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THE ENVIRONMENT AND CHILD OBESITY: ENVIRONMENTAL, SOCIAL AND INDIVIDUAL ASPECTS OF CHILDHOOD AND ADOLESCENT OBESITY.

DOCTORAL THESIS

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CERTIFICA

Que la memoria de la Tesis Doctoral que presenta al superior juicio de Tribunal que designe la Comisión de Doctorado doña Ingrid Johanna Catherina de Ruiter, titulada **"THE ENVIRONMENT AND CHILD OBESITY: ENVIRONMENTAL, SOCIAL AND INDIVIDUAL ASPECTS OF CHILDHOOD AND ADOLESCENT OBESITY"**, es expresión de a capacidad investigadora e interpretativa de su autora, en condiciones que la hace acreedora al titulo de Doctor, siempre que así lo considere el citado Tribunal.

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"The journey of a thousand miles begins with one step" - Lao Tzu

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Abbreviations

AMA - American Medical Association

BMI – Body Mass Index

CAPI – Computer Assisted Personal Interview

CI – Confidence Interval

EU – European Union

INE– [Spanish] National Statistics Institute

IOTF – International Obesity Task Force

ISCED – International Standard Classification of Education

NHS – [Spanish] National Health Survey

OECD – The Organization for Economic Co-operation and Development

OR – Odds Ratio

SD – Standard deviation

SES – Socio-economic Status

WHO – World Health Organization

WOF – World Obesity Federation

Resumen (Español)

Introducción

Esta tesis investiga la obesidad infantil en España y considera tendencias y factores ambientales, sociales e individuales asociados. La obesidad infantil es un problema de salud pública actual y una gran preocupación en todo el mundo. La alta prevalencia de obesidad infantil ha sido documentada en todo el mundo desarrollado, incluyendo España. Europa estima que el 20% de los niños y adolescentes tienen sobrepeso, de los cuales un tercio son obesos.

Las consecuencias para la salud de la obesidad infantil son inmediatas y a largo plazo, ya que los perfiles de riesgo siguen su curso posterior y predicen la obesidad adulta. Además, se ha demostrado que la obesidad en la infancia y la adolescencia se asocia con pre-diabetes y perfiles de riesgo cardiovascular. Como tal, la infancia es un período de vida importante para la investigación y la prevención del exceso de peso y sus consecuencias.

La Organización Mundial de la Salud define la obesidad como una enfermedad, una condición compleja con dimensiones físicas, sociales y psicológicas, con serias consecuencias sanitarias y económicas. Los factores determinantes parecen deberse a una mezcla compleja entre el entorno y los genes. El entorno se considera como el estatus socioeconómico y los factores de vida urbanos, sociales, culturales, escolares y familiares que afectan las opciones de estilos de vida.

Se han identificado muchos factores modificables asociados a la obesidad infantil en las últimas décadas. Estos factores incluyen la dieta y la actividad física, así como el entorno alimentario. Un factor potencial modificable adicional identificado es la duración del sueño. Se ha demostrado que la corta duración del sueño está asociada con la obesidad infantil. Como

factor de estilo de vida modificable, es necesario realizar más investigaciones sobre la duración del sueño y las asociaciones con la obesidad, particularmente en el contexto hispano.

La batalla contra la obesidad infantil se ha complicado aún más dado que los padres ahora son más propensos a subestimar el estado de exceso peso de su hijo. Esto es preocupante, ya que si los padres no son conscientes o se encuentran despreocupados por el exceso de peso de su hijo, es poco probable que hagan los cambios necesarios para revertir la situación. Todavía se necesita hacer mucha investigación sobre la obesidad infantil.

El concepto

Esta tesis considera el modelo Dahlgren y Whitehead (Dalgren and Whitehead 1991) como base para desarrollar el modelo conceptual que ha guiado los artículos presentados en esta tesis. Esta tesis utiliza este modelo y un marco ecológico al considerar su enfoque de la obesidad infantil. Cuando se consideran los factores infantiles de conducta y estilo de vida, debemos reconocer que están inextricablemente ligados a los ambientes familiares, escolares, culturales y socioeconómicos; La dieta de un niño es determinada por sus cuidadores. En esta tesis, tendencias y cohortes se consideran inicialmente en un período de tiempo de dos décadas. Después, la obesidad infantil se considera en su contexto socio-cultural-ambiental considerando factores individuales, socioeconómicos y familiares.

Justificación

La obesidad infantil es y sigue siendo un problema de salud pública complejo y considerable. Históricamente, la obesidad ha sido excesivamente simplificada, con pocos resultados a largo plazo o un impacto significativo de los programas de intervención. El medio ambiente es clave para la investigación, la comprensión y las intervenciones, ya que los genes por sí solos no pueden explicar el rápido cambio en la prevalencia en las últimas décadas. Como tal, su

compleja naturaleza polifacética sigue siendo investigada y hay una gran necesidad de una mayor investigación de las tendencias y factores contribuyentes.

Las encuestas nacionales de salud contienen una gran cantidad de información que se puede explorar usando modelos multi-variables y de tendencias en el tiempo. A pesar de sus debilidades (cross-sectional, datos subjetivos y el uso de proxy informantes) puede dar información útiles para temas de salud pública y dar un base de información desde que se puede continuar la investigación.

Objetivos

El objetivo general de esta tesis es investigar la asociación entre factores individuales y / o factores en el entorno del niño y exceso de peso (sobrepeso y obesidad) en niños y adolescentes de 2 a 17 años de edad.

Metodología

Esta tesis se compone de cuatro artículos científicos, publicados en revistas indexadas. El primer artículo, publicado en 2014, es un estudio transversal que investiga un conjunto de factores individuales, familiares y medioambientales asociados con el exceso de peso pediátrico en España. Este estudio utilizó un conjunto de datos de una encuesta nacional hecho en 2012 como parte de un proyecto más amplio (Número de proyecto PI10 / 02018). El segundo, tercero y cuarto artículos publicados utilizaron los datos recogidos en las encuestas nacionales de salud desde 1987 hasta 2011. Los datos de las encuestas nacionales españolas de salud están disponibles gratuita y públicamente en internet. Los datos de las encuestas nacionales de salud fueron combinados en una sola base de datos y limpiados. El análisis de los datos varió en función de los objetivos de cada estudio.

La metodología detallada de cada estudio se describe en cada uno de los cuatro artículos.

Resultados

Véase los cuatro artículos en capituló 5, página 50.

Conclusiones

La obesidad infantil en España ha permanecido relativamente estable durante las últimas dos décadas con algunos altibajos. Sin embargo, algunos grupos han experimentado un aumento en la prevalencia de la obesidad. La estabilidad de la obesidad es consistente con los estudios de otros países. Sin embargo, la prevalencia es demasiado alta y sigue siendo un importante problema de salud pública.

La obesidad infantil tiene una etiología multifactorial que todavía no se entiende completamente. Muchos estudios, incluidos los presentados en esta tesis, proporcionan evidencia de numerosos factores modificables asociados con la obesidad infantil. Estos factores incluyen aspectos dietéticos, actividad física y duración del sueño.

La duración del sueño infantil ha disminuido en general en España durante las dos últimas décadas: una tendencia similar a las tendencias internacionales. Debido a la asociación entre la falta de sueño y los problemas de salud a largo plazo, particularmente la obesidad, la duración del sueño debe considerarse un factor de estilo de vida modificable y un problema de salud pública.

Por último, los niños dependen de sus padres para la dieta, el modelado de comportamientos saludables y la provisión de un entorno saludable. Sin embargo, si los padres no son conscientes de la situación de exceso de peso de sus hijos, es poco probable que implementen medidas con las que poder ayudar. En España, la tasa de percepción errónea de la obesidad

infantil es muy alta, especialmente con los niños más pequeños. No sólo las características demográficas de los padres afectan la probabilidad de identificar correctamente a sus hijos con exceso de peso, sino también la propia percepción que tienen de su hijo afecta a la identificación correcta. Si los padres consideran que un niño es activo, feliz y con pocos problemas sociales, la probabilidad de que los padres identifiquen correctamente la obesidad en ese niño disminuye. Se necesita más trabajo e investigación en este campo.

1. Introduction

1. Introduction

This thesis investigates childhood obesity in Spain and considers trends and associated environmental, social and individual factors. Childhood obesity is a contemporary public health issue and a major concern worldwide.

1.1 Child obesity as a multi-factorial public health problem

Childhood obesity is considered an important public health problem worldwide with high prevalences having been documented throughout the developed world including Spain (Sánchez-Cruz et al. 2013; van Stralen et al. 2012; Wang and Lobstein 2006). Europe estimates 20% of children and adolescence to be overweight, with one third of these obese (World Health Organization 2007). In Spain, the 2011 National Health Survey reported a prevalence of excess weight of 29.1% in boys and 26.5% in girls (Spanish Ministry of Health and Social Policies 2013). Over the last decades, prevalence of childhood obesity worldwide has increased substantially, although has reached a plateau in a number of countries.

The health consequences of child obesity are both immediate and long term, as risk profiles track into later life, and are a known predictor of adult obesity (a S. Singh et al. 2008). Adult obesity is a known cardiovascular and metabolic risk factor. Obesity in childhood and adolescence has also been shown to be associated with pre-diabetes and cardiovascular risk profiles(Ram Weiss et al. 2003). Both overweight and obesity during adolescence have been shown to be strongly associated with cardiovascular outcomes and mortality in middle age(Twig et al. 2016a). As such, childhood is an important life period for research and prevention of excess weight and its consequences.

Obesity is defined by the World Health Organization(WHO) as a disease, a complex condition with physical, social and psychological dimensions, with serious health and economic

consequences (World Health Organization 2000). This comprehensive definition highlights that the cause and solution to obesity are far more complex than the all too often argued and simplistic energy balance equation or over-eating of high calorie western diets. Rather the determinants appear to be due to a complex mix of environment, genetics, gene-environment interactions, epigenetics, early life exposures and gut microbiome amongst others (McAllister et al. 2009). The rapid increase in prevalence over the last decades also point to environmental causes rather than genes and are likely the result of a complex interaction between the two. Environment in this context includes socio-economic status and societal, cultural, school, family and urban/living factors affecting lifestyle choices. Many modifiable factors have been identified with extensive research over the last decades. These factors include diet and physical activity as well as the food and activity environment: E.g. opportunities for exercise, food advertising and fast food availability to name a few(Bodor et al. 2008; Fairclough et al. 2009; Reilly et al. 2005; World Health Organization 2000). An additional potential modifiable factor identified is sleep duration. Sleep duration in childhood varies widely worldwide as does sleep recommendations, with little international consensus on physiological requirements. However, short sleep duration has been shown to be associated with childhood obesity. As a modifiable lifestyle factor, further investigation on sleep duration and associations with obesity, particularly in a Spanish context is necessary.

In 2013 the American Medical Association (AMA) officially declared obesity a medical condition, firmly putting itself against the stance of obesity being a personal failure (Pollack 2013). While this negates the idea of obesity being solely the result of individual lifestyle choices, this does not conflict with the evidence pointing to many modifiable factors. As mentioned above, many modifiable factors, or lifestyle choices, are the result of societal, cultural or environmental conditions and can be intervened at both individual and population levels

Due to the high and increasing prevalence and health consequences effective strategies to combat child obesity have been on the public agenda in many countries for a number of decades, with the most recent WHO Commission on Ending Childhood Obesity being published in 2016 (World Health Organization 2015a). However, many individual strategies and interventions over the last decades, while showing some success, have not had a lasting or wide impact as shown by increasing trends despite these efforts (Oude Luttikhuis et al. 2009). These have been further complicated by the "generational shift in social norms related to body weight"(Hansen et al. 2014) with visual perceptions of what constitutes normal weight increasing. Parents are now more likely to misperceive and underestimate their child's weight status (Salcedo et al. 2010). This is concerning, as we do not fix what we don't know is broken. If parents are unaware or unconcerned about the excess weight status of their child they are unlikely to make the necessary changes to remedy the situation. More effort and ongoing research on childhood obesity is still very much needed.

1.2 PhD Thesis as a compendium of peer-reviewed articles

This PhD thesis is a compendium of peer-reviewed articles rather than the traditionally known thesis. There are a number of reasons for choosing to pursue a PhD via this pathway as opposed to one long thesis. Primarily I chose this method as learning to publish peer-reviewed articles and gaining experience in publishing is part of the learning objectives of a PhD. In this way I learn first-hand the steps and skills required to publish my research and have solid evidence of these skills with first author papers as an immediate outcome of the PhD.

Developing and publishing a compendium of peer-reviewed articles assists in developing a solid base and experience in Scientific Method. With each study requiring the development of an appropriate research question, hypothesis, designing a study to adequately investigate the

research question, analysis of data, develop and draw conclusions from the results and reporting the findings.

Furthermore, publishing research during the PhD allows for faster dissemination of findings which is important in today's fast-paced research environment, and childhood obesity is no exception. This PhD pathway also ensures public dissemination of the research findings rather than leave the possibility of turning the thesis into peer-reviewed articles as an afterthought or post-PhD extra.

Publishing research throughout the PhD also provides constant international peer-review with feedback and critique which improves the research and subsequent published papers. This ongoing critique and feedback adds an extra layer of learning and pushes for excellence.

Articles

This thesis comprises of four peer-reviewed scientific articles, published in indexed journals.

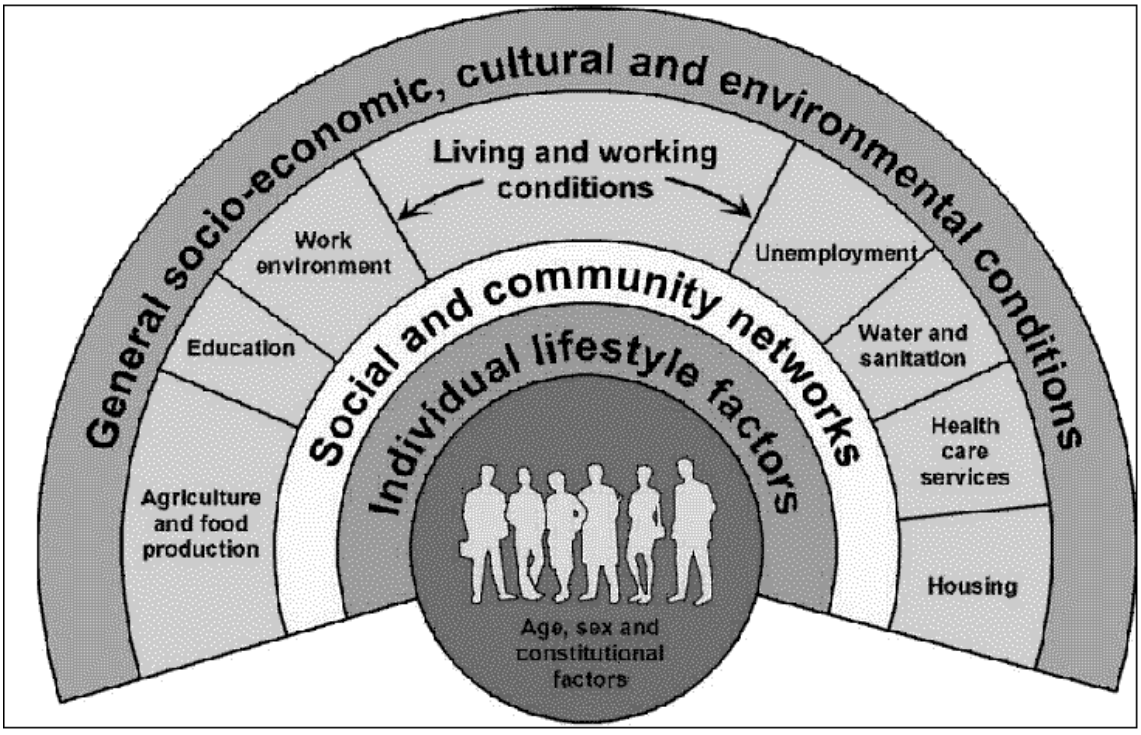
The four articles that make up this doctoral thesis are the following:

- **De Ruiter I**, Olmedo-Requena R, Sánchez-Cruz J-J, Jiménez-Moleón J-J. Trends in Child Obesity and Underweight in Spain by Birth Year and Age, 1983 to 2011. Rev Esp Cardiol. 2017. http://dx.doi.org/10.1016/j.rec.2016.12.013
- **De Ruiter I**, Olmedo-Requena R, Sánchez-Cruz J-J, Jiménez-Moleón J-J. Changes in sleep duration in spanish children aged 2–14 years from 1987 to 2011. *Sleep Med* 2016; **21**: 145–150
- Sánchez-Cruz J, **De Ruiter I**, Jiménez-Moleón J, Individual, family and environmental factors associated with paediatric excess weight in Spain: a cross-sectional study. BMC Pediatrics. 01/2014; 14(1):3.

