consideran los factores de forma independiente, pero pocos estudian el efecto combinado de conductas relacionadas con el balance energético y su relación con el desarrollo de obesidad. En una muestra de 11.674 niños europeos se han observado asociaciones entre las agrupaciones de comportamientos caracterizadas por elevado consumo de actividades sedentarias, bajo consumo de frutas y vegetales, bajo consumo de bebidas azucaradas y bajos niveles de actividad física y elevados indicadores de composición corporal (IMC y perímetro de cintura).

9. Main thesis contributions

Paper I. Obesity has a multifactorial origin, that it is based on an energetic imbalance. Sedentary behaviors are some of the factors involved in this imbalance. Current evidence shows that decreasing sedentary time is essential to obtain a health benefit and the efforts should be done at preschool ages. It is necessary to follow the international recommendations regarding time devoted to sedentary behaviours to prevent overweight and obesity development in children and adolescents.

Paper II. Several studies have evaluated sedentary behaviours prevalence, but focused on specific regions or countries. The present study included the assessment of 15.330 European children. Detailed description of sedentary behaviours and physical activity by age, sex and country shows differences by behaviours between children that participated in the study. Children exceeded international recommendation for total screen time. Availability of a television set in personal space increased the risk of excess total screen time.

Paper III. Current evidence shows that sedentary behaviours are involved in obesity development, but the mechanisms are uncertain. One potential mechanism is the association of unhealthy food intake with sedentary behaviours. The assessment of multiple sedentary behaviours and food groups allows to increase the current knowledge. In the sample of 2.202 European adolescents, the time that adolescents spent watching television, playing computer or using internet has been associated with high consumption of sugar-sweetened beverages and low fruit consumption

Paper IV. Different studies have analyzed the impact of several sedentary behaviours and food intake, but taking into consideration individual foods and sedentary behaviours. In the sample of 2.202 adolescents from 8 European cities associations between high consumption of sedentary activities like watching television, playing computer or using internet and low adherence of healthy or breakfast dietary patterns has been observed in European boys. Additionally, these behaviours have been associated with higher adherence of snacking dietary patterns. In girls, higher consumption of TV or internet for recreational reasons has been associated with higher adherence to the snacking dietary pattern and lower adherence to healthy dietary patterns. Moreover, study time has been associated with lower adherence to the snacking dietary pattern and higher adherence to the plant based and breakfast dietary patterns.

Paper V. Most of the studies which hindered to understand the mechanisms of obesity development consider individually some factors related with energy balance related behaviours. In a sample of 11.674 European children, associations between

clusters characterized by high sedentary time, low fruit and vegetables and sugar-sweetened beverage consumption, and low PA levels and elevated body composition indicators (BMI and waist circumference).

10. Conclusiones

Artículo I: La evidencia actual indica que disminuir y romper las conductas sedentarias son esenciales para lograr una mejor salud de la población. Las recomendaciones que se deben dar son: (1) los padres deben ser conscientes del impacto de los diferentes estilos de vida en la salud de los niños y promover hábitos saludables; (2) retirar los aparatos electrónicos del espacio personal de los niños y adolescentes, principalmente la televisión; (3) los niños no deberían comer mientras estén viendo la televisión; (4) las familias deberían disminuir el tiempo de exposición a los anuncios de comida; (5) las autoridades y las comunidades no deberían incentivar los entretenimientos electrónicos pasivos; y (6) tener en cuenta todos los factores vinculados a la obesidad en el desarrollo de intervenciones para prevenir la obesidad infantil y lograr un éxito a largo plazo.

Artículo II: Aproximadamente un tercio de los niños no cumplen las recomendaciones para el tiempo total de pantalla. La disponibilidad de televisión en el espacio personal de los niños aumenta el riesgo de exceder las recomendaciones del tiempo total de pantalla.

Artículo III: Elevados consumos de tiempo dedicado a ver la televisión, a jugar a los ordenadores y a utilizar internet durante la adolescencia están asociados con un mayor riesgo de consumir de refrescos azucarados y un menor riesgo de consumir fruta.

Artículo IV: Los patrones dietéticos de los adolescentes están relacionados con el tiempo invertido en diferentes conductas sedentarias. En chicos, un mayor consumo de tiempo viendo la televisión, jugando a juegos de ordenador y utilizando internet en su tiempo libre está asociado con una menor adherencia a los patrones saludables, y con una mayor adherencia a los patrones menos saludables. En chicas, un mayor consumo de televisión y utilizando internet en su tiempo de ocio está asociado con una mayor adherencia a los patrones dietéticos menos saludables. Además, el tiempo que los adolescentes estudian está asociado con una menor adherencia a los patrones menos saludables y con una mayor adherencia a los más saludables.

Artículo V: Las agrupaciones de comportamientos caracterizadas por elevado tiempo dedicado a conductas sedentarias (televisión) pueden considerarse las más obesogénicas. En niños, la cohexistencia junto con bajos niveles de AF, así como un bajo consumo de frutas y verduras presenta la asociación más perjudicial.

10. Conclusions

Paper I: The current evidence says that decreasing and breaking sedentary behaviours may be important for achieving a better population health. Some practical recommendations can be made: (1) parents should be aware of how different lifestyles impact theirs children's health in order to promote healthy behaviours; (2) remove electronic devices outside children/adolescent's bedroom, specially TV set; (3) children should not eat while watching TV; (4) families should minimize the amount of time that children are exposed to food advertisements; (5) governments should not incentive passive electronic entertainment; and (6) given the multi-factorial origin of obesity, taking into consideration all of them in the prevention strategies in order to obtain a successful result for a long term.

Paper II: Approximately a third of the children failed to meet current screen time recommendations. Availability of a television set in personal space increased the risk of excess total screen time.

Paper III: Increased television viewing and computer and Internet use during adolescence is associated with higher odds of consumption of sweetened beverages and lower odds of fruit consumption.

Paper IV: Adolescents' DPs are related with the time spent in several sedentary behaviours. In boys, higher consumption of time watching television, playing computer games or using internet for recreational reasons had lower adherence to the health DPs and higher adherence to the unhealthy DPs. In girls, higher consumption of time watching TV and using internet for recreational reasons was associated with higher adherence to the unhealthy DPs and lower adherence with the healthy DPs. Also, the time that adolescents studying was associated with lower adherence to the unhealthy DPs and with higher adherence to the healthy DPs.

Paper V: Clusters characterized by high sedentary behaviours can be considered as the most obesogenic in children. In boys, coexistence with low levels of PA and low F&V consumption was the most deleterious association.

European PhD Thesis. Alba M Santaliestra-Pasías, 2014

11. Referencias [References]

1. Blair SN. Physical inactivity: the biggest public health problem of the 21st century. *Br J Sports Med.* Jan 2009;43(1):1-2.

2. Ekelund U, Brage S, Froberg K, et al. TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS Med.* Dec 2006;3(12):e488.

3. Rey-Lopez JP, Vicente-Rodriguez G, Bueno G, Moreno LA. Sedentary behaviors and obesity in children and adolescents. In: Moreno LA, Pigeot I, Ahrens W, eds. *Epidemiology of obesity in children and adolescents. Prevalence and etiology*. New York: Springer Science; 2011:367-376.