- **De Ruiter I**, Olmedo-Requena R, Jiménez-Moleón J-J. Parental mispeception and underestimation of child obesity. *Under second Review Journal of Maternal and Child Health [MACI-D-17-00042R1]*

1.3 Conceptual model

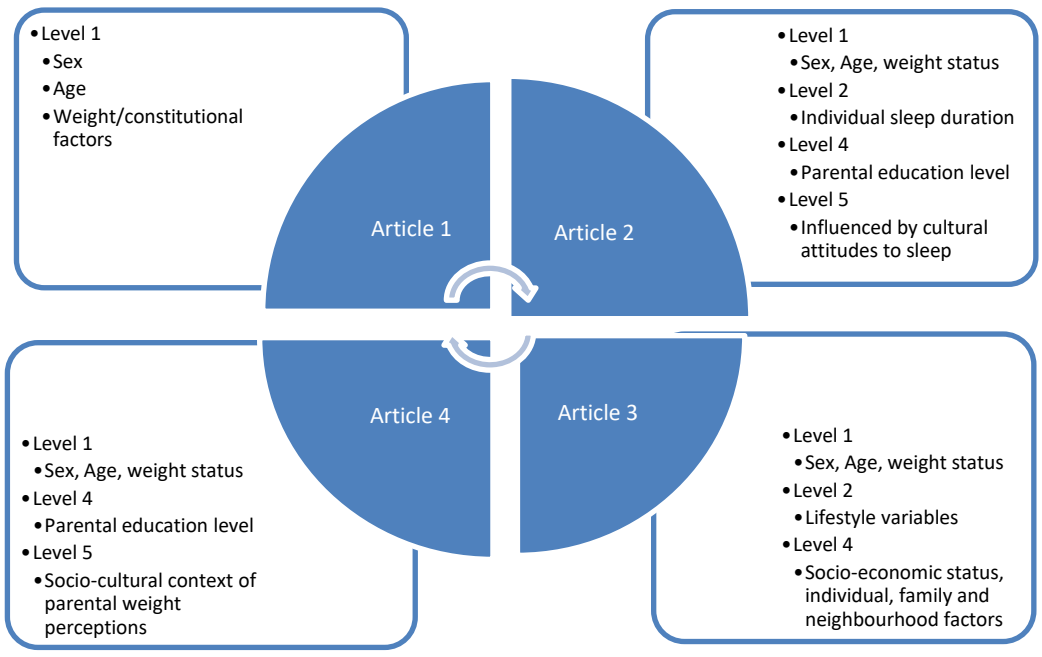
This thesis considers the Dahlgren and whitehead model as a basis from which to develop the conceptual model that guided the articles presented in this thesis. (Dalgren and Whitehead 1991) The Dahlgren and whitehead model is well-known and part of the thread work of public health. It considers the impact of various levels on an individual's health ranging from the individual level which encompasses genetics, age and constitutional factors to social and community influencing factors to population level factors and environments.

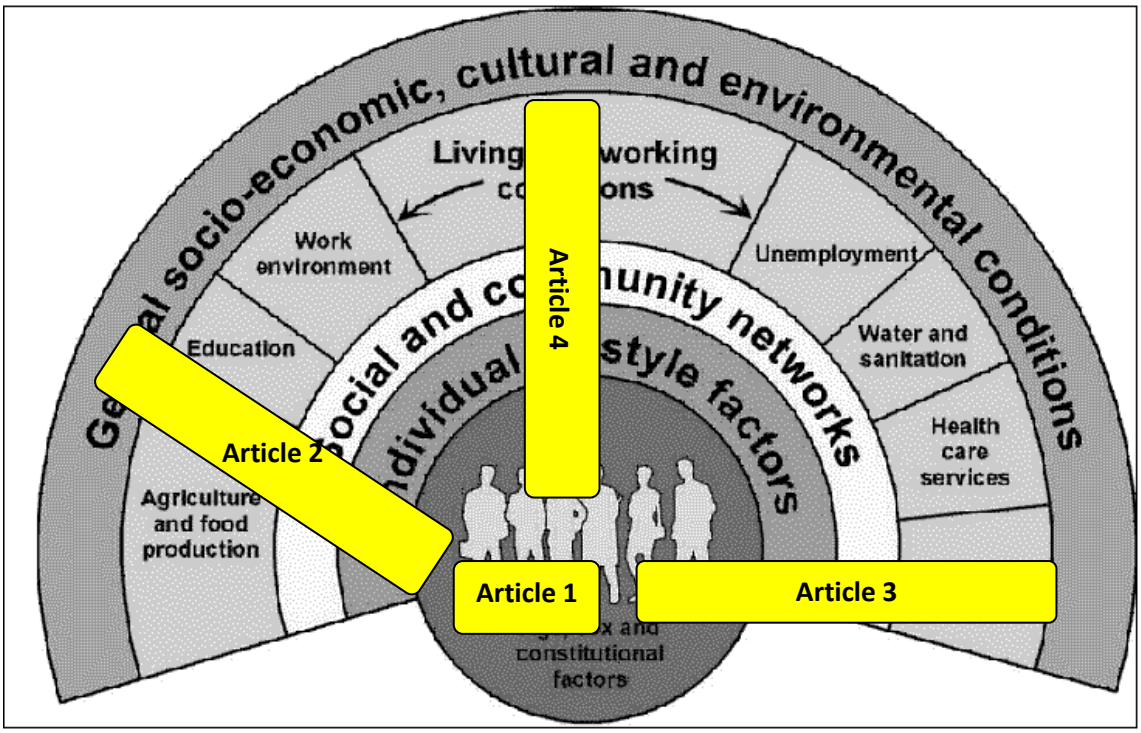


This thesis uses this model and an ecological framework when considering its approach to childhood obesity. When considering childhood behavioural and lifestyle factors we must

acknowledge that they are inextricably linked to family, school, cultural and socio-economic environments; a child's diet is determined by their caregivers. In this thesis trends and cohorts are initially considered over a two decade time period. Then childhood obesity considered in its socio-cultural-environmental context considering individual, socio-economic and family factors. Weight discourse takes place in a wider social discourse and families need to negotiate complex contradictory messages when constructing beliefs and actions relating to obesity management (Thomas et al. 2014). Parents gauge their child's weight status in comparison with others rather than assessing their weight status on an absolute scale. This is known as social comparison theory(Hansen et al. 2014) and is contributes to an obesogenic environment. This is investigated in the final article analysing factors associated with parental underestimation of child excess weight. Perceived social factors are included in the study.

The figures below show the approach of each article and how it fits into this framework.




Work environment
Unemployment
Education
Water and sanitation
Health care services
Agriculture and food production
Article 4
Article 2
Article 1
Article 3

2. Justification

2. Justification

2.1 Selection of research area and environmental approach

Childhood obesity is and remains a complex and sizeable national and international public health problem. Obesity has historically been over-simplified (Keith et al. 2006) with little long term results or significant impact from intervention programs. Environment is key to research, understanding and interventions as genes alone cannot explain the sizeable and rapid change in prevalence over the last decades(Yeh, Kushner, and Schiff 2016). As such, its complex multi-faceted nature continues to be investigated and there is great need for further investigation of trends and contributing factors. Successful and large impact public health interventions (at both individual and population levels) will only be successful with full and correct understanding of childhood obesity and subsequent appropriately designed and targeted intervention/prevention strategies. The research included in this thesis hopes to contribute and add small pieces of the puzzle to the national (and global) picture and associated environment characteristics maps.

2.2 Use of Spanish National Health Survey data

The Spanish National Health Surveys collect a large amount of information that has not been processed and analysed in sufficient depth, and despite some of the weaknesses and downsides of the National Health Surveys - for example it´s cross-sectional nature, subjective data, use of proxy informants - they contain valuable information and lend themselves to detailed multivariable and longitudinal analyses.(González Montero de Espinosa, Herráez, and Marrodán Serrano 2013)

Along these lines, when I wished to pursue further investigation into child obesity I realized that Spain, as with many countries, collects national and regional health and lifestyle data and has done for many years. These databases hold a wealth of information waiting to be

extracted and investigated. Despite some of the aforementioned limitations and it not being specifically designed to investigate child obesity, they [NHS Data] provide a good base and starting point from which to gain information and insight into the child obesity issue on both a general and national level, including national trends and associated factors.

Data and some of the results from three of the studies included in this thesis were corroborated with a study using data from a project designed specifically to investigate child obesity and associated factors in Spain.

Every block of stone has a statue inside it and it is the task of the sculptor to discover it – Michelangelo

3. Objectives

3. Objectives

3.1 Main objective

The overall aim of this thesis is to investigate the association between individual factors and/or factors in the child's environment and excess weight (overweight and obesity) in children and adolescents, 2-17 years of age.

3.2 Specific objectives

3.2.1. To provide empirical evidence of the association that some individual, family and environmental factors may have on excess body weight during childhood and adolescence.

3.2.2. To determine the prevalence and trends of child obesity in Spain over the last two decades.

3.2.3 To investigate the sleep duration trends for children in Spain from 1987 to 2011 and associated socio-demographic characteristics. And to investigate associations between child sleep duration and child obesity.

3.2.4. To investigate parental perceptions of child weight and child and parental characteristics associated with misperceptions of child weight and child obesity.

4. Methods

4. Methods

4.1 General overview

This thesis comprises of four peer-reviewed scientific articles, published in indexed journals. The first article, published in 2014 - a cross-sectional study investigating a set of different individual, family and environmental factors associated with paediatric excess weight in Spain - used a dataset resulting from a nationwide survey in 2012 as part of a wider project (project number PI10/02018). The second, third and fourth articles published used data collected in the Spanish National Health Surveys, from 1987 to 2011. Data from the Spanish National Health Surveys are freely and publically available online.(Spanish Ministry of Health and Social Policies 2013) Data were downloaded and combined in a single database and cleaned. Data analysis varied depending on the objectives of each study.

Detailed methodology for each study is described in each of the four articles.

4.2 General overview of Methods for the Spanish National Health Surveys

The NHS investigates the health indicators of citizens in Spanish territories including Ceuta and Melilla. The first NHS was undertaken in 1987 by the "Centro de Investigaciones Sociológicas" for the Ministry of Health. The NHS was continued bi annually with the exception of 1999. From 2002 and agreement between the Ministry of Health the National Statistics Institute (INE) saw the subsequent NHS undertaken by the INE. As with all National Health Surveys, surveys change with time due to changing socio-cultural-economic changes. Changes made from 2002 were done in such a way to allow for comparability with earlier surveys. Instruments and scopes have been added over the years to align with other international surveys such as the European Health Surveys and OECD instruments. From 2003 a separate household survey was collected. Questionnaires were also coded in such a way that

integration of data from all surveys would be possible. 2012 also saw the introduction of the Computer Assisted Personal Interview. (Spanish Ministry of Health and Social Policies 2013)

4.2.1 Design

The NHS are national cross-sectional surveys generally under taken every 2 years.

The sample design uses a stratified multi-stage sample. The first stage units are the census sections. The second stage units are main family dwellings. Subsequently, within each household an adult is selected to complete the adults questionnaire and if there are children (0 to 15 years old), one of these is selected as well to complete the child questionnaire.

The first stage units are grouped into strata depending on the size of the municipality to which the section belongs.

(Spanish Ministry of Health and Social Policies 2013)

4.2.2 Time Period and scope

The NHS is generally undertaken every two years and surveys the non-institutionalized Spanish population residing in households within the national territory, including Ceuta and Melilla.

The NHS has been done in the following years: 1987, 1993, 1995, 1997, 2001, 2003/2004, 2006/2007, 20011/2012

From 1995, the NHS was undertaken in four equal waves over a twelve month period to avoid seasonal influences.

4.2.3 Study Population

Selection criteria:

The NHS surveys the non-institutionalized Spanish population residing in households within the national territory, including Ceuta and Melilla (except in 1987, 1995, and 1997). For the purposes of the studies presented in this thesis, we restricted data to surveys including a child aged 2-14 years in peninsula Spain (i.e. excluding Ceuta and Melilla)

Sample selection:

The sample design uses stratified multi-stage sampling. Within each stratum the sections are selected with probability proportional to their size. Dwellings are selected in each section with equal probability by means of random start systematic sampling. Within households adults and children are randomly selected. If more than one household existed within a dwelling, an adult and a minor (if present) were selected from each household.

Sample sizes NHS Children's survey (0-15 years):

1987 - 10104 (1-15 years)

1993 - 5280 children

1995 - 2000 children

1997 - 2000 children

2001 - 5280 children

2003/2004 - 6463 children

2006/2007 - 9122 children

2011/2012 - 5495 children

4.2.4 Information sources

Information for the adult questionnaires was collected via direct personal interview; and in 2011/2012 via a Computer Assisted Personal Interview (CAPI). In exceptional cases the interview was permitted to be supplemented by telephone interview if an interview in person was not possible on several occasions. If the adult selected was unable to facilitate the required data, a proxy informant was used.

In the case of the children's questionnaires, where possible the data was collected via direct personal interview. A proxy adult was used in the case of minors unable to facilitate the required data due to age, normally either a parent or guardian.

Information for the household questionnaire was generally obtained via direct personal interview with the main breadwinner of the household. Only where necessary was this permitted to be supplemented by telephone interview. If the main breadwinner was unable to respond to the questionnaire another member of the household was permitted to answer the questions with an order preference based on their relationship to the reference person.

4.2.5 Study variables

The variables and focus of the NHS has evolved over the years and expanded with changing requirements.

In 2012 the variables studied fell into the following categories:

- Identification variables
- Classification variables

- Geographic variables
- Socio-demographic variables
- Socio-economic variables

- Objective variables
  - Health status module
  - Health Service utilization module
  - Determinants of Health module

The variables used in each respective study presented in this thesis are presented in the following table.

Article	Principal Variable(s)	Variables	Survey Years
Trends in Child Obesity and Underweight in Spain by Birth Year and Age, 1983 to 2011.	➢ BMI (Derived from child height, weight)	• Child Age • Child Sex • Education level of head of household	1983, 1993, 1995, 1997, 2001, 2003/2004, 2006/2007, 2011/2012
Changes in sleep duration in spanish children aged 2–14 years from 1987 to 2011.	➢ Sleep duration ➢ BMI (Derived from child height, weight)	• Child Age • Child Sex • Education level of head of household • Physical Activity level	1983, 1993, 1995, 1997, 2001, 2003/2004, 2006/2007, 2011/2012
Parental mispeception and underestimation of child obesity.	➢ BMI (Derived from child height, weight) ➢ Parental perception of child's weight status	Child variables • Child Age • Child Sex • Perceived Health • Mental and Social Health variables • Exercise, Sleep, Sedentary variables • Food Habit variables Adult variables • Age • Sex • Education level • Health/Quality of life variables • Exercise/Sleep variables • Food Habit variables	2011/2012

4.2.6 Data Analysis

4.2.5.1 Data Analysis of Article 1

This article investigates excess weight and underweight trends in Spain from 1987 to 2011 using data collected in the Spanish National Health Surveys. Cases with missing BMI data or BMI extremes were excluded, as were cases from Ceuta and Melilla. Data was weighted using population proportionality with census data for consistency between surveys and to ensure data were representative of the population. BMI was calculated and overweight and obesity defined according to the 2012 updated International Obesity Task Force (IOTF)[1] criteria.(Cole and Lobstein 2012)

Using the health surveys as a series of cross-sectional studies, prevalence and trends of excess weight and underweight was calculated for children aged 2-14 years per survey year and per birth year.

The complete reference for this article is:

- **De Ruiter I**, Olmedo-Requena R, Sánchez-Cruz J-J, Jiménez-Moleón J-J. Trends in Child Obesity and Underweight in Spain by Birth Year and Age, 1983 to 2011. Rev Esp Cardiol. 2017. http://dx.doi.org/10.1016/j.rec.2016.12.013

See page 50 of this thesis for the full article and methods

4.2.5.2 Data Analysis of Article 2

This article investigates paediatric sleep duration trends over the last two decades for three different paediatric age groups and sleep duration associations with obesity.

[1] Now known as World Obesity Federation

This study used data collected in the Spanish National Health Surveys from 1987 to 2011. Cases were restricted to children aged 2-14 years living in peninsula Spain. Using the health surveys as a series of cross-sectional studies, prevalence and trends of sleep duration were calculated for children aged 2-14 years. Age-related sleep duration was compared with international recommendations regarding sufficient sleep duration to dichotomize data into sufficient and insufficient. Prevalence and trends of sufficient sleep duration were calculated. Finally association between sleep duration and obesity was investigated.

The complete reference for this article is:

- **De Ruiter I**, Olmedo-Requena R, Sánchez-Cruz J-J, Jiménez-Moleón J-J. Changes in sleep duration in spanish children aged 2–14 years from 1987 to 2011. *Sleep Med* 2016; **21**: 145–150.
- *See page 63 of this thesis for the full article and methods*

4.2.5.3 Data Analysis of Article 4

This study used cross-sectional data from the Spanish National Health Survey in 2011-12 for children aged 2-14 years living in peninsula Spain who are overweight or obese. Percentages of parental underestimation of excess weight were calculated. Underestimation was defined as case where a child with a BMI in the overweight or obese range whose parents considered their weight in relation to height to be normal.

Independent factors for analysis were chosen based on literature search of factors associated with child obesity, adult obesity and factors associated with perception and stigma of obesity (Gray, Kahhan, and Janicke 2009; Hardus et al. 2003; Jain et al. 2001; Warschburger 2005). The factors were divided into child and adult factors then further categorized into: General

Characteristics, Perceived Health, Social and Mental Health, Exercise and Rest, and Food Behaviours.

Crude and adjusted analyses were performed using binary logistic regression for both child and parental factors analysing associations with misperception. Effect size of each factor on underestimation of excess weight for each variable was reported.

The complete reference for this article is:

- **De Ruiter I**, Olmedo-Requena R, Jiménez-Moleón J-J. Parental misperception and underestimation of child obesity. Under *Review*
- *See page 84 of this thesis for the full article and methods*

4.3 General overview of Methods for Project PI10/02018

This project undertook a cross-sectional observational study carried out across family households in peninsula Spain in 2012 of children aged 8-17 years. The general objective of this project was to investigate child obesity in Spain.

The questions and response scale used personal interview are part of the standardised questionnaire used in the Andalusian and National Health surveys. The questionnaire used in this study was also initially tested on a sample of 50 people of the target population.

4.3.1 Design

This project involved a cross-sectional observational study using a multistage clustered and stratified sample representative of the Spanish population resident in family households aged 8-17 years in peninsula Spain, 2012.

4.3.2 Time Period and scope

Data were collected during April and May in 2012.

The study population consisted of children and adolescents, of both sexes, between the ages of 8 and 17 years inclusive, resident in family households in peninsular Spain.

4.3.3 Study Population

Selection criteria:

The study population consisted of children and adolescents, of both sexes, between the ages of 8 and 17 years inclusive, resident in family households in peninsular Spain.

Sample selection:

Probability sampling was used to select study subjects from the study population. The probabilistic sample was based on a multistage clustered and stratified sample. A probability proportional to size method was used to select primary sampling units (municipalities) and secondary units (census groups). Tertiary units (households) and individual units were selected using a combination of random pathways and quotas for sex and age. Population strata were formed by the intersection of the fifteen mainland regions with municipality population size divided into 5 categories:

- less than or equal to 2000 inhabitants
- 2001 to 10 000
- 10 001 to 50 000
- 50 001 to 200 000
- more than 200 000 inhabitants

The selected sample was proportional to the size of the strata. The distribution of the two age groups in the sample population (8–12 years and 13– 17 years) was equal to their proportions in the population.

Sample size:

A collaboration rate of 80% was achieved (subjects that completed both the questionnaire and the required measurements). The final sample consisted of 978 subjects.

4.3.4 Information sources

Data were collected in person via a CAPI. The questions and response scale used are the same as the standardised questionnaire used in the Andalusian and National Health surveys. Responses to the CAPI were provided by the adult responsible for the study subject's diet (a parent or guardian).

Height and weight variables were measured objectively in the presence of the adult responding to the questionnaire. A weighing scale and height tape measure were used to collect the anthropometric measurements of the various members of the household, following a specific measurement protocol. The specific models used were: *a)* Tefal® PP1027 A9 scale, and *b)* Soehnle® 5002.01.001 wall-mounted tape measure. BMI was determined by applying the formula obtained when dividing the weight (kilograms) by the square of the height (meters).

4.3.5 Study variables

Principal outcome variables were objective anthropometric measurements of height and weight. BMI data was subsequently calculated by the quotient of body mass in kg by height in

meters squared (m^2), and overweight and obesity were defined according to the World Health Organization criteria (World Health Organization 2015b).

The variables considered in the study presented in this thesis, with their initial categorization, are shown in the following table:

Variable	Categorization
Age group of child	8–12 years (REF) 13–17 years
Sex of child	male (REF) female
Population category of municipality	less than or equal to 2000 inhabitants 2001 to 10 000 10 001 to 50 000 50 001 to 200 000 more than 200 000 inhabitants
Education level of the adult responsible for the child's diet	Primary (REF) Secondary or University level studies
Employment status of the adult responsible for the child's diet	Employed Unemployed but previously employed Looking for first employment Retired (worked previously) Housewife Student Disability Permanent Disability Other
Occupation of the adult responsible for the food of the children	Categorization according to the national classification of occupations 2001 (CON-11)
Walking	less than 30 min per day (REF) 30 min or more per day
Sleep duration	less than 9 hours per night (REF) 9 hours or more per night
Variables related to dietary habits	daily breakfast, daily freshly-squeezed orange juice, daily Yoghurt
TV watching	watches TV every day does not watch TV every day
Perception of neighbourhood quality	Good/Very Good Average/Poor/Very Poor (REF)
Perception of Neighbourhood Safety	Good/Very Good (REF) Average/Poor/Very Poor

Caregiver perception of Excess Weight	Excess weight is not detrimental to health Is detrimental but not as much as is alleged by doctors or the media Is detrimental for health
Maternal Age	*Considered as a continuous variable*
Paternal Age	*Considered as a continuous variable*

Some variables were subsequently reclassified, due to the low number of observations in some categories or due to similar behaviour with respect to the dependent variable.

4.3.6 Data Analysis

The data used from this study is presented in article 3 (Individual, family and environmental factors associated with paediatric excess weight in Spain: a cross-sectional study). Detailed methodology is presented in the article.

Initial descriptive statistics were calculated as the mean and standard deviation for continuous variables and percentage distributions for categorical variables. Comparison of proportions was carried out using the chi-squared statistic if its conditions were met otherwise the Fisher exact test was used.

An initial logistic regression model of excess weight with respect to the child's sex and age was fitted. Subsequently, a new variable was added successively using the forward method of introducing variables manually. The effect of each exploratory variable in the model and its significance was analysed: if the variable improved the model fit and adequacy it was kept for the next step; otherwise, the variable was excluded. The model was checked for pair-wise interaction between covariates. Once the model was fitted to the data, the goodness of fit of the model was assessed by the Hosmer-Lemeshow test.

The complete reference for this article is:

- Sánchez-Cruz J, **De Ruiter I**, Jiménez-Moleón J, Individual, family and environmental factors associated with paediatric excess weight in Spain: a cross-sectional study. BMC Pediatrics. 01/2014; 14(1):3.
- *See page 73 of this thesis for the full article and methods.*

5. Results: Articles Published

5. Results

5.1 Article 1: Trends in child obesity in Spain

Rev Esp Cardiol. 2016;xx(x):xxx–xxx

Original article

Trends in Child Obesity and Underweight in Spain by Birth Year and Age, 1983 to 2011

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ABSTRACT

Introduction and objectives: The prevalences of child obesity and overweight are increasing worldwide and are a significant public health issue, particularly in terms of long-term cardiovascular risk profiles, which continue into adulthood unless obesity is reversed. Accurately identifying trends and at-risk subgroups is crucial to correctly target public health initiatives. The objective of this study was to examine changes in the prevalences of child obesity and underweight in Spain from 1983 to 2011 taking into consideration both age and birth year.

Methods: A series of cross-sectional studies representative of the pediatric population in Spain between 1987 and 2011 was used to calculate the prevalence and trends of excess weight and underweight in girls and boys aged 2 to 14 years per survey year and per birth year.

Results: The overall prevalence of overweight and obesity remained relatively stable. The prevalence of overweight in boys aged 10 to 14 years increased from 13.9% to 22.2%. The prevalence of obesity in girls aged 2 to 5 years decreased from 30% to 19.8%, whereas the prevalence of underweight in this group increased from 13.7% to 22.6%.

Conclusions: Child obesity trends in Spain over the last 2 decades appear to be stable with some fluctuations, but the trends differ depending on age and sex, and have stabilized at too high a level. The prevalence of underweight also appears to have increased and should be considered alongside excess weight when designing and implementing child health and weight measures.

Tendencia de la obesidad y el bajo peso infantiles en España, por año de nacimiento y edad, 1983-2011

Palabras clave:
Obesidad
Tendencias
Epidemiología
Población infantil
Factores de riesgo

RESUMEN

Introducción y objetivos: Las prevalencias de obesidad infantil y sobrepeso están en aumento en todo el mundo y representan un importante problema de salud pública, especialmente en los perfiles de riesgo cardiovascular en la edad adulta si la obesidad no se revierte. La identificación precisa de las tendencias y los subgrupos en riesgo es crucial para orientar correctamente las iniciativas de salud pública. El objetivo de este estudio es examinar los cambios en la obesidad infantil y la prevalencia del bajo peso en España desde 1983 a 2011, teniendo en cuenta la edad y el año de nacimiento.

Métodos: Se utiliza una serie de estudios transversales representativos de la población pediátrica en España entre 1987 y 2011, se calcularon la prevalencia y las tendencias de exceso de peso y el bajo peso en niños de 2-14 años, a partir de las encuestas anuales y por año de nacimiento.

Resultados: La prevalencia general de sobrepeso y obesidad se mantuvo relativamente estable. La prevalencia del sobrepeso en los varones de 10-14 años aumentó del 13,9 al 22,2%. La prevalencia de la obesidad disminuyó en las mujeres de 2-5 años del 30 al 19,8%, mientras que la prevalencia de bajo peso en este grupo aumentó del 13,7 al 22,6%.

Conclusiones: Las tendencias de la obesidad infantil en España durante las últimas 2 décadas parecen mantenerse estables, con algunas fluctuaciones; sin embargo, las tendencias varían en función del sexo y la edad, y se han estabilizado en un nivel alto. La prevalencia de bajo peso también parece haber

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1885-5857/

aumentado y debe considerarse, junto con el exceso de peso, en el diseño y la implementación de las medidas de salud y peso infantiles.

Abbreviations

BMI: body mass index
SES: socioeconomic status

INTRODUCTION

The increasing prevalence of child overweight and obesity in European countries has been reported to have reached epidemic proportions and has emerged as a significant public health issue.[1,2] In many countries, childhood obesity is leveling off, but the prevalence in Spain continues to be on the rise and is among the highest in Europe.[3,4]

The consequences of child obesity are both immediate and long-term, because risk profiles carry into later life and are a known predictor of adult obesity.[5] Adult obesity is a known cardiovascular risk factor with cardiovascular diseases being one of the primary causes of hospitalization and mortality in Spain.[6,7] Obesity in childhood and adolescence has also been shown to be associated with prediabetes and cardiovascular risk profiles[8] and a recent article found that both overweight and obesity during adolescence were strongly associated with cardiovascular outcomes and mortality in middle age.[9] Therefore, the early years of life are an important time for prevention of excess weight and its consequences and for research into this topic. More importance needs to be placed on primary prevention with focus on modifiable risk factors, extending primary intervention into childhood and adolescence.

The prevalence of obesity in Spain is considerably lower during adolescence than during childhood.[7] Differences in the prevalence of obesity among children and adolescents have also been observed in other countries.[10–13] Consequently, overweight in childhood may not necessarily translate into overweight in adolescence.[12] There are a number of factors to be considered: an age effect, period effect and/or cohort effect with possible differences in the incidence and persistence of overweight or obesity during childhood and adolescence.[14] Cohort effects and period effects have already been shown to be associated with the prevalence of obesity in adulthood, suggesting that early life exposures affect later susceptibility.[15,16] However, little research has been done on cohort or birth year effects in childhood.

Population interventions have focused on reducing the prevalence of excess weight but we need to ensure that these strategies are not increasing the burden of underweight. Population strategies promoting weight loss without taking into consideration an individual's body mass index (BMI) may negatively affect those with borderline normal weight. Studies have also suggested that children with a low BMI who develop obesity in adulthood are at particular risk of metabolic syndrome.[17] There is little literature on prevalence and trends in underweight children in Europe and even less that analyze them alongside those of obesity.[18] There is a need to monitor and investigate the prevalence of underweight and its associated trends alongside those of excess weight.

In this study, we investigate underweight, overweight, and obesity trends in 2- to 14-year-olds in Spain during the last 3 decades, considering both age and birth cohort year.

METHODS

Study Design and Population

This study used data collected by the Spanish Ministry of Health and National Institute of Statistics in a series of cross-sectional National Health Surveys in 1987, 1993, 1995, 1997, 2001, 2003/2004, 2006/2007, and 2011.[19] Data were collected in a multistage stratified random sample, with strata based on municipality size to ensure representativeness. Our population sample was restricted to children and adolescents aged 2 to 14 years inclusive. We excluded persons with missing data on age, sex, or anthropological characteristics, as well as individuals with extreme BMIs (> 40 or < 10). Ceuta and Melilla were also excluded. After the exclusion criteria were applied, the sample size was 4417 in 1987, 2730 in 1993, 1040 in 1995, 1111 in 1997, 2956 in 2001, 4808 in 2003/2004, 5356 in 2006/2007, and 3642 in 2011.

Variables

Parental education level was used as a proxy for socioeconomic status (SES). This was obtained from the highest education level achieved by the head of the household, who was defined as the member of the household with the highest income. In 2011 this information was not available and was approximated using the highest education level achieved by either a parent or legal guardian. During 1997 and 2001, if the head of the household was the person completing the child's questionnaire, no information on level of education was available, resulting in systematic loss of data. The education level categories used were: *a)* illiterate/primary education, and *b)* secondary/university education.

Data on BMI were derived from parent/caregiver-reported height and weight of the child in cm and kg. BMI by sex and age was categorized as per the latest International Obesity Task Force definitions for BMI centile cutoffs for persons aged less than 18 years[20]: The centiles for underweight, overweight, and obesity were 15.5, 90.5, and 98.9, respectively, for boys and were 16.5, 89.3, and 98.6, respectively, for girls. Age in months is usually used to calculate age-specific BMI, but as the National Health Survey reports ages in years, all children were assumed to be at the midpoint of their age-year for this calculation.

Statistical Analysis

Prevalences and their 95% confidence intervals were calculated for each weight status category by both survey year and birth year categories. Analyses were stratified by age, sex, and SES. Due to the combined nature of our analyses and the need for standardization of weighting for each survey year, data were weighted using the principles of proportionality for the subgroups of age, sex, and autonomous community and by using population data from the Spanish Statistical Office corresponding to each survey year.[21,22] Analyses were performed using the statistical package SPSS, version 20.

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Table 1
Unweighted Survey Population Characteristics

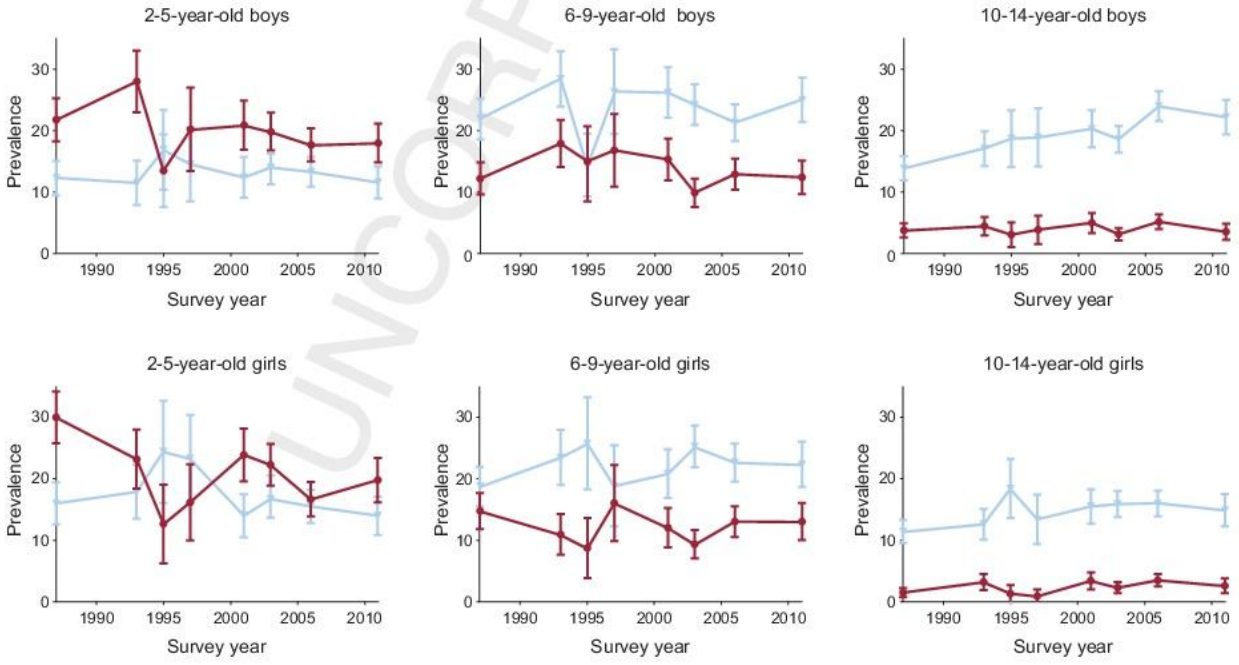
Survey year	1987	1993	1995	1997	2001	2003-04	2006-07	2011	Total
Sex									
Male	2352 (53.2)	1389 (50.9)	554 (53.3)	559 (50.3)	1521 (51.2)	2475 (51.5)	2743 (51.2)	1954 (53.6)	13547 (52.0)
Female	2065 (46.8)	1341 (49.1)	486 (46.7)	552 (49.7)	1445 (48.8)	2333 (48.5)	2613 (48.8)	1688 (46.4)	12523 (48.0)
Education level *									
Illiterate/primary	2222 (60.7)	1618 (60.0)	568 (54.6)	608 (56.1)	1255 (57.8)	2650 (55.1)	2411 (45.4)	1017 (27.9)	12349 (50.6)
Secondary/university	1440 (39.3)	1080 (40.0)	472 (45.4)	476 (43.9)	916 (42.2)	2158 (44.9)	2904 (54.6)	2625 (72.1)	12071 (49.4)
Missing, No.	2055	32	0	27	795	0	41	0	1650
Age									
2-5 **y**	985 (22.3)	603 (22.1)	231 (22.2)	270 (24.3)	768 (25.9)	1202 (25.0)	1474 (27.5)	1054 (28.9)	6587 (25.3)
6-9 **y**	1182 (26.8)	731 (26.8)	282 (27.1)	292 (26.3)	835 (28.2)	1279 (26.6)	1428 (26.7)	1042 (28.6)	7071 (27.1)
10-14 **y**	2250 (50.9)	1396 (51.1)	527 (50.7)	549 (49.4)	1363 (46.0)	2327 (48.4)	2454 (45.9)	1546 (42.4)	12412 (47.6)
Total, No.	4417	2730	1040	1111	2966	4808	5356	3642	26070

Values are expressed as No. (%).
* Based on level of education of the head of household.

RESULTS

The unweighted general characteristics of the sample population for each survey year from 1987 to 2011 are shown in Table 1. The total survey population consisted of approximately 52% boys, 25% aged between 2 and 5 years, 27% aged between 6 and 9 years, and 48% aged 10 to 14 years. Of the total sample, approximately 51% had a maximum SES of primary education, but there appeared to be a change during the last 2 decades in the educational levels of the head of the household with a higher percentage with at least secondary education in more recent years. Missing SES data predominantly came from the early survey years.