4. Danaei G, Ding EL, Mozaffarian D, et al. The preventable causes of death in the United States: comparative risk assessment of dietary, lifestyle, and metabolic risk factors. *PLoS Med.* Apr 28 2009;6(4):e1000058.

5. Dunstan DW, Salmon J, Owen N, et al. Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults. *Diabetologia.* Nov 2005;48(11):2254-2261.

6. Gao X, Nelson ME, Tucker KL. Television viewing is associated with prevalence of metabolic syndrome in Hispanic elders. *Diabetes Care.* Mar 2007;30(3):694-700.

7. Hamilton MT, Hamilton DG, Zderic TW. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes.* Nov 2007;56(11):2655-2667.

8. Pigeot I, Moreno LA, Ahrens W. Introduction. In: Moreno LA, Pigeot I, Ahrens W, eds. *Epidemiology of obesity in children and adolescents. Prevalence and etiology* New York: Springer Science; 2011:1-6.

9. Schneider M, Dunton GF, Cooper DM. Media use and obesity in adolescent females. *Obesity (Silver Spring).* Sep 2007;15(9):2328-2335.

10. Bleich S, Cutler D, Murray C, Adams A. Why is the developed world obese? *Annu Rev Public Health.* 2008;29:273-295.

11. Utter J, Neumark-Sztainer D, Jeffery R, Story M. Couch potatoes or french fries: are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? *J Am Diet Assoc.* Oct 2003;103(10):1298-1305.

12. Prentice AM, Jebb SA. Obesity in Britain: gluttony or sloth? *BMJ.* Aug 12 1995;311(7002):437-439.

13. Rodriguez G, Moreno LA. Is dietary intake able to explain differences in body fatness in children and adolescents? *Nutr Metab Cardiovasc Dis.* May 2006;16(4):294-301.

14. Fleming-Moran M, Thiagarajah K. Behavioral interventions and the role of television in the growing epidemic of adolescent obesity--data from the 2001 Youth Risk Behavioral Survey. *Methods Inf Med.* 2005;44(2):303-309.

15. WHO. Global Strategy on diet and Physical Activity. Paper presented at: World Health Assembly 57.17, 2004; Geneva.

16. Pate RR, O'Neill JR, Lobelo F. The evolving definition of "sedentary". *Exerc Sport Sci Rev.* Oct 2008;36(4):173-178.

17. Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev.* Jul 2010;38(3):105-113.

18. Biddle SJ, Gorely T, Marshall SJ, Murdey I, Cameron N. Physical activity and sedentary behaviours in youth: issues and controversies. *J R Soc Promot Health.* Jan 2004;124(1):29-33.

19. Marshall SJ, Gorely T, Biddle SJ. A descriptive epidemiology of screen-based media use in youth: a review and critique. *J Adolesc.* Jun 2006;29(3):333-349.

20. Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc.* Sep 2000;32(9 Suppl):S498-504.

21. Bryant MJ, Lucove JC, Evenson KR, Marshall S. Measurement of television viewing in children and adolescents: a systematic review. *Obes Rev.* May 2007;8(3):197-209.

22. DuRant RH, Baranowski T, Johnson M, Thompson WO. The relationship among television watching, physical activity, and body composition of young children. *Pediatrics.* Oct 1994;94(4 Pt 1):449-455.

23. Pate RR, McIver K, Dowda M, Brown WH, Addy C. Directly observed physical activity levels in preschool children. *J Sch Health.* Aug 2008;78(8):438-444.

24. Brown WH, Pfeiffer KA, McIver KL, Dowda M, Addy CL, Pate RR. Social and environmental factors associated with preschoolers' nonsedentary physical activity. *Child Dev.* Jan-Feb 2009;80(1):45-58.

25. Bower JK, Hales DP, Tate DF, Rubin DA, Benjamin SE, Ward DS. The childcare environment and children's physical activity. *Am J Prev Med.* Jan 2008;34(1):23-29.

26. Epstein LH, Paluch RA, Kilanowski CK, Raynor HA. The effect of reinforcement or stimulus control to reduce sedentary behavior in the treatment of pediatric obesity. *Health Psychol.* Jul 2004;23(4):371-380.

27. Vandewater EA, Shim MS, Caplovitz AG. Linking obesity and activity level with children's television and video game use. *J Adolesc.* Feb 2004;27(1):71-85.

28. Academy of Pediatrics A. Children, adolescents, and television. *Pediatrics.* Feb 2001;107(2):423-426.

29. Australia Co. Healthy Eating and Physical activity Guidelines for Early Childhood Settings; 2009.

30. Currie C, Nic Gabhainn S, Godeau E, et al. *Inequalities in young people´s heath: health behaviour in school-aged children (HBSC) study; international report from the 2005/2006 survey. World Health Organization, Regional Office for Europe. Heatlh Policy for Children and Adolescents. Report nº 5* 2008.

31. Rey-Lopez JP, Vicente-Rodriguez G, Ortega FB, et al. Sedentary patterns and media availability in European adolescents: The HELENA study. *Prev Med.* Jul 2010;51(1):50-55.

32. Tremblay MS, Willms JD. Is the Canadian childhood obesity epidemic related to physical inactivity? *Int J Obes Relat Metab Disord.* Sep 2003;27(9):1100-1105.

33. Shields M, Tremblay MS. Sedentary behaviour and obesity. *Health Rep.* Jun 2008;19(2):19-30.

34. Mark AE, Janssen I. Relationship between screen time and metabolic syndrome in adolescents. *J Public Health (Oxf).* Jun 2008;30(2):153-160.

35. World Health Organization W. The 10 leading cause of death. http://www.who.int/mediacentre/factsheets/fs317/en/index.html, March 2013.

36. Serrano-Ríos M, Caro J, Carraro R, Gutierrez-Fuentes J. *The metabolic sindrome at the begining of the XXIst century*. 1st ed. Madrid; 2005.

37. Janz KF, Burns TL, Levy SM. Tracking of activity and sedentary behaviors in childhood: the Iowa Bone Development Study. *Am J Prev Med.* Oct 2005;29(3):171-178.

38. Marshall SJ, Biddle SJ, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *Int J Obes Relat Metab Disord.* Oct 2004;28(10):1238-1246.

39. Hinkley T, Salmon J, Okely AD, Trost SG. Correlates of sedentary behaviours in preschool children: a review. *Int J Behav Nutr Phys Act.* 2010;7:66.

40. Biddle SJ, Gorely T, Marshall SJ. Is television viewing a suitable marker of sedentary behavior in young people? *Ann Behav Med.* Oct 2009;38(2):147-153.

41. Chaput JP, Klingenberg L, Astrup A, Sjodin AM. Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obes Rev.* May 2010;12(5):e12-20.

42. Lowry R, Wechsler H, Galuska DA, Fulton JE, Kann L. Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of

fruits and vegetables among US high school students: differences by race, ethnicity, and gender. *J Sch Health.* Dec 2002;72(10):413-421.

43. Platat C, Perrin AE, Oujaa M, et al. Diet and physical activity profiles in French preadolescents. *Br J Nutr.* Sep 2006;96(3):501-507.