The trends in the prevalence of overweight and obesity per survey year, from 1987 to 2011, stratified by age, sex, and SES are shown in Table 2. During this period, the prevalence of overweight in boys aged 10 to 14 years increased from 13.9% to 22.2%, whereas the prevalence of obesity stayed relatively steady at around 3.6% to 3.8%. For boys aged 6 to 9 years, the prevalence of overweight rose from 21.9% to 25%, with the prevalence of obesity remaining steady at around 12.2% to 12.4% with some fluctuations in between. The prevalence of overweight and obesity remained similar for boys aged 2 to 5 years with some fluctuations during this period (12.3-11.6 and 21.8-18.0, respectively). Similar patterns were seen among girls. During this period, the prevalence of overweight in girls aged 10 to 14 years rose from 11.4% to 14.9% and for obesity, from 1.5% to 2.6% with numerous fluctuations in between. In the group aged 6 to 9 years, the prevalence of overweight rose from 18.8% to 22.4% and that of obesity decreased from 14.8% to 13.1%. In the youngest group of girls, aged 2 to 5 years, the prevalence of overweight remained relatively steady from16.0% in 1987 to 14.0% in 2011, whereas the prevalence of obesity decreased during this period from 30% to 19.8%. Trends by survey year are depicted graphically in Figure 1.



Q3 **Figure 1.** Prevalence of overweight and obesity by age, sex, and survey year.

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Table 2
Prevalence of Overweight and Obesity in Children Aged 2 to 14 Years by Age, Sex, and Socioeconomic Status From 1987 to 2011 (IOTF criteria)

	Total	Ages, y			Socioeconomic status	
	% (95%CI)	2-5 y % (95%CI)	6-9 y % (95%CI)	10-14 y % (95%CI)	Secondary or more, 1st % (95%CI)	Primary, 2nd % (95%CI)
Overweight						
Male						
1987	16.0 (14.5-17.5)	12.3 (9.5-15.1)	21.9 (18.6-25.2)	13.9 (11.9-15.9)	17.2 (14.5-19.9)	15.8 (13.7-17.9)
1993	18.6 (16.6-20.6)	11.5 (7.9-15.1)	28.4 (23.9-32.9)	17.1 (14.3-199)	16.6 (13.5-19.7)	20.8 (18.0-23.6)
1995	17.0 (13.9-20.1)	16.9 (10.4-23.4)	14.0 (8.5-19.5)	18.7 (14.1-23.3)	14.4 (10.1-18.7)	19.3 (14.8-23.8)
1997	19.8 (16.5-23.1)	14.5 (8.5-20.5)	26.3 (19.4-33.2)	18.9 (14.2-23.6)	19.4 (15.8-23.0)	20.4 (17.3-23.5)
2001	20.0 (18.0-22.0)	12.4 (1-15.7)	26.2 (22.1-30.3)	20.3 (17.3-23.3)	17.2 (13.7-20.7)	20.7 (17.6-23.8)
2003-4	18.9 (17.4-20.4)	14.0 (11.3-16.7)	24.2 (20.9-27.5)	18.6 (16.4-20.8)	18.5 (16.2-20.8)	19.2 (17.1-21.3)
2006-7	19.8 (18.3-21.3)	13.3 (10.9-15.7)	21.3 (18.3-24.3)	24.0 (21.6-26.4)	18.6 (16.6-20.6)	21.4 (19.1-23.7)
2011	19.8 (18.0-21.6)	11.6 (9.0-14.2)	25.0 (21.4-28.6)	22.2 (19.4-25.0)	18.3 (16.3-20.3)	24.0 (20.3-27.7)
Female						
1987	14.9 (13.4-16.4)	16.0 (12.6-19.4)	18.8 (15.6-22.0)	11.4 (9.5-13.3)	13.1 (10.5-15.7)	16.2 (14.0-18.4)
1993	16.0 (14.1-17.9)	17.9 (13.5-22.3)	23.5 (19.0-28.0)	12.6 (10.1-15.1)	18.6 (15.3-21.9)	15.1 (12.6-17.6)
1995	21.6 (17.9-25.3)	24.4 (16.1-32.7)	25.8 (8.3-33.3)	18.4 (13.6-23.2)	21.0 (15.6-26.4)	22.1 (17.1-27.1)
1997	17.3 (14.1-20.5)	23.3 (16.2-30.4)	18.9 (1.3-25.5)	13.4 (9.4-17.4)	13.9 (10.7-17.1)	19.4 (16.3-22.5)
2001	16.6 (14.7-18.5)	14.0 (10.5-17.5)	20.9 (16.9-24.9)	15.5 (12.7-18.3)	11.0 (8.1-13.9)	19.1 (16.0-22.2)
2003-4	18.9 (17.3-20.5)	16.7 (13.7-19.7)	25.3 (21.9-28.7)	15.9 (13.8-18.0)	18.4 (16.1-20.7)	19.4 (17.2-21.6)
2006-7	17.8 (16.3-19.0)	15.5 (12.8-18.2)	22.7 (19.6-25.8)	16.0 (13.9-18.1)	15.4 (13.5-17.3)	20.7 (18.4-23.0)
2011	16.9 (15.1-18.7)	14.0 (10.9-17.1)	22.4 (18.7-26.1)	14.9 (12.3-17.5)	16.4 (14.3-18.5)	18.3 (14.9-21.7)
Obese						
Male						
1987	11.1 (9.8-12.4)	21.8 (18.3-25.3)	12.2 (9.6-14.8)	3.8 (2.7-4.9)	10.3 (8.2-12.5)	10.8 (9.-12.6)
1993	13.9 (12.1-15.7)	28.0 (23.0-33.0)	17.9 (14.1-21.7)	4.5 (3.0-6.0)	9.1 (6.7-11.5)	15.7 (13.2-18.2)
1995	8.7 (6.3-11.0)	13.5 (7.6-19.4)	15.0 (9.3-20.7)	3.1 (1.1-5.1)	9.5 (5.9-13.1)	8.1 (5.0-11.2)
1997	11.6 (8.9-14.3)	20.2 (13.4-27.0)	16.8 (10.9-22.7)	3.9 (1.6-6.2)	8.9 (6.3-11.5)	12.2 (9.7-14.7)
2001	12.0 (10.4-13.6)	20.9 (16.9-24.9)	15.3 (11.9-18.7)	5.0 (3.4-6.6)	7.9 (5.4-10.4)	12.7 (10.1-15.3)
2003-4	10.1 (8.9-11.3)	19.8 (16.7-22.9)	9.9 (7.6-12.2)	3.2 (2.2-4.2)	8.6 (6.9-10.3)	11.4 (9.7-13.1)
2006-7	11.3 (10.1-12.5)	17.7 (15.0-20.4)	12.9 (10.4-15.4)	5.2 (4.0-6.4)	9.2 (7.6-10.8)	14.1 (12.3-15.9)
2011	10.6 (9.2-12.0)	18.0 (14.9-21.1)	12.4 (9.7-15.1)	3.6 (2.3-4.9)	9.4 (7.9-10.9)	14.2 (11.2-17.2)
Female						
1987	12.9 (11.5-14.3)	30.0 (25.8-34.2)	14.8 (11.9-17.7)	1.5 (0.8-2.2)	12.5 (10.0-15.0)	12.6 (10.6-14.6)
1993	10.8 (9.2-12.4)	23.2 (18.4-28.0)	11.0 (7.7-14.3)	3.2 (1.9-4.5)	8.1 (5.8-10.4)	9.7 (7.6-11.8)
1995	5.7 (3.6-7.8)	12.7 (6.3-19.1)	8.8 (3.9-13.7)	1.3 (−0.0,2.7)	8.0 (4.4-11.6)	3.7 (1.4-6.0)
1997	8.6 (6.3-10.9)	16.2 (10.0-22.4)	16.1 (9.9-22.3)	0.9 (−0.2-2.0)	8.2 (5.7-10.7)	9.1 (6.8-11.4)
2001	11.2 (9.6-12.8)	23.9 (19.6-28.2)	12.1 (8.9-15.3)	3.4 (2.0-4.8)	11.5 (8.6-14.4)	11.5 (9.0-14.0)
2003-4	10.2 (9.0-11.4)	22.3 (18.9-25.7)	9.4 (7.1-11.7)	2.3 (1.4-3.2)	9.0 (7.3-10.7)	11.3 (9.6-13.0)
2006-7	10.2 (9.0-11.4)	16.7 (13.9-19.5)	13.1 (10.6-15.6)	3.5 (2.5-4.5)	9.2 (7.6-10.8)	11.4 (9.7-13.1)
2011	11.1 (9.6-12.6)	19.8 (16.2-23.4)	13.1 (10.1-16.1)	2.6 (1.4-3.8)	9.6 (7.9-11.3)	14.7 (11.6-17.8)

95%CI, 95% confidence interval.

The prevalence trends for underweight during the same time period are shown in Table 3. While SES did not seem to influence trends among boys, the prevalence of underweight in girls with a higher SES increased from 12.5% to 16.2% but was relatively stable in those with a lower SES with numerous fluctuations from 12.1% in 1987 to 10.8% in 2011. Despite these fluctuations, the prevalence of underweight appears to have increased in both girls and boys aged 2 to 5 years (18.8%-23.0% and 13.7% and 22.6%, respectively).

When trends by birth cohort were compared, both boys and girls aged 10 to 14 years showed an increase in the prevalence of overweight and obesity, with a corresponding decline in the prevalence of underweight. A large increase in the prevalence of overweight was observed in 10- to 14-year-olds born after 1980 compared with earlier cohorts. However, in the group aged 6 to 9 years, the trends were relatively more stable. Excess weight appears to have decreased in both boys and girls aged 2 to 5 years with corresponding increases in underweight (Table 4 and Figure 2).

DISCUSSION

From 1987 to 2011, the overall prevalence of pediatric excess weight in Spain did not increase markedly; however, the trends observed varied between age groups with a particularly noticeable upward trend in the prevalence of overweight among 10 to 14 year olds. A slight increase in the prevalence of overweight was seen in

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Table 3
Prevalence of Underweight per Survey Year Stratified by Sex, Age and SES (IOTF criteria)

	1987	1993	1995	1997	2001	2003/2004	2006/2007	2011
	Underweight, % (95%CI)	Underweight, % (95%CI)	Underweight, % (95%CI)	Underweight, % (95%CI)	Underweight, % (95%CI)	Underweight, % (95%CI)	Underweight, % (95%CI)	Underweight, % (95%CI)
Male								
Age, y								
2-5	18.8 (15.5-22.1)	23.2 (18.5-27.9)	22.1 (14.9-29.3)	15.4 (9.3-21.5)	20.2 (16.2-24.2)	17.1 (14.1-20.1)	17.6 (14.9-20.3)	23.0 (19.6-26.4)
6-9	9.3 (7.0-11.6)	9.3 (6.4-12.2)	13.0 (7.6-18.4)	5.7 (2.1-9.3)	10.0 (7.2-12.8)	13.4 (10.8-16.0)	9.3 (7.2-11.4)	9.9 (7.4-12.4)
10-14	11.5 (9.7-13.3)	9.0 (6.9-11.1)	10.6 (7.0-14.2)	7.8 (4.6-11.0)	7.0 (5.1-8.9)	9.4 (7.8-11.0)	8.3 (6.8-9.8)	8.9 (7.0-10.8)
SES								
Secondary/university, 1st	13.3 (10.9-15.7)	15.4 (12.4-18.4)	15.3 (10.9-19.7)	10.7 (7.9-13.5)	14.2 (11.0-17.4)	12.1 (10.2-14.0)	11.9 (10.3-13.5)	14.0 (12.2-15.8)
Illitetate/primary, 2nd	12.1 (10.2-14.0)	10.2(8.1-12.3)	12.8(9.0-16.6)	8.5 (6.3-10.7)	10.2 (7.9-12.5)	13.4 (11.6-15.2)	11.2 (9.4-13.0)	12.0 (9.2-14.8)
Female								
Ages, y								
2-5	13.7 (10.5-16.9)	19.3 (14.8-23.8)	21.8 (13.8-29.8)	13.3 (7.6-19.0)	22.9 (18.7-27.1)	18.1 (15.0-21.2)	21.8 (18.7-24.9)	22.6 (18.9-26.3)
6-9	9.8 (7.3-12.3)	8.4 (5.5-11.3)	7.0 (2.6-11.4)	6.3 (2.2-104)	6.4 (4.0-8.8)	12.3 (9.7-14.9)	10.7 (8.4-13.0)	9.4 (6.8-12.0)
10-14	14.4 (12.3-16.5)	13.1 10.6-15.6	8.3 (4.9-11.7)	11.4 (7.7-15.1)	10.9 (8.5-13.3)	11.4 (9.5-13.3)	10.9 (9.1-12.7)	12.4 (10.0-14.8)
SES								
Secondary/university, 1st	12.5 (10.0-15.0)	11.8 (9.1-14.5)	11.5 (7.3-15.7)	9.8 (7.1-12.5)	11.7 (8.8-14.6)	13.0 (11.0-15.0)	14.8 (12.9-16.7)	16.2 (14.1-18.3)
Illitetate/primary, 2nd	13.1 (11.1-15.1)	14.1 (11.7-16.5)	10.3 (6.6-14.0)	11.7 (9.2-14.2)	12.3 (9.7-14.9)	14.2 (12.3-16.1)	13.4 (11.5-15.3)	10.8 (8.1-13.5)

95%CI, 95% confidence interval; SES, socioeconomic status.

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Table 4
Prevalence of Obesity by Year of Birth and Age (IOTF criteria)

Birth year/age	2 to 5 y			6 to 9 y			10 to 14 y		
	Underweight, % (95%CI)	Overweight, % (95%CI)	Obese, % (95%CI)	Underweight, % (95%CI)	Overweight, % (95%CI)	Obese, % (95%CI)	Underweight, % (95%CI)	Overweight, % (95%CI)	Obese, % (95%CI)
Male									
1971-75							13.1 (10.7-15.5)	13.1 (10.7-15.5)	3.6 (2.3-4.9)
1976-80				9.3 (6.7-11.9)	24.1 (20.3-27.9)	10.1 (7.4-12.8)	9.4 (7.3-11.5)	14.9 (12.4-17.4)	3.5 (2.2-4.8)
1981-85	18.8 (15.5-22.1)	12.3 (9.5-15.1)	21.8 (18.3-25.3)	7.3 (4.5-10.1)	23.3 (18.7-27.9)	17.3 (13.2-21.4)	9.6 (7.6-11.6)	18.4 (15.8-21.0)	3.7 (2.4-5.0)
1986-90	20.1 (15.2-25.0)	13.7 (9.5-17.9)	24.0 (18.8-29.2)	10.3 (7.5-13.1)	21.9 (18.1-25.7)	16.1 (12.7-19.5)	7.8 (6.3-9.3)	20.0 (17.7-22.3)	4.5 (3.3-5.7)
1991-95	20.2 (15.7-24.7)	14.7 (10.7-18.7)	18.8 (14.4-23.2)	11.5 (9.2-13.8)	24.8 (21.7-27.9)	14.1 (11.6-16.6)	7.9 (6.4-9.2)	20.3 (18.4-22.2)	4.4 (3.4-5.4)
1996-2000	18.2 (15.6-20.8)	13.6 (11.3-15.9)	20.7 (18.0-23.4)	11.8 (9.8-13.8)	21.4 (18.8-24.0)	11.3 (9.3-13.3)	9.2 (7.4-11.0)	21.0 (18.5-23.5)	3.7 (2.5-4.9)
2001-05	18.2 (15.8-20.6)	12.9 (10.8-15.0)	17.7 (15.3-20.1)	9.8 (7.5-12.1)	24.9 (21.5-28.3)	12.6 (10.0-15.2)	7.2 (2.9-11.5)	27.7 (20.3-35.1)	3.5 (0.5-6.5)
2006-10	23.0 (19.6-26.4)	11.6 (9.0-14.2)	18.0 (14.9-21.1)						
Female									
1971-75							16.6 (13.8-19.4)	9.8 (7.5-12.1)	0.8 (0.1-1.5)
1976-80				7.6 (5.1-10.1)	19.8 (16.0-23.6)	13.8 (10.5-17.1)	12.3 (9.8-14.8)	11.0 (8.6-13.4)	1.7 (0.7-2.7)
1981-85	13.7 (10.5-16.9)	16.0 (12.6-19.4)	30.0 (25.8-34.2)	11.4 (8.0-14.8)	18.3 (14.1-22.5)	14.4 (10.6-18.2)	10.4 (8.3-12.5)	15.5 (13.1-17.9)	2.5 (1.4-3.6)
1986-90	22.6 (17.2-28.0)	17.8 (12.9-22.7)	22.8 (17.4-28.2)	7.2 (4.7-9.7)	23.5 (19.3-27.7)	11.9 (8.7-15.1)	12.7 (10.7-14.7)	14.5 (12.4-16.6)	1.7 (0.9-2.5)
1991-95	15.7 (11.6-19.8)	23.7 (18.9-28.5)	15.0 (11.0-19.0)	8.7 (6.6-10.8)	22.0 (18.9-25.1)	11.6 (9.2-14.0)	9.3 (7.9-10.7)	18.9 (17.0-20.8)	3.4 (2.5-4.3)
1996-2000	20.8 (18.0-23.6)	16.1 (13.5-18.7)	22.5 (19.6-25.4)	12.7 (10.7-14.7)	25.1 (22.4-27.8)	10.1 (8.2-12.0)	12.5 (10.3-14.7)	15.2 (12.9-17.6)	2.9 (1.8-4.0)
2001-05	19.0 (16.4-21.6)	14.4 (12.0-16.8)	21.0 (18.3-23.7)	9.3 (6.9-11.7)	22.2 (18.7-25.7)	13.3 (10.5-16.1)	10.8 (5.3-16.3)	15.9 (9.5-22.3)	2.9 (0.0-5.9)
2006-10	22.6 (18.9-26.3)	14.0 (10.9-17.1)	19.8 (16.2-23.4)						

95%CI, 95% confidence interval.