44. Lioret S, Touvier M, Lafay L, Volatier JL, Maire B. Dietary and physical activity patterns in French children are related to overweight and socioeconomic status. *J Nutr.* Jan 2008;138(1):101-107.

45. Rosenberg DE, Norman GJ, Sallis JF, Calfas KJ, Patrick K. Covariation of adolescent physical activity and dietary behaviors over 12 months. *J Adolesc Health.* Nov 2007;41(5):472-478.

46. Haerens L, Craeynest M, Deforche B, Maes L, Cardon G, De Bourdeaudhuij I. The contribution of psychosocial and home environmental factors in explaining eating behaviours in adolescents. *Eur J Clin Nutr.* Jan 2008;62(1):51-59.

47. Grimm GC, Harnack L, Story M. Factors associated with soft drink consumption in school-aged children. *J Am Diet Assoc.* Aug 2004;104(8):1244-1249.

48. Coon KA, Goldberg J, Rogers BL, Tucker KL. Relationships between use of television during meals and children's food consumption patterns. *Pediatrics.* Jan 2001;107(1):E7.

49. Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. *Curr Opin Lipidol.* Feb 2002;13(1):3-9.

50. Bibiloni Mdel M, Martinez E, Llull R, Pons A, Tur JA. Western and Mediterranean dietary patterns among Balearic Islands' adolescents: socio-economic and lifestyle determinants. *Public Health Nutr.* Apr 2012;15(4):683-692.

51. Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. *Best Pract Res Clin Endocrinol Metab.* Sep 2005;19(3):343-358.

52. Wiecha JL, Peterson KE, Ludwig DS, Kim J, Sobol A, Gortmaker SL. When children eat what they watch: impact of television viewing on dietary intake in youth. *Arch Pediatr Adolesc Med.* Apr 2006;160(4):436-442.

53. Must A, Barish EE, Bandini LG. Modifiable risk factors in relation to changes in BMI and fatness: what have we learned from prospective studies of school-aged children? *Int J Obes (Lond).* Jul 2009;33(7):705-715.

54. Global Strategy on diet and Physical Activity. *World Health Assembly 57.17*. Geneva: World Health Organization; 2004.

55. Moreno LA, Rodriguez G. Dietary risk factors for development of childhood obesity. *Curr Opin Clin Nutr Metab Care.* May 2007;10(3):336-341.

56. Rey-Lopez JP, Vicente-Rodriguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. *Nutr Metab Cardiovasc Dis.* Mar 2008;18(3):242-251.

57. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics.* Dec 2007;120 Suppl 4:S164-192.

58. Green paper: Promoting healthy diets and physical activity: a European dimension for the prevention of overweight, obesity and chronic disease. Brussels: Comimission of the European Communities; 2005.

59. Thompson F, Subar A. Dietary assessment methodology. In: Coulston A, Boushey C, eds. *Nutrition in the Prevention and Treatment od Disease*. 2nd ed. San Diego: Elsevier Academic Press; 2008:3-39.

60. Livingstone MB, Robson PJ. Measurement of dietary intake in children. *Proc Nutr Soc.* May 2000;59(2):279-293.

61. Beaton GH. Approaches to analysis of dietary data: relationship between planned analyses and choice of methodology. *Am J Clin Nutr.* Jan 1994;59(1 Suppl):253S-261S.

62. Kushi LH. Gaps in epidemiologic research methods: design considerations for studies that use food-frequency questionnaires. *Am J Clin Nutr.* Jan 1994;59(1 Suppl):180S-184S.

63. Sempos CT, Liu K, Ernst ND. Food and nutrient exposures: what to consider when evaluating epidemiologic evidence. *Am J Clin Nutr.* Jun 1999;69(6):1330S-1338S.

64. Kipnis V, Subar AF, Midthune D, et al. Structure of dietary measurement error: results of the OPEN biomarker study. *Am J Epidemiol.* Jul 1 2003;158(1):14-21; discussion 22-16.

65. Subar AF, Kipnis V, Troiano RP, et al. Using intake biomarkers to evaluate the extent of dietary misreporting in a large sample of adults: the OPEN study. *Am J Epidemiol.* Jul 1 2003;158(1):1-13.

66. Buzzard IM, Faucett CL, Jeffery RW, et al. Monitoring dietary change in a low-fat diet intervention study: advantages of using 24-hour dietary recalls vs food records. *J Am Diet Assoc.* Jun 1996;96(6):574-579.

67. Casey PH, Goolsby SL, Lensing SY, Perloff BP, Bogle ML. The use of telephone interview methodology to obtain 24-hour dietary recalls. *J Am Diet Assoc.* Nov 1999;99(11):1406-1411.

68. What we eat in America, NHANES. www.ars.usda.gov/Services/docs.htm?dicud=9098.

69. Mennen LI, Bertrais S, Galan P, Arnault N, Potier de Couray G, Hercberg S. The use of computerised 24 h dietary recalls in the French SU.VI.MAX Study: number of recalls required. *Eur J Clin Nutr.* Jul 2002;56(7):659-665.

70. Probst YC, Tapsell LC. Overview of computerized dietary assessment programs for research and practice in nutrition education. *J Nutr Educ Behav.* Jan-Feb 2005;37(1):20-26.

71. Rebro SM, Patterson RE, Kristal AR, Cheney CL. The effect of keeping food records on eating patterns. *J Am Diet Assoc.* Oct 1998;98(10):1163-1165.

72. Burke BS. The dietary history as a tool in research. *J Am Diet Assoc.* Jan 1947;23:1041-1046.

73. Burke BS, Stuart HC. A method of diet analysis: application in research and pediatric practise. *J Pediatr.* 1938;12:493-503.

74. Burrows TL, Martin RJ, Collins CE. A systematic review of the validity of dietary assessment methods in children when compared with the method of doubly labeled water. *J Am Diet Assoc.* Oct 2010;110(10):1501-1510.

75. Basch CE, Shea S, Arliss R, et al. Validation of mothers' reports of dietary intake by four to seven year-old children. *Am J Public Health.* Nov 1990;80(11):1314-1317.

76. Klesges RC, Klesges LM, Brown G, Frank GC. Validation of the 24-hour dietary recall in preschool children. *J Am Diet Assoc.* Oct 1987;87(10):1383-1385.

77. Branca F, Nikogosian H, Lobstein T. The challenge of obesity in the WHO European Region and the strategies for response. Denmark: WHO Regional Office for Europe; 2007.

78. DAFNE Data food networking. The Pan-European Food Data Bank based on household budget surveys [online database]. 2014.

79. Ahrens W, Bammann K, Siani A, et al. The IDEFICS cohort: design, characteristics and participation in the baseline survey. *Int J Obes (Lond).* Apr 2011;35 (Suppl 1):S3-15.

80. Ahrens W, Bammann K, de Henauw S, et al. Understanding and preventing childhood obesity and related disorders--IDEFICS: A European multilevel epidemiological approach. *Nutrition, Metabolism and Cardiovascular Diseases.* 2006;16(4):302-308.

81. Moreno LA, De Henauw S, Gonzalez-Gross M, et al. Design and implementation of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study. *Int J Obes (Lond).* Nov 2008;32 Suppl 5:S4-11.

82. Moreno LA, Gonzalez-Gross M, Kersting M, et al. Assessing, understanding and modifying nutritional status, eating habits and physical activity in European

adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr.* Mar 2008;11(3):288-299.

83. UNESCO. United Nations Educational Scientific and Cultural Organization. International Standard Classitication of Education. http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx. Accessed April 2012.

84. Bammann K, Sioen I, Huybrechts I, et al. The IDEFICS validation study on field methods for assessing physical activity and body composition in children: design and data collection. *Int J Obes (Lond).* Apr 2011;35 Suppl 1:S79-87.

85. Stomfai S, Ahrens W, Bammann K, et al. Intra- and inter-observer reliability in anthropometric measurements in children. *Int J Obes (Lond).* Apr 2011;35 Suppl 1:S45-51.

86. USDA/ORC. Macro Report nº10. Developing effective wording and format options for a children's nutrition behavior questionnaire for mothers of children in kindergarten. Washington, DC: USDA; 2005.

87. Bel-Serrat S, Mouratidou T, Pala V, et al. Relative validity of the Children's Eating Habits Questionnaire-food frequency section among young European children: the IDEFICS Study. *Public Health Nutr.* Feb 2012;17(2):266-276.

88. Bornhorst C, Bel-Serrat S, Pigeot I, et al. Validity of 24-h recalls in (pre-)school aged children: comparison of proxy-reported energy intakes with measured energy expenditure. *Clin Nutr.* Feb 2013;33(1):79-84.

89. Currie C, Molcho M, Boyce W, Holstein B, Torsheim T, Richter M. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med.* Mar 2008;66(6):1429-1436.

90. Tanner JM, Whitehouse RH. Clinical longitudinal standards for height, weight, height velocity, weight velocity, and stages of puberty. *Arch Dis Child.* Mar 1976;51(3):170-179.

91. Vereecken CA, Covents M, Matthys C, Maes L. Young adolescents' nutrition assessment on computer (YANA-C). *Eur J Clin Nutr.* May 2005;59(5):658-667.

92. Vereecken CA, Covents M, Sichert-Hellert W, et al. Development and evaluation of a self-administered computerized 24-h dietary recall method for adolescents in Europe. *Int J Obes (Lond).* Nov 2008;32 Suppl 5:S26-34.

93. Harttig U, Haubrock J, Knuppel S, Boeing H. The MSM program: web-based statistics package for estimating usual dietary intake using the Multiple Source Method. *Eur J Clin Nutr.* Jul 2011;65 Suppl 1:S87-91.

94. Dehne LI, Klemm C, Henseler G, Hermann-Kunz E. The German Food Code and Nutrient Data Base (BLS II.2). *Eur J Epidemiol.* Apr 1999;15(4):355-359.

95. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics.* Feb 2001;107(2):423-426.

96. Rey-Lopez JP, Ruiz JR, Ortega FB, et al. Reliability and validity of a screen time-based sedentary behaviour questionnaire for adolescents: The HELENA study. *Eur J Public Health.* Apr 15 2011.

97. NIH. Strategic plan for National Institutes of Health obesity research: a report of the NHI Obesity Task Force.; 2011.

98. Boone-Heinonen J, Gordon-Larsen P, Adair LS. Obesogenic clusters: multidimensional adolescent obesity-related behaviors in the U.S. *Ann Behav Med.* Dec 2008;36(3):217-230.

99. Maffeis C. Aetiology of overweight and obesity in children and adolescents. *Eur J Pediatr.* Sep 2000;159 Suppl 1:S35-44.

100. Cameron AJ, Crawford DA, Salmon J, et al. Clustering of obesity-related risk behaviors in children and their mothers. *Ann Epidemiol.* Feb 2011;21(2):95-102.

101. French S, Rosenberg M, Knuiman M. The clustering of health risk behaviours in a Western Australian adult population. *Health Promot J Austr.* Dec 2008;19(3):203-209.

102. Sabbe D, De Bourdeaudhuij I, Legiest E, Maes L. A cluster-analytical approach towards physical activity and eating habits among 10-year-old children. *Health Educ Res.* Oct 2008;23(5):753-762.

103. te Velde SJ, De Bourdeaudhuij I, Thorsdottir I, et al. Patterns in sedentary and exercise behaviors and associations with overweight in 9-14-year-old boys and girls--a cross-sectional study. *BMC Public Health.* 2007;7:16.

104. Vries Hd, Kremers S, Smeets T, Reubsaet A. Clustering of diet, physical activity and smoking and a general willingness to change. *Psychology & Health.* 2011/09/01 2008;23(3):265-278.

105. De Vries H, van 't Riet J, Spigt M, et al. Clusters of lifestyle behaviors: Results from the Dutch SMILE study. *Preventive Medicine.* 2008;46(3):203-208.

106. Bel-Serrat S, Mouratidou T, Santaliestra-Pasias AM, et al. Clustering of multiple lifestyle behaviours and its association to cardiovascular risk factors in children: the IDEFICS study. *Eur J Clin Nutr.* Aug 2013;67(8):848-854.

107. Ottevaere C, Huybrechts I, Benser J, et al. Clustering patterns of physical activity, sedentary and dietary behavior among European adolescents: The HELENA study. *BMC Public Health.* 2011;11:328.

108. Bammann K, Peplies J, Sjöström M, et al. Assessment of diet, physical activity and biological, social and environmental factors in a multi-centre European project on diet- and lifestyle-related disorders in children (IDEFICS). *Journal of Public Health.* 2006;14(5):279-289.

109. Lanfer A, Hebestreit A, Ahrens W, et al. Reproducibility of food consumption frequencies derived from the Children's Eating Habits Questionnaire used in the IDEFICS study. *Int J Obes (Lond).* Apr 2011;35 Suppl 1:S61-68.

110. Huybrechts I, Bornhorst C, Pala V, et al. Evaluation of the Children's Eating Habits Questionnaire used in the IDEFICS study by relating urinary calcium and potassium to milk consumption frequencies among European children. *Int J Obes (Lond).* Apr 2011;35 Suppl 1:S69-78.

111. Kaiser Family Foundation. Generation M: media in the lives of 8-18-year-olds. http://kff.org/entmedia/mh012010pkg.cfm.

112. Gore PA. Cluster analysis. In: Brown HEATaSD, ed. *Handbook of appied multivariate statistics and mathematical modeling*. San Diego, CA: Academic Press; 2000:297-321.

113. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. *Fam Med.* May 2005;37(5):360-363.

114. De Henauw S, Verbestel V, Marild S, et al. The IDEFICS community-oriented intervention programme: a new model for childhood obesity prevention in Europe? *Int J Obes (Lond).* Apr 2011;35 Suppl 1:S16-23.

115. Fruit and Vegetable promotion Initiative - report of the meeting. Geneva World Health Organization 2003.

116. Agostoni C, Braegger C, Decsi T, et al. Role of dietary factors and food habits in the development of childhood obesity: a commentary by the ESPGHAN Committee on Nutrition. *J Pediatr Gastroenterol Nutr.* Jun 2011;52(6):662-669.