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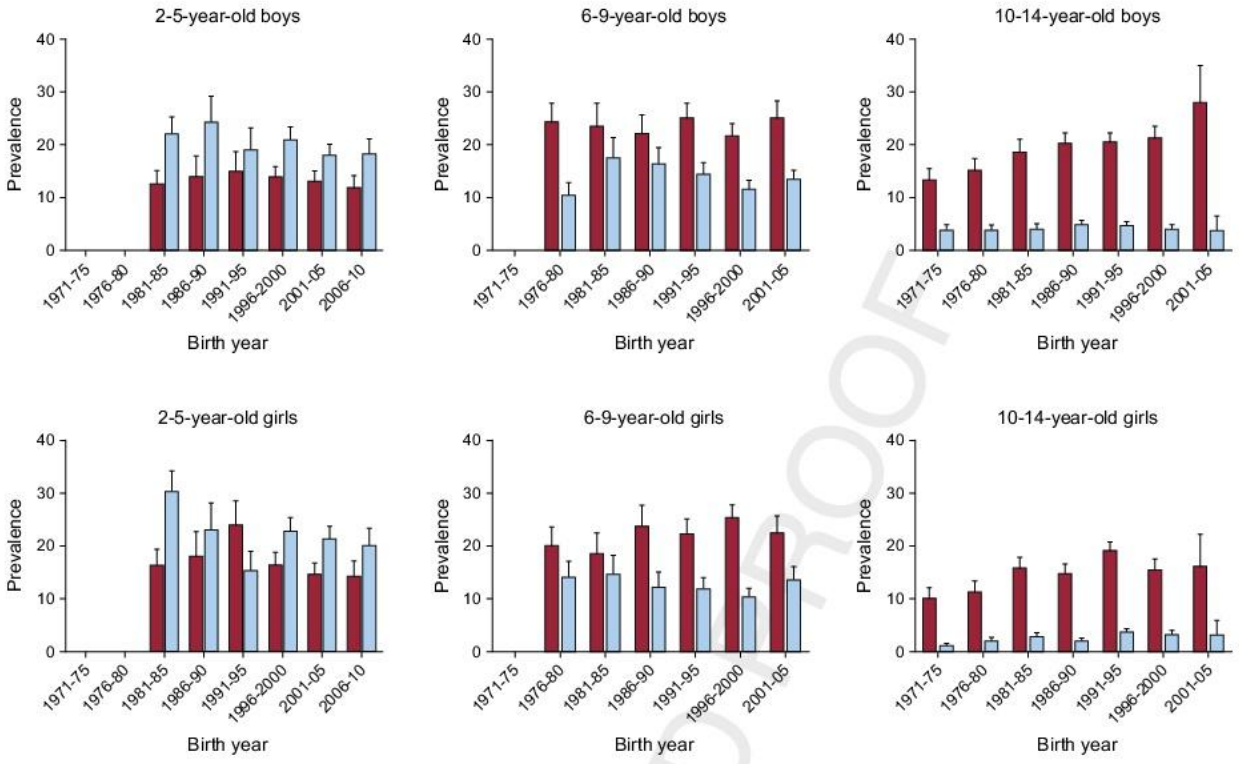

Q4 **Figure 2.** Prevalence of overweight and obesity by age, sex, and birth year.

both boys and girls, while no increases were seen in the overall prevalence of obesity. Other Spanish studies have reported increases in the prevalence of excess weight in both sexes or, as in our study, indications of a stabilization trend.[4,7,18,23,24] The differences with our study most likely reflect differing age groups, time periods, obesity definition, exclusion or inclusion criteria, or subpopulation groups reflecting regional differences. For example, the Enkids study, 1998-2000, measured prevalences higher than the corresponding years in our study, but used a wider age range (2-24 years) and a different obesity definition, thus hampering direct comparisons.[25] Nevertheless, the pattern of higher excess weight in boys than girls is similar to ours. Sánchez-Cruz et al.[7] also found a slightly higher prevalence but used an older age group (8-17 years), but similarly concluded that the prevalence of excess weight had not increased in the last decade. Of note, the trends observed in this study are consistent with other recently published research undertaken in Spain.[24,26]

A recent study has proposed perinatal inflammation as an early factor in the origin of cardiovascular disease with associations of early exposures with adverse cardiovascular risk profiles, including excess weight, in both childhood and adulthood.[27] With evidence of early origins of cardiovascular disease, these measured prevalences are too high and are a potentially early modifiable risk factor for cardiovascular disease.

Stabilization of trends is consistent with international data in other developed countries, with reversal of trends seen in a select few. Countries with documented trend stabilization include Denmark, Greece, England, France, Netherlands, Sweden, the United States, and Australia, while Switzerland appears to have reversed trends. The timing of the turning point in the trend differs between countries, but generally occurred after 1995. Despite stabilization of trends, the level of stabilization differs between countries and remains too high.[28–30]

The reasons for this plateau remain unclear. Various theories have been postulated, including a saturation of excess weight levels.[28] This theory suggests that with the environmental, nutritional, behavioral and societal changes that have occurred during the last few decades, all persons who would have become obese or overweight have already become so and a new set level has been established. Alternatively, the stimulus for the increasing epidemic may no longer be prevalent. Last, health promotion and obesity prevention programs may have had some impact.

When considering the observed trends, it is important to consider SES and the socioeconomic context of Spain during this time period. In our study, we considered the highest parental education level of the household as an indicator of SES, which may explain the lack of association found, possibly because childhood nutrition is often dependent on maternal level of education.[7] The relationship between SES and obesity is complex, is influenced by its definition, and is not entirely consistent between developed countries.[31] The financial crisis commencing in 2008 has been shown to affect the health of Europeans.[24] In Spain, this has increased child poverty, unemployment, and social inequalities, which can be expected to have an effect on nutrition and other lifestyle risk factors.[24] However, Spanish social policies have provided protection to children belonging to lower socioeconomic classes, potentially attenuating any association measured.[32] Some of these protections, such as food subsidies, have been removed in recent years, thus increasing social inequalities and potentially causing a flow-on effect to diet quality and other lifestyle risk factors in economically vulnerable families.[26] Any impact on the prevalence of childhood excess weight may still occur and there is a need for ongoing monitoring.

The trends observed in our study differed by age, sex, and SES and also differed between overweight and obesity categories. Downward trends for obesity were observed in both boys and girls

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aged 2 to 5 years, while trends remained steady for the overweight and underweight categories. Among children aged 6 to 9 years, despite some fluctuations, there was no notable change for either boys or girls during the study period. The largest changes were seen in girls and boys aged 10 to 14 years, with an increase in the prevalence of overweight in both sexes and a doubling of obesity among girls. Obesity prevalence appears to remain level among boys in this age group. The differing trends by sex and age seen in our study are consistent with other Spanish studies.[18,33]

Sex differences in trends have also been observed in other European countries and the USA.[34–37] Various explanations have been given for these differences. Prior to sexual maturation, it is unlikely that physiological differences, such as muscle mass, have a strong influence. However, studies have demonstrated marked differences in obesity-associated behaviors between sexes.[38,39] Data from the Spanish National Health Survey indicate sex differences in the increasing trends of sedentary behavior among youth in Spain.[33] Sex differences in weight-related behaviors and perceptions of weight need to be taken into consideration when planning prevention strategies.

Consistent with our findings, age group differences in trends have been reported in other European countries as well as the USA, with a plateau in younger age groups, and increases in overweight in adolescence.[37,40] The differing trends and prevalence at distinct ages raises 3 possible effects to consider: *a)* incidence vs persistence; *b)* cohort, period/early life exposure effect, and *c)* age effect with differing influences at distinct ages including physiological and behavioral effects.

The percentage of overweight and obesity in adolescence is determined by the incidence and persistence of excess weight. Many overweight and obese children spontaneously recover normal weight before or after puberty, but the percentage regaining normal weight, or changing weight status group, differs in distinct populations.[41] In Spain, the prevalence of obesity in 10 to 14 year old boys is 5 times lower than that in boys aged 2 to 5 years. While we found a decreasing trend in obesity for children aged 2 to 5 years, this did not correspond to a decrease in obesity in older age groups, suggesting that either persistence and/or incidence are increasing in the older age groups in the newer birth cohorts.[14]

The age differences in the trends observed suggest an age effect. With varying BMI trajectories and differing influences throughout childhood and adolescence, the age groups analyzed can affect results. Due to the associations of adiposity rebound and age at puberty with obesity, as well as increasing social independence, adolescents and preteens should not be grouped together.

While child obesity after the age of 6 years is considered a good predictor of adult obesity,[29] in Spain only a small percentage of children in this age group who are overweight or obese remain so during adolescence. There are many potential factors that could influence the difference between overweight prevalence in preteens and early adolescence, including physiological, environmental, and behavioral factors. Increasing social pressures on weight and self-perceptions of weight may come into play in early adolescence, which are not found in younger age groups. A recent study showed age variation in diet and activity-related behaviors between the ages of 2 and 16 years.[38]

Worryingly, the prevalence of overweight among early adolescents is increasing in contrast with the relative stability of other age groups. Potentially, health promotion and child obesity prevention initiatives focusing on early intervention, such as the well-child program, have functioned well in younger age groups but are not appropriate for adolescents. As children become increasingly independent with age, there may be an increasing media-parent and social-parent incongruity. In adolescence the social network and leisure activities have an effect on obesity, and food advertising influences intake in school-aged children.[42–44] Food marketing, social networks, and media-based programs may be more appropriate for obesity intervention in this age group.[43] PERSEO, a school-based program, run by the Ministries of Health and Education in Spain, has shown indicators of success and is another potential approach in this age group.[45]

Few studies consider trends in underweight children in Europe and even fewer consider them alongside those of obesity.[18] In our study, underweight increased in children aged 2 to 5 years. When introducing population-based obesity interventions, it is important not to increase the burden of thinness; this concept was introduced by Rose when discussing population-based preventive strategies and the need for security for those at the lower limit.[46] This potential consequence of obesity prevention strategies needs further investigation.[47]

There are some weaknesses of this study, with potential effects on the interpretation of our results. Anthropometric data were collected in a subjective manner. Parental reporting of children's height and weight may lead to overestimation of obesity in younger children and underestimation in adolescence.[48] However, this method is widely used and is considered to have an acceptable level of validity in population-based studies.[49] A study of Spanish children reported a sensitivity and specificity of obesity diagnosis based on parent-reported weight and height to be 78% and 96%, respectively.[49] The subjective nature of these measurements will not change the trends observed, unless the over/under estimation bias changes over time.

Additionally, the proportion of missing data were higher in the early survey years. Although study samples were large, we cannot rule out a nonresponder effect, which may explain the larger fluctuations seen during this time period. Sample sizes varied for different survey years and the autonomous communities subsample. Given the association between autonomous community and the prevalence of excess weight, this was adjusted for in calculations of overall prevalence.

This study also has numerous strengths. The use of national survey data allowed analysis of nationally representative data collected with standardized methodology over 2 decades. The same questions were used in each survey year for height and weight measurements, increasing comparability between surveys. This study was also able to demonstrate trends over a 24-year period, ranging from individuals born in 1973 to those born in 2009. The use of trends by birth year allowed analysis of the potential effects of period or birth year, including early life exposures. Our study also considers underweight trends alongside excess weight trends and does not group underweight with normal weight as is often done.

CONCLUSIONS

In conclusion, the child obesity epidemic in Spain has remained relatively stable over the last 2 decades with a plateau similar to those recorded in other countries. However, it has stabilized at too high a level and remains a public health issue. Furthermore, despite this overall stable picture, the subgroup of 10- to 14-year-olds shows a worrying upward trend, particularly for the prevalence of overweight, and requires appropriate investigation and measures to halt and reverse this trend.

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WHAT IS KNOWN ABOUT THE TOPIC?

- Child obesity in Europe has reached epidemic proportions and is a significant public health problem.
- Spain ranks among the European countries with the highest rates of childhood obesity.
- In some countries child obesity rates have stabilized.
- Childhood BMI predicts adult BMI and is a potentially modifiable adverse cardiovascular phenotype.

WHAT DOES THIS STUDY ADD?

- Overall excess weight trends appear to be stable in Spain, with some fluctuations. Despite child obesity trends not increasing exponentially, the prevalence has stabilized at a too high a level and remains a major public health issue.
- Trends differ depending on age, sex, and SES, with a significant upward trend in the prevalence of overweight in 10- to 14-year-olds.
- Analysis of trends by birth year.
- Inclusion of pediatric underweight trends in Spain alongside child obesity trends showing an increasing trend among children aged 2 to 5 years.

ETHICS APPROVAL

This article does not contain any studies with human participants or animals performed by any of the authors. All data files consist of anonymous data for analysis and are publically available.

INFORMED CONSENT

As per the National Health Survey guidelines, parental/guardian consent to participate was required prior to data collection on minors. All data files consist of anonymous data for analysis and are publically available.

CONFLICTS OF INTEREST

Q2 None declared.

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5.2 Article 2: Changes in sleep duration in Spanish children aged 2–14 years from 1987 to 2011

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Highlights

• Sleep duration was assessed in Spanish children from 1987 to 2011. • Sleep duration in children has decreased by about 20 minutes over the last two decades. • Short sleep is significantly associated with obesity, socio-economic status, and exercise. • Children in Spain sleep less than their Swiss or English counterparts.

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Original Article

Changes in sleep duration in Spanish children aged 2–14 years from 1987 to 2011

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ABSTRACT

Objective: Historical decreases in sleep duration in children have been documented worldwide; however, there is sparse information on sleep duration in differing cultural regions. We assess sleep duration and its trends for children in Spain from 1987 to 2011 and associated sociodemographic characteristics.

Methods: Data from eight Spanish National Health Surveys, from 1987 to 2011, were collected on parent-reported sleep duration and associated socio-demographic characteristics including age, sex, parental level of education, child BMI, and physical activity. A total of 24,867 children aged 2–14 years were included in the final sample.

Results: Overall, short sleep duration increased to 44.7% from 29.8% in 1987. Decreasing sleep duration trends were found in all demographic groups, decreasing by around 20 minutes in 24 hours from 1987 to 2011; decreasing to 10 hours 16 minutes in 2- to 5-year olds, 9 hours 31 minutes in 6- to 9-year-olds, and 8 hours 52 minutes in 10- to 14-year-olds. No difference in sleep duration was found between girls and boys. Sleep duration was associated with year of survey, age, level of parental education, obesity, and exercise.

Conclusions: Almost 45% of children in Spain are not sleeping the recommended amount. Regional differences in sleep attitudes and duration alongside a lack of consistency in cut-offs for age-appropriate ideal sleep in literature is a barrier for international comparison and highlights the need for research in physiological sleep requirements. With the association of short sleep duration with many different health outcomes, sleep should be considered as a modifiable lifestyle factor and a public health issue.

1. Introduction

The importance of sleep in childhood in terms of quality and duration is increasingly coming under scrutiny. Not least because of the short term and long term consequences. Childhood sleep patterns are thought to potentially continue on into adulthood [1]. Sleep in early childhood is important for cognitive, psychological development and growth [2]. Furthermore, short sleep duration in childhood has been associated with obesity, poor academic performance, behavioral problems and affects physical and mental health as well as secondary effects impacting on the family [3–5].

Sleep duration during childhood and adolescence is determined by a mix of genes and environment, with a higher influence from the shared environment [1,5]. Sleep duration has a large cultural component [5] and factors found to be associated in previous studies include family environment, demographic factors, health status and parental sleep habits [1,2]. Understanding cultural and regional variations in sleep duration is important when considering sleep duration norms, recommendations and defining sleep problems.

International studies report a decreasing trend in sleep duration [6,7] and little is still known of the long term impact this will have during childhood and adulthood in terms of both physical and mental health. Given the increasing trend in child obesity, sleep duration may be an important modifiable contributing factor and some previous studies have shown an association between the two [2,8–10], although this is inconsistent [11]. Despite young children having less control over their food intake, it is still hypothesized that short sleep increases overweight risk via higher energy intake [12]. Other mechanisms including hormonal regulation and decreased energy expenditure due to fatigue have also been proposed [9].

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As far as we are aware, no other studies have been published on the trends of sleep duration during childhood and adolescence in Spain. We investigate the sleep duration trends for children in Spain from 1987 to 2011 and associated socio-demographic characteristics.

2. Methods

2.1. Study design and population

This study used data collected by the Spanish Ministry of Health and National Institute of Statistics in a series of cross-sectional National Health Surveys in 1987, 1993, 1995, 1997, 2001, 2003/2004, 2006/2007, and 2011 [13]. Data were collected in a multi-stage stratified random sample, with strata based on municipality size. Questionnaires were conducted in person by a trained interviewer. In 2011, computer-assisted personal interviews were used. Our population sample was restricted to children and adolescents aged 2–14 years inclusive. Exclusion criteria included cases in which sleep duration, sex, age, or anthropometric data were missing. Ceuta and Melilla were also excluded, as they are extrametropolitan Spanish cities in North Africa with a different demographic. The household response rates for each survey year were as follows: 2011, 89.62%; 2006, 96.11%; and 2003, 97.93%. No response rates were available for survey years before this; however, more detailed information on methodology and response rate analyses for each survey year can be found on the National Health Survey section on the website of the Ministry of Health, Social Security and Equality [13].

Case with body mass index (BMI) extremes (>40 or <10) and cases with sleep duration extremes (above the 95th percentile and below the 5th percentile) were removed during raw data cleaning. Cases with BMI extremes were generally found to have erroneous weight or height measurements (eg, an adolescent with a height of 40 cm). Similar results were found for sleep duration extremes, with a few cases documenting more than 24 hours of sleep. Removing sleep duration and BMI extremes did not significantly affect the results.

After exclusion criteria were applied, the total sample size was 24,857.

2.2. Variables

Sleep duration was measured using a single question asking about total sleep during 24 hours including naps: "Could you tell me approximately how many hours does _____ (name of child) usually sleep? Including the siesta." This variable was parent reported. Sleep duration categories were based on age-year, and ideal sleep was defined as per the meta analysis by Chen [11]: children 5 years old, ≥11 hours; those 5–10 years old, 10 or more hours; and those more than 10 years old, 9 or more hours.