117. Naska A, Bountziouka V, Trichopoulou A. Soft drinks: time trends and correlates in twenty-four European countries. A cross-national study using the DAFNE (Data Food Networking) databank. *Public Health Nutr.* Sep 2010;13(9):1346-1355.

118. Popkin BM. Patterns of beverage use across the lifecycle. *Physiol Behav.* Apr 26 2010;100(1):4-9.

119. Duffey KJ, Huybrechts I, Mouratidou T, et al. Beverage consumption among European adolescents in the HELENA study. *Eur J Clin Nutr.* Feb 2011;66(2):244-252.

120. American Academy of Pediatrics. Children, adolescents, and television. *Pediatrics.* Vol 107. 2001/02/07 ed; 2001:423-426.

121. Physical Activity Guidelines for Americans. In: (US) DoHHS, ed; 2008.

122. Landsberg B, Plachta-Danielzik S, Lange D, Johannsen M, Seiberl J, Muller MJ. Clustering of lifestyle factors and association with overweight in adolescents of the Kiel Obesity Prevention Study. *Public Health Nutr.* Oct 2010;13(10A):1708-1715.

123. De Bourdeaudhuij I, van Oost P. A cluster-analytical approach toward physical activity and other health related behaviors. *Med Sci Sports Exerc.* Apr 1999;31(4):605-612.

124. Santaliestra-Pasías AM, Mouratidou T, Verbestel V, et al. Food consumption and screen-based sedentary behaviors in European adolescents. The HELENA study. *Arch Pediatr Adolesc Med.* 2012;in press.

125. Proctor MH, Moore LL, Gao D, et al. Television viewing and change in body fat from preschool to early adolescence: The Framingham Children's Study. *Int J Obes Relat Metab Disord.* Jul 2003;27(7):827-833.

126. Mouratidou T, Mesana MI, Manios Y, et al. Assessment tools of energy balance-related behaviours used in European obesity prevention strategies: review of studies during preschool. *Obes Rev.* Mar 2012;13 Suppl 1:42-55.

127. Hands BP, Chivers PT, Parker HE, Beilin L, Kendall G, Larkin D. The associations between physical activity, screen time and weight from 6 to 14 yrs: the Raine Study. *J Sci Med Sport.* Sep 2011;14(5):397-403.

128. Harris JL, Bargh JA, Brownell KD. Priming effects of television food advertising on eating behavior. *Health Psychol.* Jul 2009;28(4):404-413.

129. Temple JL, Giacomelli AM, Kent KM, Roemmich JN, Epstein LH. Television watching increases motivated responding for food and energy intake in children. *Am J Clin Nutr.* Feb 2007;85(2):355-361.

130. Rey-Lopez JP, Vicente-Rodriguez G, Repasy J, et al. Food and drink intake during television viewing in adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. *Public Health Nutr.* Sep 2011;14(9):1563-1569.

131. Vereecken CA, Todd J, Roberts C, Mulvihill C, Maes L. Television viewing behaviour and associations with food habits in different countries. *Public Health Nutr.* Apr 2006;9(2):244-250.

132. Santaliestra-Pasías AM, Mouratidou T, Verbestel V, et al. Food consumption and screen-based sedentary behaviors in european adolescents: The helena study. *Archives of Pediatrics & Adolescent Medicine.* 2012:1-11.

133. Hoyos Cillero I, Jago R, Sebire S. Individual and social predictors of screen-viewing among Spanish school children. *Eur J Pediatr.* Jan 2011;170(1):93-102.

134. Gorely T, Marshall SJ, Biddle SJ. Couch kids: correlates of television viewing among youth. *Int J Behav Med.* 2004;11(3):152-163.

135. Fernandes RA, Junior IF, Cardoso JR, Vaz Ronque ER, Loch MR, de Oliveira AR. Association between regular participation in sports and leisure time behaviors in Brazilian adolescents: a cross-sectional study. *BMC Public Health.* 2008;8:329.

136. Hallal PC, Wells JC, Reichert FF, Anselmi L, Victora CG. Early determinants of physical activity in adolescence: prospective birth cohort study. *BMJ.* Apr 29 2006;332(7548):1002-1007.

137. Fainardi V, Scarabello C, Brunella I, et al. Sedentary lifestyle in active children admitted to a summer sport school. *Acta Biomed.* Aug 2009;80(2):107-116.

138. He M, Harris S, Piche L, Beynon C. Understanding screen-related sedentary behavior and its contributing factors among school-aged children: a social-ecologic exploration. *Am J Health Promot.* May-Jun 2009;23(5):299-308.

139. Hoyos Cillero I, Jago R. Systematic review of correlates of screen-viewing among young children. *Prev Med.* Jul 2010;51(1):3-10.

140. Burke V, Beilin LJ, Durkin K, Stritzke WG, Houghton S, Cameron CA. Television, computer use, physical activity, diet and fatness in Australian adolescents. *Int J Pediatr Obes.* 2006;1(4):248-255.

141. Taveras EM, Field AE, Berkey CS, et al. Longitudinal relationship between television viewing and leisure-time physical activity during adolescence. *Pediatrics.* Feb 2007;119(2):e314-319.

142. Mota J, Gomes H, Almeida M, Ribeiro JC, Carvalho J, Santos MP. Active versus passive transportation to school-differences in screen time, socio-economic position and perceived environmental characteristics in adolescent girls. *Ann Hum Biol.* May-Jun 2007;34(3):273-282.

143. Kremers SP, van der Horst K, Brug J. Adolescent screen-viewing behaviour is associated with consumption of sugar-sweetened beverages: the role of habit strength and perceived parental norms. *Appetite.* May 2007;48(3):345-350.

144. Holsten JE, Deatrick JA, Kumanyika S, Pinto-Martin J, Compher CW. Children's food choice process in the home environment. A qualitative descriptive study. *Appetite.* Feb 2012;58(1):64-73.

145. Verzeletti C, Maes L, Santinello M, Baldassari D, Vereecken CA. Food-related family lifestyle associated with fruit and vegetable consumption among young adolescents in Belgium Flanders and the Veneto Region of Italy. *Appetite.* Apr 2010;54(2):394-397.

146. Hare-Bruun H, Nielsen BM, Kristensen PL, Moller NC, Togo P, Heitmann BL. Television viewing, food preferences, and food habits among children: A prospective epidemiological study. *BMC Public Health.* 2010;11:311.

147. Charreire H, Kesse-Guyot E, Bertrais S, et al. Associations between dietary patterns, physical activity (leisure-time and occupational) and television viewing in middle-aged French adults. *Br J Nutr.* Mar 2011;105(6):902-910.

148. Blass EM, Anderson DR, Kirkorian HL, Pempek TA, Price I, Koleini MF. On the road to obesity: Television viewing increases intake of high-density foods. *Physiol Behav.* Jul 30 2006;88(4-5):597-604.

149. Richter A, Heidemann C, Schulze MB, Roosen J, Thiele S, Mensink GB. Dietary patterns of adolescents in Germany - Associations with nutrient intake and other health related lifestyle characteristics. *BMC Pediatr.* Mar 22 2012;12(1):35.

150. van Kooten M, de Ridder D, Vollebergh W, van Dorsselaer S. What's so special about eating? Examining unhealthy diet of adolescents in the context of other health-related behaviours and emotional distress. *Appetite.* May 2007;48(3):325-332.

151. Aranceta J, Perez-Rodrigo C, Ribas L, Serra-Majem L. Sociodemographic and lifestyle determinants of food patterns in Spanish children and adolescents: the enKid study. *Eur J Clin Nutr.* Sep 2003;57 Suppl 1:S40-44.

152. Craig LC, McNeill G, Macdiarmid JI, Masson LF, Holmes BA. Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity. *Br J Nutr.* Feb 2010;103(3):319-334.

153. Kiefte-de Jong JC, de Vries JH, Bleeker SE, et al. Socio-demographic and lifestyle determinants of 'Western-like' and 'Health conscious' dietary patterns in toddlers. *Br J Nutr.* Apr 5 2012:1-11.

154. Moreira P, Santos S, Padrao P, et al. Food patterns according to sociodemographics, physical activity, sleeping and obesity in Portuguese children. *Int J Environ Res Public Health.* Mar 2010;7(3):1121-1138.

155. Chapman CD, Benedict C, Brooks SJ, Schioth HB. Lifestyle determinants of the drive to eat: a meta-analysis. *Am J Clin Nutr.* Sep 2012;96(3):492-497.

156. WHO/FAO. WHO Technical Report Series 916. Diet, nutrition and the prevention of chronic diseases. Geneva: WHO; 2003.

12. Apéndice [Appendix]

Factor de impacto de las revistas y ranking en 2012 y 2013 (según el año de publicación del artículo) en "*ISI Web of Knowlwdge-Journal Citation Reports (JCR)*" dentro de sus áreas temáticas correspondientes.

[Impact factor and ranking of each Journal in 2012 and 2013 (based on the year's publication date) in "ISI Web of Knowlwdge-Journal Citation Reports (JCR)" within their subject categories]

	Revista [Journal]	Factor de impacto [Impact factor]
Artículo I	Nutricion Hospitalaria	1.250
	Ranking in 2013 ISI JCR: 62/78 (Nutrition and Dietetics)	
Artículo II	Public Health Nutrition	2.483
	Ranking in 2013 ISI JCR: 38/78 (Nutrition and Dietetics)	
Artículo III	Archives of Pediatrics & Adolescent Medicine	4.282
	Ranking in 2012 ISI JCR: 3/122 (Pediatrics)	
Artículo IV	European Journal of Clinical Nutrition	2.950
	Ranking in 2013 ISI JCR: 28/78 (Nutrition and Dietetics)	

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Gracias a tod@s!!

14. Anexos [Anexes]

14.1 Artículos metodológicos

A continuación se adjuntan los resúmenes de los artículos metodológicos de los estudios en los que se ha basado la presente Tesis Doctoral.

Estudio IDEFICS

Int J Obes (Lond). 2011 Apr;35 Suppl 1:S3-15. doi: 10.1038/ijo.2011.30.

The IDEFICS cohort: design, characteristics and participation in the baseline survey.

Ahrens W, Bammann K, Siani A, Buchecker K, De Henauw S, Iacoviello L, Hebestreit A, Krogh V, Lissner L, Mårild S, Molnár D, Moreno LA, Pitsiladis YP,Reisch L, Tornaritis M, Veidebaum T, Pigeot I; IDEFICS Consortium.

BACKGROUND: The European IDEFICS (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants) study was set up to determine the aetiology of overweight, obesity and related disorders in children, and to develop and evaluate a tailored primary prevention programme.

OBJECTIVE: This paper focuses on the aetiological element of the multicentre study, the measures and examinations, sociodemographiccharacteristics of the study sample and proportions of participation.

DESIGN: Prospective cohort study with an embedded intervention study that started with a baseline survey in eight countries in 2007-2008.

SUBJECTS AND MEASUREMENTS: Baseline participants of the prospective cohort study were 16,224 children aged 2-9 years. Parents reported sociodemographic, behavioural, medical, nutritional and other lifestyle data for their children and families. Examinations of children included anthropometry, blood pressure, fitness, accelerometry, DNA from saliva and physiological markers in blood and urine. The built environment, sensory taste perception and other mechanisms of children's food choices and consumer behaviour were studied in subgroups.

RESULTS: Between 1507 and 2567, children with a mean age of 6.0 years and an even sex distribution were recruited from each country. Of them, 82% lived in two-parent families. The distribution of standardised income levels differed by study sample, with low-income groups being strongly represented in Cyprus, Italy and Germany. At least one 24-h dietary recall was obtained for two-thirds of the children. Blood pressure and anthropometry were assessed in more than 90%. A 3-day accelerometry was performed in 46%, motor fitness was assessed in 41%, cardiorespiratory fitness in 35% and ~11% participated in taste perception tests. The proportion of children donating venous blood, urine and saliva was 57, 86 and 88%, respectively.

CONCLUSION: The IDEFICS cohort provides valuable data to investigate the interplay of social, environmental, genetic, physiological and behavioural factors in the development of major diet- and lifestyle-related disorders affecting children at present.

Estudio HELENA

Int J Obes (Lond). 2008 Nov;32 Suppl 5:S4-11. doi: 10.1038/ijo.2008.177.

Design and implementation of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study.

Moreno LA, De Henauw S, González-Gross M, Kersting M, Molnár D, Gottrand F, Barrios L, Sjöström M, Manios Y, Gilbert CC, Leclercq C, Widhalm K, Kafatos A, Marcos A; HELENA Study Group.

OBJECTIVE: To provide an overview of the Healthy Lifestyle in Europe by Nutrition in Adolescence Cross-Sectional Study (HELENA-CSS) design, with particular attention to its quality control procedures. Other important methodological aspects are described in detail throughout this supplement.

DESIGN: Description of the HELENA-CSS sampling and recruitment approaches, standardization and harmonization processes, data collection and analysis strategies and quality control activities.

RESULTS: The HELENA-CSS is a multi-centre collaborative study conducted in European adolescents located in urban settings. The data management systems, quality assurance monitoring activities, standardized manuals of operating procedures and training and study management are addressed in this paper. Various quality controls to ensure collection of valid and reliable data will be discussed in this supplement, as well as quantitative estimates of measurement error.

CONCLUSION: The great advantage of the HELENA-CSS is the strict standardization of the fieldwork and the blood analyses, which precludes to a great extent the kind of immeasurable confounding bias that often interferes when comparing results from isolated studies.

14.2 Cuestionarios utilizados

A continuación se presentan los cuestionarios utilizados de los estudios en los que se ha basado la presente Tesis Doctoral.

ESTUDIO IDEFICS

Cuestionario sobre actividad física y comportamientos sedentarios

1. **¿Cuánto tiempo pasa al día su hijo/a jugando <u>en el patio o las calles cerca de casa</u>(casas de amigos, vecinos o familiares)?**

   Por favor, indique para cada intervalo horario:

	0 minutos	***1-15 minutos***	***16-30 minutos***	***31-60 minutos***	***Más de 60 minutos***
Desde que se levanta hasta el mediodía	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5
Mediodía hasta las 18:00	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5
18:00 hasta la hora de dormir	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5

2. **¿Cuánto tiempo pasa normalmente su hijo/a al día <u>en el parque, el patio del recreo o en otras zonas recreativas</u> (Ej. Piscina, zoo, parque de diversiones)?** Por favor, indique para cada intervalo horario. Incluya el tiempo que pasa en la guardería o la escuela.