Parental education level was obtained from the highest education level achieved by the head of the household, which was defined as the member of the household with the highest income. In 2012, this information was not available and was approximated using the highest education level achieved by either parent or legal guardian. During 1997 and 2001, if the head of the household was the person answering the child's questionnaire, no information on level of education was available, resulting in systematic loss of data. Education level were coded to correspond with education levels according to the International Standard Classification of Education (ISCED) [14] and grouped into the following categories: (1) illiterate/no formal education, (2) primary level education, (3) secondary level and nonuniversity education, and (4) university education.

Data on BMI were derived from parent/caregiver reported height and weight of the child in centimeters and in kilograms, and was not independently verified. BMI for sex and age was categorized as per the latest International Obesity Task Force (IOTF) definitions for BMI cut-offs for under the age of 18 years [15,16].

Age in months is usually used to calculate BMI specific to age; however, as the National Health Survey reports ages in year, all children were assumed to be at the midpoint of their age-year for this calculation.

Physical activity was measured with a single question and used the same levels of activity in all surveys: "Which of the following options best describes how often the girl/boy participates in physical activity? 1. Does not exercise. His/her free time is spent almost completely in sedentary activity (reading, watching television, movies, lying on the bed or cot…); 2. Does some physical activity or sport occasionally (walking or riding a bike, light gymnastics, recreational activities with light effort…); 3. Does physical activity a number of times per month (sports, gymnastics, running, swimming, cycling, team sports …); 4. Does sports or physical training a number of times per week." In 2003, only dichotomized data were made available, and no information on physical activity was collected in 1987. Physical activity levels were subsequently categorized into two levels, namely, no exercise and some exercise.

2.3. Statistical analysis

Data were analyzed using SPSS version 20 software. Due to the combined nature of our analyses and the need for standardization of weighting for each survey year, data were weighted using principles of proportionality for the subgroups of sex, age, and Autonomous Community (Regions of Spain with limited self-governance) using population data from the Spanish Statistical Office corresponding to each survey year [17,18]. All subsequent analyses were performed taking the complex sampling design into account using SPSS Complex samples module. Confidence intervals were calculated using logit transformation.

The mean durations of sleep for the three age categories were calculated for each survey year from 1987 to 2011, and the trend was analyzed using simple logistic regression. Proportions for sleep categories were calculated for each survey year, and differences in proportions were tested using the chi-square test for column and rows.

Analyses of demographic characteristics were initially performed on the combined national survey data. Subsequently analyses of demographic characteristics were performed for each survey year, and simple trend analyses were performed using the chi-square test for trend, with 1987 as the baseline year. Associations between weight and short sleep were analyzed for each survey year.

Finally, crude and then adjusted analyses were performed using logistic regression, and odds of short sleep for each variable were reported.

2.4. Ethics statement

As per the National Health Survey guidelines, parental or guardian consent to participation was required before collecting data on minors. All data files consist of anonymous data and cases for analysis.

3. Results

The mean sleep duration by age from 1987 to 2011 is shown in Table 1. The downward trend was found to be statistically significant in each age group: decreasing from 10 hours 40 minutes in 2- to 5-year-olds in 1987 to 10 hours 16 minutes in 2011 (Standard error 4.38 minutes); decreasing by 20 minutes from 9 hours 51 minutes in 1987 for 6- to 9-year-olds to 9 hours 31 minutes in 2011 (Standard error 2.82 minutes), and in 10–14 year olds decreasing

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Table 1
Mean sleep duration by age, from 1987 to 2011.

Age group	1987 Mean (n) 95% CI	1993 Mean (n) 95% CI	1995 Mean (n) 95% CI	1997 Mean (n) 95% CI	2001 Mean (n) 95% CI	2003 Mean (n) 95% CI	2007 Mean (n) 95% CI	2011 Mean (n) 95%CI	*P*
2–5 yr	10.67 (944) 10.56, 10.79	10.56 (578) 10.43, 10.69	10.55 (214) 10.35, 10.76	10.39 (258) 10.22, 10.55	10.49 (731) 10.38, 10.60	10.29 (1157) 10.20, 10.39	10.53 (1407) 10.45, 10.61	10.27 (1025) 10.18, 10.35	<0.001
(hh:mm)	10:40	10:34	10:33	10:23	10:29	10:17	10:32	10:16	
6–9 yr	9.85 (1131) 9.78, 9.92	9.61 (702) 9.53, 9.70	9.74 (272) 9.62, 9.86	9.64 (286) 9.52, 9.75	9.62 (801) 9.54, 9.71	9.61 (1234) 9.54, 9.67	9.63 (1375) 9.57, 9.69	9.51 (1018) 9.45, 9.58	<0.001
(hh:mm)	09:51	09:37	09:44	09:38	09:37	09:37	09:38	09:31	
10–14 yr	9.32 (2051) 9.28, 9.37	9.06 (1330) 9.00, 9.12	9.12 (510) 9.03, 9.21	8.98 (529) 8.90, 9.06	8.98 (1304) 8.92, 9.04	8.97 (2201) 8.92, 9.01	8.96 (2311) 8.92, 9.00	8.86 (1488) 8.81, 8.91	<0.001
(hh:mm)	09:19	09:04	09:07	08:59	08:59	08:58	08:58	08:52	

Abbreviations: CI, confidence interval.

from 9 hours 19 minutes in 1987 to 8 hours 52 minutes in 2011 (standard error 1.98 minutes). As no difference was found between sexes, sleep duration is presented in age groups only.

Table 2 shows the prevalence of short sleep duration from 1987 to 2011. Overall short sleep duration increased from 29.8% in 1987 to 44.7% in 2011. In 2011, just over half of children aged 2–14 years had sufficient sleep. Fig. 1 demonstrates the overall sleep duration by age in 2011.

Table 3 presents characteristics and trends associated with short sleep. The increasing trend of short sleep was statistically significant in all subgroups. The prevalence of short sleep duration in 2- to 5-year-olds increased from 39.8% in 1987 to 53% in 2011, from 34.3% to 45.1% in 6- to 9-year-olds, and increased from 19.9% to 37.8% in 10- to 14-year-olds. Trends were the same for both males and females. For those for whom the level of education of the head of the household was up to a maximum of primary education or secondary education, short sleep duration increased from around 30% to around 45%. For those with university education, short sleep changed from 26% to 42.1%. In underweight children, the prevalence of short sleep duration increased from 31.7% to 48.4%. The trends for normal-weight children increased from 26.8% to 42.6% and for overweight children increased from 34.2% to 41.6%. In obese children, the prevalence of short sleep increased from 36.5% in 1987 to 55.8% in 2011. For children who did not exercise, short sleep prevalence increased from 37.1% in 1993 to 50.7% in 2011, and for those who engaged in some exercise, short sleep prevalence increased from 34.4%to 43.6%.

The multivariate analysis presented in Table 4 shows that the odds of short sleep duration are significantly associated with survey year, age, level of education of the head of the household, obesity, and amount of exercise. The association with survey year showed increasing odds of short sleep from 1993 to 2011 when compared with 1993. The odds of short sleep were lower in older age groups and in children who engaged in some exercise.

Table 2
Prevalence of short and ideal sleep duration in children 2–14 years of age, from 1987 to 2011.

Year	n	Total 24-h sleep duration*		*P*
		Short % (95% CI)	Ideal % (95% CI)	
1987	4126	29.8 (28.1, 31.5)	70.2 (68.5, 71.9)	<0.001
1993	2610	34.8 (32.7, 37.0)	65.2 (63.0, 67.3)	
1995	996	33.5 (30.3, 36.8)	66.5 (63.2, 69.7)	
1997	1073	39.7 (36.6, 43.0)	60.3 (57.0, 63.4)	
2001	2836	38.4 (36.2, 40.6)	61.6 (59.4, 63.8)	
2003	4592	41.7 (39.9, 43.5)	58.3 (56.5, 60.1)	
2007	5093	38.9 (37.4, 40.5)	61.1 (59.5, 62.6)	
2011	3531	44.7 (42.9, 46.5)	55.3 (53.5, 57.1)	

* Weighted analysis, %.

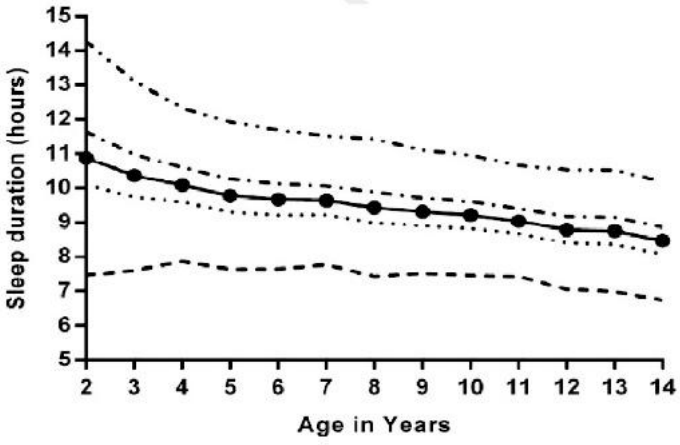

Fig. 1. Twenty-four-hour sleep duration, by age, in 2011. Abbreviation: sd, standard deviation.

4. Discussion

Our study results clearly show a statistically significant decrease in 24-hour sleep duration in children aged 2–14 years over the last two decades. This is consistent with other international studies [7,19,20]. With a decrease in average sleep duration of about 20 minutes or more in each age group from 1987 to 2011, this downward trend is slightly higher than the –0.73 minutes per year reported by Matricciani et al. [7] This downward trend is reflected in the increasing percentage of Spanish children sleeping less than the ideal amount as defined in a recent meta-analysis [11]. By 2011, only 55% of Spanish children between the ages of 2 and 14 years were sleeping enough. We did not find any sex difference in sleep duration or in sleep duration trends. The decreasing trend in sleep duration was consistent over all demographic and individual groups.

When comparing international data, there is little consensus on sleep requirements and regular updates based on local expert opinion [7]. Alongside sleep trends, sleep recommendations have also decreased over the last century and consistently appear to be 37 minutes longer than actual average child sleep duration [7]. International studies show a large interchild variation in sleep duration [5,11,19,21]. Comparing international data is further complicated by varying reference sleep requirements when analyzing associations [8].

The principal reason proposed for declining sleep duration is increasingly later bedtimes [6]. This has been found by Iglowstein et al. [19], and other studies in Europe [5]. The later bedtimes did not correspond to later wake times, resulting in short sleep patterns [6,20]. Reasons for later bedtimes have been proposed, such as parental

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Table 3
Participant characteristics and trends of short sleep.

	1987 % (N) 95% CI	1993 % (N) 95% CI	1995 % (N) 95% CI	1997 % (N) 95% CI	2001 % (N) 95% CI	2003 % (N) 95% CI	2007 % (N) 95% CI	2011 % (N) 95% CI	P[a]
Total	29.8 (4126) 28.1,31.5	34.8 (2610) 32.7, 37.0	33.5 (996) 30.3, 36.8	39.7 (1073) 36.6, 43.0	38.4 (2836) 36.2, 40.6	41.7 (4592) 39.9, 43.5	38.9 (5093) 37.4, 40.5	44.7 (3531) 42.9, 46.5	<0.001
Age									
2–5 yr	39.8 (944) 35.9, 43.7	41.4 (578) 36.8, 46.1	43.4 (214) 36.3, 50.8	44.7 (258) 38.1, 51.5	45.1 (731) 40.9, 49.3	51.3 (1157) 47.7, 54.8	43.5 (1407) 40.6, 46.5	53.0 (1025) 49.6, 56.3	<0.001
6–9 yr	34.3 (1131) 31.1, 37.5	41.8 (702) 37.6, 46.2	35.9 (272) 29.9, 42.3	44.6 (286) 38.4, 50.9	41.6 (801) 37.6, 45.8	42.5 (1234) 39.2, 45.9	41.2 (1375) 38.2, 44.2	45.1 (1018) 41.8, 48.4	<0.001
10–14 yr	19.9 (2051) 18.0, 21.9	28.9 (1330) 26.0, 31.8	28.1 (510) 23.9, 32.7	34.4 (529) 30.2, 39.0	32.6 (1304) 29.4, 36.0	34.1 (2201) 31.7, 36.5	33.9 (2311) 31.8, 36.2	37.8 (1488) 35.1, 40.5	<0.001
Sex									
Male	29.1 (2194) 26.9, 31.4	33.8 (1328) 30.9, 36.9	32.9 (533) 28.6, 37.5	40.2 (542) 35.8, 44.8	38.7 (1449) 35.6, 41.9	42.4 (2353) 39.9, 44.8	38.1 (2608) 36.0, 40.3	45.1 (1897) 42.6, 47.6	<0.001
Female	30.4 (1932) 28.0, 33.0	35.9 (1282) 32.8, 39.1	34.2 (463) 29.6, 39.1	39.2 (531) 34.8, 43.9	38.1 (1387) 35.0, 41.3	41.0 (2239) 38.4, 43.6	39.8 (2485) 37.6, 42.0	44.2 (1634) 41.6, 46.9	<0.001
SES									
Primary/illiterate	29.3 (609) 27.0, 31.7	34.1 (542) 31.4, 37.0	31.7 (172) 27.5, 36.2	39.8 (235) 35.6, 44.1	38.3 (439) 34.9, 41.8	42.6 (987) 40.3, 45.0	40.3 (904) 38.0, 42.6	46.8 (458) 43.4, 50.3	<0.001
Secondary+	29.5 (1174) 26.3, 32.9	35.1 (769) 31.2, 39.3	33.1 (291) 27.5, 39.4	40.3 (268) 34.1, 46.8	38.1 (556) 33.2, 43.3	44.2 (1262) 40.8, 47.7	38.4 (1703) 35.7, 41.1	45.1 (1501) 42.3, 47.9	<0.001
University	26.0 (266) 20.4, 32.5	36.4 (273) 29.9, 43.3	39.5 (163) 31.6, 48.1	38.8 (180) 31.5, 46.7	32.7 (328) 26.9, 39.1	35.6 (821) 31.6, 39.8	37.4 (1080) 34.1, 40.7	42.1 (1053) 38.9, 45.5	0.01
BMI									
Underweight	31.7 (529) 27.1, 36.7	34.9 (333) 29.3, 41.0	37.8 (119) 28.8, 47.7	37.6 (114) 28.7, 47.4	38.9 (324) 32.8, 45.3	41.9 (605) 37.0, 47.0	39.5 (634) 35.2, 44.0	48.4 (493) 43.5, 53.3	<0.001
Normal	26.8 (2505) 24.7, 28.9	32.7 (1506) 30.0, 35.6	32.1 (607) 28.1, 36.3	39.8 (656) 35.7, 44.0	36.6 (1650) 33.7, 39.6	39.9 (2738) 37.7, 42.2	37.2 (2977) 35.3, 39.3	42.6 (2027) 40.2, 45.0	<0.001
Overweight	34.2 (642) 29.9, 38.8	34.8 (465) 30.0, 40.0	31.5 (196) 24.7, 39.2	36.6 (202) 29.7, 44.1	39.2 (543) 34.3, 44.3	44.8 (843) 40.7, 48.9	41.2 (976) 37.7, 44.8	41.6 (652) 37.5, 45.8	0.01
Obese	36.5 (450) 31.4, 42.0	45.5 (306) 38.9, 52.3	43.6 (74) 32.3, 55.7	46.7 (100) 36.4, 57.3	46.0 (319) 39.5, 52.6	45.7 (405) 39.8, 51.6	43.7 (506) 38.8, 48.6	55.8 (359) 50.2, 61.3	<0.001
Exercise									
No exercise	–	37.1 (403) 31.6, 43.1	49.7 (79) 37.6, 61.7	49.7 (106) 39.4, 60.0	41.5 (376) 35.4, 47.8	50.0 (1243) 46.6, 53.4	47.2 (578) 42.5, 51.9	50.7 (592) 46.2, 55.2	0.02
Some exercise	–	34.4 (2168) 32.1, 36.8	32.0 (901) 28.7, 35.4	39.0 (953) 35.7, 42.5	37.7 (2441) 35.3, 40.1	38.1 (3349) 36.0, 40.1	37.6 (4448) 36.0, 39.3	43.6 (2936) 41.6, 45.6	<0.001

Abbreviations: BMI, body mass index; CI, confidence interval.
[a] Chi-square test, complex samples confidence interval using logit transformation.

attitudes, technology, and school work commitments in older children [22]. The latter does not explain the shorter sleep times seen in preschool or early primary school children. In Spain, we would propose that parental attitudes and changing parenting styles are likely factors contributing to later bedtimes. However, identifying the causes of this decline is beyond the scope of this study.

4.1. Sleep and age

We found that parent-reported sleep duration also decreased with age, again a finding which is consistent with international data [5,19,21] and known changes in sleep architecture [23].

The younger age groups of individuals in Spain sleep less than when compared with northern European countries, the United Kingdom, and Australia [5,19,21,24]. Blair et al. reported a mean sleep duration of 11.3 hours at 69 months of age and 10.5 at 115 months of age, compared with a mean sleep duration of 10.27 hours in 2- to 5-year-olds and 9.51 hours in 6- to 9-year-olds in our study [5]. This is likely due to the influence that culture and beliefs regarding sleep requirements have in different countries; although more emphasis is placed on sleep in some countries, in Spain, much like in Italy, integration into family social life is more valued, with unstructured, flexible, and later bedtimes [24]. As studies show that total sleep duration is more closely linked to bedtime [1,5,25–27], it is likely that this difference in cultural practice explains much of the shorter sleep values in younger children in Spain, with less difference in bedtimes between younger children and adolescents, as may be found in other developed countries. These cultural differ-

Table 4
Characteristics associated with deficient sleep in children 2–14 years of age.