	0 minutos	***1-15 minutos***	***16-30 minutos***	***31-60 minutos***	***Más de 60 minutos***
Desde que se levanta hasta el mediodía	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5
Mediodía hasta las 18:00	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5
18:00 hasta la hora de dormir	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5

3. **Piense por un momento en el típico día entre semana de su hijo/a durante el último mes. ¿Cuánto tiempo diría que pasa su hijo jugando fuera en un día tipico entre semana?**

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

4. Ahora piense en el típico día de fin de semana de su hijo/a durante el último mes. ¿Cuánto tiempo diría que pasa su hijo jugando fuera en un día típico de fin de semana?

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

5. ¿Es miembro su hijo/a de algún club deportivo?

❍1 Sí

❍2 No ➔➔➔ **Por favor, continúe con la pregunta 49**

¿Cuánto tiempo pasa a la semana haciendo ejercicio en el club deportivo?

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

6. ¿Cuánto tiempo suele ver su hijo/a la televisión/vídeo/DVD por día?

	Nada en absoluto	***Menos de 30 min. por día***	***Menos de 1 hora por día***	***Aprox. 1-2 horas por día***	***Aprox. 2-3 horas por día***	***Más de tres horas por día***
Entre semana	❍0	❍1	❍2	❍3	❍4	❍5
Sábado/domingo	❍0	❍1	❍2	❍3	❍4	❍5

7. ¿Cuánto tiempo suele usar su hijo/a el ordenador o la consola al día?

	Nada en absoluto	***Menos de 30 min. por día***	***Menos de 1 hora por día***	***Aprox. 1-2 horas por día***	***Aprox. 2-3 horas por día***	***Más de tres horas por día***
Entre semana	❍0	❍1	❍2	❍3	❍4	❍5

Sábado/domingo	❍ 0	❍ 1	❍ 2	❍ 3	❍ 4	❍ 5

8. ¿Cuáles de los siguientes aparatos tiene su hijo/a en su habitación?

Por favor, marque todas las opciones que correspondan

❍ 1 Televisor

❍ 1 Ordenador

❍ 1 Conexión a Internet

❍ 1 Vídeo/DVD

❍ 1 Ninguno de ellos

Cuestionario de frecuencia de consumo de alimentos (CEHQ-FFQ)

En el último mes, ¿con qué frecuencia ha consumido su hijo/a los siguientes alimentos y bebidas?

Por favor, limítese a las cuatro últimas semanas y excluya las comidas del colegio o guardería.

	Nunca/ menos de una vez por semana	1 - 3 veces por semana	4 – 6 veces por semana	1 vez al día	2 veces al día	3 veces al día	4 o más veces al día	No lo sé
Vegetales								
Verduras, patatas y legumbres cocinadas (también combinadas en el mismo plato)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Patatas fritas, croquetas de patata	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Vegetales crudos (mezclados en la ensalada, zanahoria, pepino, lechuga, tomate, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Frutas								
Frutas frescas (también licuadas) ***sin*** azúcar añadido	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Frutas frescas (también licuadas) ***con*** azúcar añadido	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Bebidas								
Agua	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Zumos de frutas (zumo de naranja, manzana, melocotón, piña,etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8

	Nunca/ menos de una vez por semana	**1 - 3 veces por semana**	**4 – 6 veces por semana**	**1 vez al día**	**2 veces al día**	**3 veces al día**	**4 o más veces al día**	**No lo sé**
Bebidas edulcoradas incluyendo bebidas deportivas, té en lata o embotellado, refrescos, etc.	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Coca-cola light o bebidas refrescantes sin azúcar	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Cereales de desayuno								
Cereales de desayuno azucarados o que se les ha añadido azúcar y muesli azucarado (ej. Corn flakes, crispies, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Papillas, copos de avena, cereales no azucarados, muesli natural	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Leche								
Leche no azucarada	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Leche azucarada (ej. con azúcar, chocolate, cola-cao, miel, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Qué tipo de leche consume su hijo/a habitualmente:	❍1 Entera ❍2 Semi-desnatada /desnatada							
Yogur								

	Nunca/ menos de una vez por semana	**1 - 3 veces por semana**	**4 – 6 veces por semana**	**1 vez al día**	**2 veces al día**	**3 veces al día**	**4 o más veces al día**	**No lo sé**
Yogur natural o kéfir sin azúcar	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Yogur azucarado y bebidas lácteas fermentadas (ej. Actimel®, LC1®, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Qué tipo de yogur consume su hijo/a habitualmente:	❍1 Entera ❍2 Semi-desnatada /desnatada							
Pescado								
Pescado fresco o congelado, sin freír	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Pescado frito y varitas de pescado	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Carne y productos cárnicos								
Productos loncheados y conservados, o listos para cocinar (ej. fiambres, embutidos, jamón, hamburguesas etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Carne fresca, sin freir (chuletas, bistec, bovino, cerdo, aves, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Carne frita (chuletas, bistec, bovino, cerdo, aves, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Huevos								

	Nunca/ menos de una vez por semana	1 - 3 veces por semana	4 – 6 veces por semana	1 vez al día	2 veces al día	3 veces al día	4 o más veces al día	No lo sé
Huevos fritos o huevos revueltos	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Huevos duros o escalfados	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Mayonesa y productos derivados de la mayonesa (ej. Ligeresa, salsa rosa, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Productos sustitutivos de la carne y productos de soja								
Tofu, tempé, leche de soja, yogures de soja, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Queso								
Queso (ej.curado, semicurado, tierno, fresco, tranchetes. etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Queso para untar (ej. Philadelphia, etc)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Queso rallado	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Productos para untar								
Mermelada, miel	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Nocilla o crema de avellanas para untar	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Mantequilla, margarina en pan	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8

	Nunca/ menos de una vez por semana	1 - 3 veces por semana	4 – 6 veces por semana	1 vez al día	2 veces al día	3 veces al día	4 o más veces al día	No lo sé
Productos bajos en grasa en pan (ej. Mermelada, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Ketchup	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Productos hechos a base de cereales								
Pan blanco, panecillos blancos, biscotes blancos	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Pan integral , panecillos integrales, biscotes integrales	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Pasta, fideos, arroz	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Cuscús, bulgur, etc.	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Pizza como plato principal	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Sandwiches (rellenos con queso, carne, vegetales, etc)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Aperitivos								
Frutos secos y semillas y frutas secas (ej. Pipas, cacahuetes, pasas etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Patatas fritas, aperitivos de maíz, palomitas de maíz, etc (ej. *Cheetos, Lay's, risketos,* etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8

	Nunca/ menos de una vez por semana	**1 - 3 veces por semana**	**4 – 6 veces por semana**	**1 vez al día**	**2 veces al día**	**3 veces al día**	**4 o más veces al día**	**No lo sé**
Tortas o bollos, pasteles (ej. Tarta de manzana, crepes, palmeras de hojaldre, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Chocolate, barritas de chocolate (Mars, Lions, Kit Kat, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Caramelos, chucherías, gominolas, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
galletas, pasteles envasados, tartas (ej.Donuts, bollycao, cañas de chocolate, etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8
Helados, polos, sorbetes de fruta(ej. Mágnum, calippo etc.)	❍1	❍2	❍3	❍4	❍5	❍6	❍7	❍8

ESTUDIO HELENA

Cuestionario sobre comportamientos sedentarios

7788399663

Healthy Lifestyle in Europe by Nutrition in Adolescence — HELENA — Sixth Framework Programme 2002 - 2006

1. Cuántas horas al día pasas ...

	ninguna	menos de media hora	de media a una hora	de una a dos horas	de dos a tres horas	de tres a cuatro horas	cuatro o más horas
viendo la televisión							
un día de colegio:	○	○	○	○	○	○	○
un día de fin de semana:	○	○	○	○	○	○	○
jugando con juegos en el ordenador							
un día de colegio:	○	○	○	○	○	○	○
un día de fin de semana:	○	○	○	○	○	○	○
jugando con la videoconsola							
un día de colegio:	○	○	○	○	○	○	○
un día de fin de semana:	○	○	○	○	○	○	○
navegando en internet por razones que no están relacionadas con el estudio							
un día de colegio:	○	○	○	○	○	○	○
un día de fin de semana:	○	○	○	○	○	○	○
navegando en internet por motivos de estudio							
un día de colegio:	○	○	○	○	○	○	○
un día de fin de semana:	○	○	○	○	○	○	○
estudiando sin utilizar internet							
un día de colegio:	○	○	○	○	○	○	○
un día de fin de semana:	○	○	○	○	○	○	○

2. cuántas horas duermes normalmente por la noche ...

durante los días de semana: ☐☐,☐ horas por noche

durante el fin de semana: ☐☐,☐ horas por noche

3. si realizas alguna actividad académica o de ocio complementaria al colegio (idiomas, ajedrez clases de repaso, clases the música) aparte del tiempo de estudio personal ¿cuántas horas supone a la semana?

☐☐,☐ horas por semana

4. Cuando estás comiendo con tu familia ¿coméis delante de la televisión?

○ todos los días en cada comida
○ todos los días en 1 0 2 comidas
○ no todos los dias pero mas de 2 comidas a la semana
○ no más de 1 0 2 comidas a la semana
○ escasas veces
○ nunca

0340399660

5. tienes en casa ...

televisión:	○ no	○ si, 1	○ si, 2	○ si, 3 o más
ordenador:	○ no	○ si, 1	○ si, 2	○ si, 3 o más
videoconsola:	○ no	○ si, 1	○ si, 2	○ si, 3 o más

tienes en tu habitación ...

televisión:	○ no	○ si
ordenador:	○ no	○ si
videoconsola:	○ no	○ si

tiene tu hermano / hermana en su habitación ...

televisión:	○ no	○ si	○ no tengo hermanos viviendo en casa
ordenador:	○ no	○ si	○ no tengo hermanos viviendo en casa
videoconsola:	○ no	○ si	○ no tengo hermanos viviendo en casa

6. sin contar las comidas principales, cuántas veces ...	**nunca**	**menos de una vez a la semana**	**1-2 días por semana**	**3-4 días por semana**	**(casi) todos los días**	**varias veces al día**
bebes algo mientras ves la televisión	○	○	○	○	○	○
comes algo mientras ves la televisión	○	○	○	○	○	○

¿qué comes y bebes mientras ves la televisión? (marca todas las respuestas oportunas de esta lista)

○ normalmente no bebo nada	☐ refrescos light	☐ infusiones
☐ agua	☐ refrescos azucarados	☐ café
☐ leche o productos derivados	☐ cerveza	☐ otras bebidas: .....
☐ zumo de frutas		

○ normalmente no como nada	☐ snack salado (patatas)	☐ bocadillo
☐ fruta	☐ bollería	☐ productos lácteos
☐ frutos secos	☐ caramelos, chocolates y chocolatinas	☐ otros: .....

7. sin contar las comidas principales, cuántas veces ...	**nunca**	**menos de una vez a la semana**	**1-2 días por semana**	**3-4 días por semana**	**(casi) todos los días**	**varias veces al día**
bebes algo mientras juegas con videojuegos:	○	○	○	○	○	○
comes algo mientras juegas con videojuegos:	○	○	○	○	○	○

¿qué comes y bebes mientras juegas con videojuegos? (marca todas las respuestas oportunas de esta lista)

○ normalmente no bebo nada	☐ refrescos light	☐ infusiones
☐ agua	☐ refrescos azucarados	☐ café
☐ leche o productos derivados	☐ cerveza	☐ otras bebidas: .....
☐ zumo de frutas		

○ normalmente no como nada	☐ snack salado (patatas)	☐ bocadillo
☐ fruta	☐ bollería	☐ productos lácteos
☐ frutos secos	☐ caramelos, chocolates y chocolatinas	☐ otros: .....

8. sin contar las comidas principales, cuántas veces ...	**nunca**	**menos de una vez a la semana**	**1-2 días por semana**	**3-4 días por semana**	**(casi) todos los días**	**varias veces al día**
bebes algo mientras navegas en internet:	○	○	○	○	○	○
comes algo mientras navegas en internet:	○	○	○	○	○	○

¿qué comes y bebes mientras navegas en internet? (marca todas las respuestas oportunas de esta lista)

○ normalmente no bebo nada	☐ refrescos light	☐ infusiones
☐ agua	☐ refrescos azucarados	☐ café
☐ leche o productos derivados	☐ cerveza	☐ otras bebidas: .....
☐ zumo de frutas		

○ normalmente no como nada	☐ snack salado (patatas)	☐ bocadillo
☐ fruta	☐ bollería	☐ productos lácteos
☐ frutos secos	☐ caramelos, chocolates y chocolatinas	☐ otros: .....

Cuestionario de frecuencia de consumo de alimentos (CEHQ-FFQ)

5618038797

¿Cuántas veces por semana sueles comer o beber...?

	nunca	menos de una vez por semana	una vez por semana	2-4 veces por semana	5-6 veces por semana	una vez al día, cada día	cada día, más de una vez
Fruta	○	○	○	○	○	○	○
Verduras	○	○	○	○	○	○	○
Dulces (caramelos o chocolate)	○	○	○	○	○	○	○
Refrescos de cola o de otros tipos que contengan azúcar	○	○	○	○	○	○	○
Refrescos de cola light o de otros tipos que sean light	○	○	○	○	○	○	○
Leche desnatada/ semidesnatada	○	○	○	○	○	○	○
Leche entera	○	○	○	○	○	○	○
Queso	○	○	○	○	○	○	○
Otros productos lácteos (como yogur, batidos, flanes, natillas…)	○	○	○	○	○	○	○
Cereales (como copos de maíz, muesli, cereales con chocolate…)	○	○	○	○	○	○	○
Pan blanco	○	○	○	○	○	○	○
Pan integral	○	○	○	○	○	○	○
Chips	○	○	○	○	○	○	○
Patatas fritas	○	○	○	○	○	○	○
Pescado	○	○	○	○	○	○	○