	Univariate		Multivariate	
	OR	95% CI	OR	95% CI
Year				
1987	Ref	–		
1993	1.26	1.1, 1.4	Ref	
1995	1.19	1.0, 1.4	0.98	0.82, 1.17
1997	1.56	1.3, 1.8	*1.26*	*1.07, 1.50*
2001	1.47	1.3, 1.7	1.09	0.94, 1.26
2003/2004	1.69	1.5, 1.9	*1.24*	*1.09, 1.40*
2006/2007	1.51	1.4, 1.7	*1.16*	*1.03, 1.31*
2011	1.91	1.7, 2.1	*1.48*	*1.30, 1.67*
Age group				
2–5 yr	Ref		Ref	
6–9 yr	0.80	0.73, 0.88	*0.86*	*0.77, 0.96*
10–14 yr	0.51	0.47, 0.55	*0.59*	*0.53, 0.66*
Sex				
Male	Ref		Ref	
Female	1.01	0.94, 1.08	0.98	0.91, 1.07
SES				
Primary/illiterate	0.97	0.88, 1.07	1.14	1.02, 1.28
Secondary+	1.02	0.92, 1.14	1.12	1.00, 1.26
University	Ref		Ref	
BMI				
Underweight	1.16	1.05, 1.30	1.02	0.90, 1.15
Normal	Ref		Ref	
Overweight	1.13	1.03, 1.24	0.97	0.87, 1.08
Obese	1.50	1.34, 1.68	*1.17*	*1.02, 1.34*
Exercise				
No exercise	Ref		Ref	
Some exercise	0.68	0.61, 0.75	*0.76*	*0.68, 0.84*

Abbreviations: CI, confidence interval; OR, odds ratio.

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ences should be considered when developing sleep duration recommendations, and we should consider whether generalized biological sleep requirements exist, given these large socio-cultural differences in sleep duration. Common sleep duration in children in one country may be the norm but may not be sufficient; alternatively, these children may be meeting their sleep requirements. Further study is required in this area.

4.2. Sleep and physical activity

In our study, a clear association was found between physical activity and sleep duration, with increased odds of short sleep duration in children who did not engage in any physical activity. This association held over all of the survey years, although we did find an increasing trend of deficient sleep among children who engaged in physical activity.

Studies show conflicting results with regard to this association. Although a large-scale study in the United States demonstrated a association similar to that in our study [28], Ekstedt et al. and Nixon et al. found no association between sleep duration and physical activity [25,29]. Pesonen et al. observed decreased sleep duration with increased physical activity [30]. However this study measured associations within a 24-hour period, and it is possible that although exercise decreases sleep duration the following night, overall sleep duration averages are longer. It is also possible that regional differences modify the association between the two [31].

This association could be bidirectional, or could go in either direction. It is possible that increased physical activity increases individual sleep requirements, or that decreased sleep results in less energy to participate in physical activity. Further investigation is required.

4.3. Sleep and obesity

Increased odds of obesity among short sleepers is consistent with a growing body of international studies [11,25,29]. However, the size of this effect is inconsistent [25]. There may be greater significance of time going to bed at night and time waking up, and circadian rhythms, rather than total duration. Various studies suggest that late to bed and late to rise is more closely associated with obesity than sleep duration [32,33]. Given that a later bedtime is associated with shorter sleep duration, this may explain the association between sleep duration and obesity in some studies. In addition, circadian misalignment in childhood may have a bidirectional impact on sleep duration and associated problems such as obesity. Melatonin onset times have been found to be associated with sleep onset and wake times and circadian misalignment associated with sleep problems. In adults and adolescents, circadian misalignment has been associated with disease, accidents, and poor academic performance [34].

Differences in cultural behaviors may also act as modifiers between sleep duration and risk of obesity, and may explain the differing size effects of this association throughout literature [25]. These differences may also be due to a time lapse effect that is not measurable in cross-sectional data [35]. The association between sleep and obesity was independent of physical activity and socioeconomic status, similar to findings by Nixon et al. and de Jong et al. [29,36]

A slight U-shaped relationship was found between sleep duration and weight status, with short sleep also increasing the odds for underweight in the univariate analysis. This relationship was attenuated when controlling for demographic factors and physical activity in the multivariate analysis. This U-shaped relationship is consistent with findings in other literature in adolescents [37].

4.4. Study strengths and weaknesses

We should note some of this study's weaknesses and their potential effects on the interpretation of the results. Sleep data were collected in a subjective manner via parental reporting, and, to our knowledge, no studies have been done testing this question's validity. However, studies comparing parental reporting to objective sleep duration measures in younger children show that parents tend to overestimate sleep duration [38,39]. This would suggest that actual sleep duration in Spanish children, especially in younger children, is actually less than measured in this study. This overestimation may differ with age groups, although this should not vary significantly over time. To our knowledge, no validation studies have been done regarding the specific question on sleep duration as used in the Spanish National Health Survey. In the National Health Survey, sleep was reported only in hours, meaning that we could not be more accurate than this; however, with the large sample numbers, this rounding should have less impact on the results. We were also unable to distinguish between night-time and daytime sleep.

Anthropometric and physical activity data were also collected in a subjective manner in this study. Although parent-reported anthropometric measurements are correlated with objective measures, they tend to overestimate height and underestimate weight [40]. The questions for height and weight were validated in a 2007 paper by Basterra-Gotari et al. using a sample of 120 individuals 18 years or older. The authors concluded that use of self-reported data is an efficient way of obtaining information about BMI, although with the afore-mentioned limitations [40]. The IPAQ questionnaire is used to collect information about physical activity in the Spanish National Health Survey. This questionnaire has been validated for Spanish adolescents in the HELENA Study. Only a weak correlation was found between parent-reported physical activity and that measured by accelerometer for individuals 14 years or younger [41,42]. This may have an impact on any associations found between BMI and physical activity.

Sample sizes were variable for the different survey years, and subsample sizes for autonomous communities were variable as well. Because of the combined nature of the analyses, and for comparability, we required a standard weighting method for all survey years. The types of weighting factors provided by the National Health Survey differed between survey years and were not provided before 1997, as the early surveys were designed to be representative at the national level. During literature searches, we found that weighting criteria and methodology are often not transparent in other studies and frequently lack justification or explanation of the methodology used. This results in difficulty with replication and affects comparability. Our study used a simple proportionality weighting method similar to that proposed by a study group in Barcelona [17].

Despite these weaknesses, this study does have numerous strengths. The use of national survey data allowed analysis of nationally representative data collected with standardized methodology over 2 decades. While being measured subjectively, the same questions were used in each survey year for increasing comparability of data between surveys. The question for sleep added "including siestas" to the question in later surveys; however, we would expect this to increase estimated sleep duration in later survey years and thereby decrease any trend measured. This study also was able to demonstrate trends over a 24-year period. National survey data also allowed us to measure sleep trends in a fairly homogenous population.

5. Conclusion

The downward sleep duration trend in all demographic groups is worrisome, and long-term health outcomes are still unclear. With the association of short sleep duration with many different health

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outcomes, we should be investigating and considering sleep as a modifiable lifestyle factor and a public health issue. Lack of consistency in cut-offs for age-appropriate ideal sleep in literature is a barrier for international comparison and highlights the need for research in physiological sleep requirements. Both individual and regional variation needs to be considered when making sleep duration recommendations. However, although there is large individual variation in sleep duration, what may be considered "normal" or "common" sleep duration may not necessarily be sufficient.

Conflict of interest

The authors declare no conflicts of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2015.12.021.

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5.3 Article 3: Individual, family and environmental factors associated with pediatric excess weight in Spain: a cross-sectional study

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Individual, family and environmental factors associated with pediatric excess weight in Spain: a cross-sectional study

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Abstract

Background: There is a growing worldwide trend of obesity in children. Identifying the causes and modifiable factors associated with child obesity is important in order to design effective public health strategies.
Our objective was to provide empirical evidence of the association that some individual and environmental factors may have with child excess weight.

Method: A cross-sectional study was performed using multi-stage probability sampling of 978 Spanish children aged between 8 and 17 years, with objectively measured height and weight, along with other individual, family and neighborhood variables. Crude and adjusted odds ratios were calculated.

Results: In 2012, 4 in 10 children were either overweight or obese with a higher prevalence amongst males and in the 8–12 year age group. Child obesity was associated negatively with the socio-economic status of the adult responsible for the child's diet, OR 0.78 (CI95% 0.59–1.00), girls OR 0.75 (CI95% 0.57–0.99), older age of the child (0.41; CI95% 0.31–0.55), daily breakfast (OR 0.59; p = 0.028) and half an hour or more of physical activity every day. No association was found for neighborhood variables relating to perceived neighborhood quality and safety.

Conclusion: This study identifies potential modifiable factors such as physical activity, daily breakfast and caregiver education as areas for public health policies. To be successful, an intervention should take into account both individual and family factors when designing prevention strategies to combat the worldwide epidemic of child excess weight.

Keywords: Overweight, Child, Adolescent, Risk factors, Physical activity, Breakfast

Background

The World Health Organization (WHO) defines obesity as a disease, a complex condition with physical, social and psychological dimensions, with serious health and economic consequences [1].

In the U.S. the 2009–2010 prevalence of overweight and obesity is 31.8% for children aged 2 to 19 years [2]. Europe estimates 20% of children and adolescence to be overweight, with one third of these obese and the annual rate of increase in this prevalence is growing [3]. In Spain, the 2011 National Health Survey of 5495 children reported a combined prevalence of overweight and obesity of 29.1% in boys aged 2 to 17 years and 26.5% in girls of the same age; slightly higher than previous National Health Survey outcomes [4].

Child obesity results in both immediate as well as long term health consequences as risk profiles track into adulthood [3,5,6]. These include social and psychological issues as well as orthopedic problems, type 2 diabetes, hypertension, sleep apnea, metabolic syndrome and lower quality of life [3,7-11]. Identifying the causes and modifiable factors associated with child obesity is important to be able to design effective public health strategies to reverse the current obesity trends.

Multiple factors, including genetic, environmental, cultural and socio-economic status may influence corporal weight [12-18]. Researchers of child and adolescent obesity have mainly focused on individual factors such as gender, socio-economic position, physical

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activity, sedentary habits, nutrition and sleep duration [12,13,19]. Evidence also suggests that environmental and family factors influence adopted habits, particularly in children [14-16,20,21]. The neighborhood environment can include both physical aspects, which create opportunities or barriers for obesogenic behaviors, and social aspects of perceived safety or facility availability [22,23]. Additionally, in children and adolescents the changing level of autonomy with age combined with parental perception of neighborhood characteristics may influence obesity related behaviors. Positive correlations between parent-reported neighborhood characteristics and child physical activity have been identified in other studies [23]. Nonetheless, the use of environmental factors in children may be difficult due to the ecological characteristics of this type of variable with a high probability of misclassification bias, difficulty to separate familial and environmental factors [15], as well as constraints in establishing causal relationships between environmental factors and child obesity. Scientific literature provides partial, incomplete, sometimes contradictory and, therefore, inconclusive findings regarding the association of many of the individual and environmental factors on obesity. There is a need for new research that combines these different types of factors, in particular with the addition of family and environmental variables. This study aims to provide empirical evidence of the association that some individual, family and environmental factors may have on excess body weight during childhood and adolescence.

Methods

Study design and population

A cross-sectional observational study was carried out using probability sampling of the study population. The study population consisted of children and adolescents, of both sexes, between the ages of 8 and 17 years inclusive, resident in family households in peninsular Spain. Data were collected during April and May in 2012.

The probabilistic sample was based on a multistage clustered and stratified sample. Primary sampling units (municipalities) and secondary units (census groups) were selected through a probability proportional to size (PPS) method. Tertiary units (households) and individual units were selected using a combination of random pathways and quotas for sex and age. Population strata were formed by the intersection of the 15 mainland regions with municipality population size divided into 5 categories: (1) less than or equal to 2000 inhabitants; (2) 2001 to 10 000; (3) 10 001 to 50 000; (4) 50 001 to 200 000; and (5) more than 200 000 inhabitants. The selected sample was proportional to the size of the strata. The distribution of the two age groups in the sample population (8–12 years and 13–17 years) was equal to their proportions in the population.

Measures and selected variables

Weight and height measurements were taken in the presence of the adult responsible for the child's diet, who was also asked to complete socio-demographic questions via computer-assisted personal interview, see Additional file 1. Anthropometric measures of the different household members were measured using a scale and height rod and followed a set measuring protocol. The specific models used were: a) Scale – Tefal PP1027 A9, and b) Height rod: 5002.01.001 Soehnle professional. The child was placed in the standing position, without shoes, with hips and shoulders perpendicular to the central axis of the body, heels firmly planted on the ground, knees close together and extended, relaxed arms, and head in the Frankfurt plane. Body weight was determined through a digital anthropometric scale graded from 0 to 150 kg with a resolution of 0.05 kg. The body mass index (BMI) was calculated by the quotient of body mass in kg by height in meters squared (m^2), and subsequently overweight and obesity were defined according to the World Health Organization criteria [24]. Excess weight was defined as the presence of overweight or obesity in the child or adolescent at the moment of recruitment.

The questions and response scale used in the computer-assisted personal interview are part of the standardized questionnaire used in the Andalusian and National Health surveys. The questionnaire used in our study was also initially tested on a sample of 50 people of the target population.

The variables considered in this study, with their initial categorization, were: a) age group of child: 8–12 years (REF), 13–17 years; b) sex of child: male (REF), female; c) population category of municipality: less than or equal to 2000 inhabitants, 2001 to 10 000, 10 001 to 50 000, 50 001 to 200 000, and more than 200 000 inhabitants; d) Education level of the adult responsible for the child's diet: Primary (REF), Secondary or University level studies; e) Employment status of the adult responsible for the child's diet: Employed, Unemployed but previously employed, Looking for first employment, Retired (worked previously), Housewife, Student, Disability, Permanent Disability, Other; f) Occupation of the adult responsible for the food of the children according to the national classification of occupations 2001 (CON-11); g) Walking: less than 30 min per day (REF), 30 min or more per day; h) Sleep duration: less than 9 hours per night (REF), 9 hours or more per night; i) Variables related to dietary habits, including: daily breakfast, daily freshly-squeezed orange juice, daily Yoghurt; j) TV watching: watches TV every day, does not watch TV every day; k) Perception of neighborhood quality: Good/Very Good, Average/Poor/Very Poor (REF); l) Perception of Neighborhood Safety: Good/Very Good

(REF), Average/Poor/Very Poor; m) Caregiver perception of Excess Weight: Excess weight is not detrimental to health, Is detrimental but not as much as is alleged by doctors or the media, Is detrimental for health. Some variables were subsequently reclassified, as shown in Table 1, due to the low number of observations in some categories or due to similar behavior with respect to the dependent variable. Maternal and paternal ages were considered as continuous variables.

Data analyses

For descriptive statistics, the mean and standard deviation were calculated for continuous variables. For categorical variables, percentage distributions are shown. Comparison of proportions was carried out using the chi-squared statistic if its conditions were met, and if the conditions were not met the Fisher exact test was used. In order to jointly analyze the relationship of the considered independent variable with respect to excess weight, a logistic regression model was applied. Possible factors associated with excess weight were included in this model and their odds ratios obtained. Maternal age was considered as continuous when modeling the data, as its relationship with the log of excess weight prevalence was approximately linear.

First, a logistic regression model of excess weight with respect to the child's sex and age was fitted. Next, a new variable was added successively in each step (using the forward method of introducing variables manually). The variables selected to introduce into the models were chosen according to epidemiological and statistical criteria. The effect of each exploratory variable in the model and its significance was studied. If the variable improved the model fit and adequacy (based on the likelihood ratio criteria and the significance of the parameter) it was kept for the next step; otherwise, the variable was excluded. Different models were fitted with respect to the factors related to the family and physical environment. The model was checked for pair-wise interaction between covariates. Interactions with the sex and age of the child were considered. Potential confounding covariates were studied using a change of significance of the parameters in the model or a change of 30% of its value [25]. Once the model was fitted to the data, the goodness of fit of the model was assessed by the Hosmer-Lemeshow test. SPSS statistical package version 18 was used to perform all analyses.

Ethics statement

Ethics approval was obtained from the Research and Ethics Committee of the Andalusia School of Public Health (Regional Ministry of Health, Regional Government of Andalusia), with assurance of the anonymity of individual data in accordance with the requirements of Spanish law. Verbal consent was obtained from parents or legal guardians as a pre-requisite to collecting information. Consent procedure required an explanation of the research project, what it consisted of and the type of data being collected.

Results

A total of 978 children were included in the analyses and an overall participation rate of 80% was achieved. The overall prevalence of overweight and obesity was 38.6% (CI95% 35.5 – 41.6%). Baseline characteristics of the study population are shown in Table 1. The mean age of the group was 12 years old (SD 2.94) and 50.2% of the whole sample were male. The mother was the adult responsible for the child's diet in the majority of cases (84.6%) and over 80% of the adults responsible for diet perceived neighborhood safety and quality as either good or very good. The majority (90%) of children ate breakfast at least 5 days per week. Just over half of children exercised at least 30 minutes per day, and around 47% also watched television daily. With respect to sleeping hours, 41% slept less than 9 hours per day on average.

The crude odds ratios are shown in Table 2 and the adjusted odds ratios (OR) in Table 3. The statistically significant associations found in the crude models held in the adjusted model for age, sex, walking, and for the child having daily breakfast. In both the crude and adjusted analyses the education level of the adult responsible for the child's diet bordered on statistical significance ($p < 0.10$). Regarding the child's characteristics, females were found to have a 25% lower risk of excess of weight compared with males. We observed a higher risk of overweight and obesity in younger children (8–12 years) compared with adolescents (13–17 years): the risk was 59% lower in this last group compared with children aged 8–12, adjusted OR 0.41 (CI 95%, 0.31 – 0.55). A lower risk was also found if the child walked at least 30 minutes per day, adjusted OR 0.73 (CI 95%, 0.56 – 0.96). Children that ate daily breakfast were observed to be less likely to have excess weight, adjusted OR 0.59 (CI 95%, 0.36 – 0.94). With respect to the characteristics of the adult responsible for the child's diet, we found a trend towards a lower risk of excess weight with a higher level of education of the adult responsible, adjusted OR 0.78 (CI 95%, 0.59-1.03). In our study, variables related to the perceived environment were not associated with youth excess weight in either the crude or in the adjusted analyses, as can be seen in Table 2.

Discussion

This study provides information on factors associated with the prevalence of excess weight among children

Table 1 Descriptive characteristics of survey population

		n, mean (SD)[1] n (%)[2]
Variables related to the child		
Age		976, 11.99 (2.94)
	8-12	534, 9.64 (1.38)
	13-17	442, 14.82 (1.43)
Sex	Male	490 (50.20)
	Female	486 (49.80)
Breakfast daily		
	4days or less per week	89 (9.1)
	5 or more days per week	887 (90.9)
Freshly squeezed orange juice		
	7 days per week	105 (11.2)
	Less than 7 days per week	832 (88.8)
Daily yoghurt		
	7 days per week	99 (10.6)
	Less than 7 days per week	839 (89.4)
TV daily		
	Watches TV everyday	459 (47.2)
	Does not watch TV everyday	514 (52.8)
Physical activity		
< 30 min per day		527 (54)
30 min or more per day		446 (46)
Sleep duration		
Less than 9 hrs/day		399 (40.9)
9 or more hrs/day		577 (59.1)
Variables related to the family		
Maternal age		950, 40.76 (6.06)
Paternal age		798, 43.43 (6.19)
Adult responsible for child's diet		
	Father	114 (11.7)
	Mother	826 (84.6)
	Others	36 (3.6)
Academic level of adult responsible for food		
	Primary	538 (57.2)
	Secondary/University	402 (42.8)
Occupation of adult responsible for food		
	Manager/Professional	70 (11.8)
	Unskilled worker/other	523 (88.2)
Employment status of adult responsible for food		
	Working	476 (52.2)
	Unemployed	135 (14.8)
	Housewife	301 (33.0)
Caregiver perceptions of excess weight		
	Excess weight is not detrimental to health	11 (1.1)
	Is detrimental, but not as much as is said by doctors or in the media	19 (1.9)
	Is detrimental for health	945 (96.8)
Variables related to the environment		
Neighbourhood quality		
	Good/Very Good	795 (81.7)
	Average/Poor/Very Poor	178 (18.3)
Neighbourhood safety		
	Good/Very Good	819 (84.0)
	Average	129 (13.2)
	Poor/Very Poor	27 (2.8)

[1]n, mean (SD): Sample size, Mean (Standard Deviation).
[2]n (%): Absolute frequency (Percentage).

and adolescents aged 8–17 in Spain. In 2012, approximately 4 out of every 10 children and adolescents were overweight or obese with a higher prevalence amongst males and those aged 8–12 years. Child obesity was also shown to be associated with the sex of the child, the education level of the adult responsible for the child's diet, the level of physical activity of the child as measured by time walking per day, and having breakfast daily. For this reason, both individual and family factors should be taken into account in the fight against the worldwide epidemic of child excess weight.

Consistent with scientific literature in this area, our findings show that the risk of excess weight is lower in females than males. This result is consistent with observational studies in Europe, Japan and the USA [2,26-28]. As has been previously commented on in literature, differences in sexes could potentially be due to a variety of influencing factors such as hormonal differences during and post- puberty, cultural gender constructs or differing influences of environmental or familial variables [29]. However, the association between sex and excess weight persists in our study after adjusting for potential confounding factors related to individual, environmental and familial variables. These differences could be explained by the role that non-modifiable variables, such as genetic and hormonal factors, play in the weight of a person.

In this study, older children were found to have a lower risk of excess weight than younger children. This finding could potentially be explained by an age-effect or could indicate that the problem is getting worse over time and will grow in the future if we do not act expediently [30]. The observed difference between age-groups close in time is worrying and warrants further investigation.

Table 2 Factors associated with excess weight in Spanish youth aged 8-17

		Crude analysis		
		OR	95% CI	p
Variables related to the child				
Sex	Male	1	Ref.	
	Female	0.79	(0.61 – 1.02)	0.071
Age	8-12 years	1	Ref.	
	13-17 years	0.86	(0.82 – 0.90)	**0.000**
Physical Activity	<30 min/day	1	Ref.	
	≥30 min/day	0.73	(0.56 – 0.95)	**0.019**
Sleep duration	<9 hrs/night	1	Ref.	
	≥9 hrs/night	1.06	(0.81 – 1.38)	0.676
Breakfast daily	No	1	Ref.	
	Yes	1.47	(0.95 – 2.28)	0.083
Related to the family				
Age of mother	Per year Increase	0.97	(0.96 – 0.98)	**0.000**
Age of father	Per year Increase	1.00	(0.99 – 1.00)	0.727
Level of education of adult responsible for food	Primary	1	Ref.	
	Secondary/University	0.77	(0.59 – 1.00)	0.051
Occupation of adult responsible for food	Professional/ Manager	1	Ref.	
	Unskilled worker/other	0.54	(0.31 – 0.94)	**0.028**
Employment status of adult responsible for food	Self-employed/ Housewife	1	Ref.	
	Unemployed	1.32	(0.87 – 2.01)	0.191
	Employed	1.35	(1.00 – 1.82)	0.052
Related to neighbourhood				
Perception of neighbourhood security	Good or very good	1	Ref.	
	Average	1.22	(0.84 – 1.78)	0.300
	Poor or very poor	1.13	(0.52 – 2.46)	0.761
Perception of neighbourhood quality	Very poor, poor or average	1	Ref.	
	Good or very good	1.04	(0.74 – 1.45)	0.836
Parental view on child obesity	Obesity is bad for health	1	Ref.	
	Obesity is not bad for health	1.85	0.90, 3.83	0.099

Table 3 Factors associated with excess weight in Spanish youth aged 8–17 - Multivariate Analysis

		Adjusted analysis		
		OR	95% CI	P
Variables related to the child				
Sex	Male	1	Ref.	
	Female	0.75	(0.57 – 0.99)	0.043
Age	8-12 years	1	Ref.	
	13-17 years	0.41	(0.31 – 0.55)	0.000
Physical activity	<30 min/day	1	Ref.	
	≥30 min/day	0.73	(0.56 – 0.96)	0.027
Breakfast daily	No	1	Ref.	
	Yes	0.59	(0.36 – 0.94)	0.028
Related to the family				
Level of education of adult responsible for food	Primary	1	Ref.	
	Secondary/ University	0.78	(0.59 – 1.03)	0.082

Variables in the crude analysis that were found to be not significant in the multivariate analysis are not included in Table 3.

Independently of the age and sex of the child, the role that modifiable factors such as diet and physical activity play in the obesity epidemic are clear and well established. However, most interventions have focused mainly on the role of diet rather than on the role of physical activity. Not having breakfast has been classically identified as a risk factor for excess weight in childhood [17,31] and many interventions have been made to combat this factor and as such, according to our results, the problem currently affects less than 10% of Spanish children. However, it seems that so far physical activity has not been given the attention it deserves. Our findings show that children carrying out physical activity on a regular basis are less prone to suffer from excess weight than those with sedentary habits, independent of sex or educational level of the adult responsible for diet. Physical activity is considered an important factor in energy balance and a growing body of evidence suggests that reduced daily physical activity is a main cause of the worldwide increase in youth obesity and overweight [1,32,33]. Physical activity should be promoted as part of a healthy lifestyle to prevent excess weight gain and this promotion should begin at an early age. However, despite efforts being made, success is limited and variable [34,35]. Perhaps a global and integrated approximation to the problem is necessary, considering not only the child but also the family and the environment where the child lives.

The behavior of children depends largely on the family environment in which they grow and we cannot analyze a child's diet and level of physical activity without considering the family environment. In this sense, a higher level of parental education is less associated with overweight and obesity in the offspring and may be related to differing lifestyle choices such as diet quality and act

in this way [17,31]. Although, considering the design and information of our study, we were not able to analyze these hypotheses. The IDEFICS consortium, based on data from a cross-sectional baseline survey of a prospective cohort aged 2 to 9 years in eight European countries, shows that the intakes of vegetables, fruits, pasta/noodles/rice, wholegrain bread and water increased as educational level increased; while intakes of fried potatoes, fried meat and fish, fast food, sugared beverages, snacks/desserts and chocolate/nut-based spread increased as educational level decreased [17]. Further study is required to clarify this relationship and investigate the underlying mechanisms.

When the factors associated with child excess weight are analyzed, we can clearly identify two types of factors: a group of factors that depends directly on the child and their behavior, and another group of factors related to the family environment. The frontier between both groups of factors is very difficult to establish, but if we want to be successful in the control and prevention of child excess weight we should consider both groups in the design of adequate interventions. Perhaps family factors have not been playing the real role that they should in child obesity prevention campaigns.

Along with individual and familial factors, we should consider the role that environmental factors may play in facilitating the adoption of healthy lifestyles. Certain environmental factors are widely considered as relevant for the development and prevention of obesity, influencing directly or indirectly the motivation of children to engage in physical activity. They may also influence diet quantity and quality, due to the availability of opportunities and places for the consumption of healthy or non-healthy foods [18,22,36]. Our findings showed no association of the measured environmental factors with excess weight in youth. There are several reasons that should be taken into account to explain these differences: 1) It is possible that the environmental variables considered in our study were measured in a subjective and perceived manner with a potential distortion from reality (if measured objectively). This could create difficulty in finding statistically significant differences compared with objective measures. For example, Bodor JN et al. described a high risk of obesity associated with fast food restaurants and convenience stores, but had not considered neighborhood quality and safety variables [36]; 2) Studies where they relate obesity to physical environmental factors usually work with adult population samples [22,36]; 3) The magnitude of the associations found between obesity and environmental characteristics are usually very weak, 1.01 (1.00 – 1.02) for fast food restaurants and obesity in Bodor's study [36]; and 4) Alternatively, environmental factors could indirectly influence obesity-related behavior through individual and familial variables, which can be very important in children [23]. Whatever the reason is for why environmental factors were not significant in this study is beyond the scope of this research.

As potential limitation of our study we should cite: 1) Its observational nature and the weakness associated with any cross-sectional study in that no temporal relationship or direction of association can be determined. One obvious drawback in this type of epidemiologic study is possible reverse causation or common upstream cause. Cross-sectional associations may reflect the combined intervention of the true effects of a particular factor as well as artificial effects due to reverse causation and confounding by other variables. The absence of association found between variables related to diet and weight in our study could be explained by this and it can't be forgotten that diet is one of the first things that people modify when wanting to lose weight; 2) Another limitation to be considered is the subjective nature of interviewees' perceptions of their neighborhood and level of physical activity, as previously discussed. However, we can also consider that the perception of neighborhood security may be more important in level of physical activity than objective neighborhood security; 3) We should also keep in mind that marginal social classes are not included in health surveys. In addition, children who belong to the lower (but non marginal) social classes enjoy great protection due to the public policies of the Spanish welfare state, and this can attenuate the observed associations between socio-economic status and excess weight. As advantages of our study we should highlight that: 1) Our sample is representative of Spanish children 8–17 years. The multi-stage probability sampling method used resulted in a sample that was representative of the target population, meaning that the results can be extrapolated to a greater population; 2) While many studies use subjective measures for child weight, this study used objective measures for weight, height and BMI outcomes; 3) We tried to integrate the role of individual and social factors on the risk of excess of weight in children, unlike other studies that are based on only individual variables; 4) Missing data were minimal and were not different from data of the included participants.

Conclusions

The results in this paper provide relevant information to be considered when developing public health policies, professional care in the area of childhood overweight and obesity and further research. In our study we identify as areas for public health policies and further research potentially modifiable factors such as physical activity and caregiver education. If we want to be successful, an adequate intervention for the control of the obesity epidemic in children should not forget to act on both the child and his social context.

Additional file

Additional file 1: File name: cuestionario obesidad infantil BMC Pediatrics.pdf. File type: Acrobat file. Title of dataset: Estudio sobre obesidad infantil y juvenil. Description: Questionnaire used in this study to collect socio-demographic information on study participants.

Competing interests
The authors declare no conflict of interests.

Authors' contributions
JJSC is the main researcher of the project number PI10/02018, he participated in the design of the study and statistical analysis of the data and the discussion of the results. IdR has collaborated in the analysis, discussion of the results and preparation of the initial draft. JJJM contributed to the analysis and discussion of the results. All authors were involved in writing the finished paper and had final approval of the submitted and published versions.

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5.4: Article 4: Factors associated with parental misperception of Child obesity

TITLE: Parental and child factors associated with under-estimation of children with excess weight in Spain.

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Parental and child factors associated with under-estimation of children with excess weight in Spain.

Abstract

Background: Understanding obesity misperception and associated factors can improve strategies to increase obesity identification and intervention. We investigate underestimation of child excess weight with a broader perspective, incorporating perceptions, views, and psychosocial aspects associated with obesity.

Methods: This study used cross-sectional data from the Spanish National Health Survey in 2011-12 for children aged 2-14 years who are overweight or obese. Percentages of parental misperceived excess weight were calculated. Crude and adjusted analyses were performed for both child and parental factors analyzing associations with underestimation.

Results: Two - five year olds have the highest prevalence of misperceived overweight or obesity around 90%. In the 10-14 year old age group approximately 63% of overweight teens were misperceived as normal weight and 35.7% and 40% of obese males and females.

Child gender did not affect underestimation, whereas a younger age did. Aspects of child social and mental health were associated with under-estimation, as was short sleep duration. Exercise, weekend TV and videogames, and food habits had no effect on underestimation.

Fathers were more likely to misperceive their child´s weight status; however parent's age had no effect. Non-smokers and parents with excess weight were less likely to misperceive their child´s weight status. Parents being on a diet also decreased odds of underestimation.

Conclusions: This study identifies some characteristics of both parents and children which are associated with under-estimation of child excess weight. These characteristics can be used for consideration in primary care, prevention strategies and for further research.

KEY WORDS: Child obesity, Epidemiology, weight misperception

Significance Statement

What is already known:

High rates of parental underestimation of child excess weight have been reported with rates associated with child age and parental gender. Underestimation is also associated with lower levels of intervention.

What this study adds:

Underestimation rates are high in Spain and highest with younger children. Aspects of parental perception of child's social and mental health were associated with under-estimation, as was short sleep duration. Non-smokers, parents on a diet and parents with excess weight were less likely to misperceive their child´s excess weight status.

Introduction

Child obesity is considered an important public health problem world-wide. High prevalence of child obesity has been documented throughout the developed world including Spain (Sanchez-Cruz, Jimenez-Moleon, Fernandez-Quesada, & Sanchez, 2013; van Stralen et al., 2012; Wang & Lobstein, 2006). Prevalence of child and adolescent overweight has been measured at 26% and obesity 12.6% (Sánchez-Cruz, Jiménez-Moleón, Fernández-Quesada, & Sánchez, 2013). Child obesity has been associated with both short- and long-term consequences, with metabolic risk profiles tracking into adulthood (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008; Twig et al., 2016; R Weiss et al., 2004; Ram Weiss et al., 2003).

Effective strategies to combat and reverse child obesity have been on the public agenda in many countries for a number of decades, with the most recent World Health Organization (WHO) Commission on Ending Childhood Obesity being published in 2016 (World Health Organization, 2015). While public health strategies have generally succeeded in raising awareness in parents regarding child obesity and its consequences (Hardus, van Vuuren, Crawford, & Worsley, 2003), this does not appear to have translated to correct identification of

excess weight by parents in their own children (Lundahl, Kidwell, & Nelson, 2014). Many parents consider overweight children to be healthy and normal with high rates of parental underestimation of child weight measured in many international studies over the last decade (Eli, Howell, Fisher, & Nowicka, 2014; He & Evans, 2007). These high percentages of underestimation of child excess weight are concerning. Parents and families need to be aware of an obesity issues in their family and be willing, able and ready to make the necessary life style changes needed as we do not fix what we do not know is a problem.

A number of international studies have found consistently high prevalences of underestimation of excess weight in children (De La et al., 2009; Hudson, McGloin, & McConnon, 2012; Katz, 2015; Lundahl et al., 2014). Underestimation reported has been associated with parental gender, child age and varying results for socio-economic status and child gender. Socio-cultural differences may explain some of the differences seen in results for child gender and socio-economic status. However, factors other than child age, parental gender, education or income level have not been included in these studies. Perceptions and beliefs of weight take place within a wider social discourse, and families need to negotiate complex and often contradictory messages when constructing beliefs and actions relating to obesity management (Thomas, Olds, Pettigrew, Randle, & Lewis, 2014). Furthermore, images and stereotypes of obesity, particularly in children, may influence parents' own views on obesity and the weight status of their own children (Eli et al., 2014; Thomas et al., 2014).

Understanding rates of underestimation and associated factors can improve and target strategies to increase obesity awareness, improve identification within families, remove barriers to correct weight status identification such as stigma, and improve subsequent appropriate management.

This study investigated underestimation of child excess weight status with a broader perspective incorporating perceptions, views, and psychosocial aspects associated with obesity, using secondary analysis of data from the Spanish National Health Survey. Specifically, this study had two objectives: 1) To identify the prevalence of parental underestimation of child weight

status in Spain, and 2) To identify the associated characteristics with parents incorrectly identifying their child´s weight status, specifically those associated with parents who perceive an overweight/obese child as being normal weight.

Methods

Study design and population

This study used cross-sectional data from the Spanish National Health Survey in 2011-12 which was conducted by the Spanish Ministry of Health and the National Institute of Statistics. The National Health Survey uses multi-stage stratified random sampling of all households in Spain, with strata based on municipality size. Questionnaires were conducted by a trained interviewer via computer-assisted personal interviews. Three questionnaires were conducted in each selected household: one household questionnaire, one adult questionnaire, and one child questionnaire if a child lived in the household. Household response rate was 89.62%. More detailed information on methodology can be found on the National Health Survey section on the Ministry of Health, Social Security and Equality website (http://www.msssi.gob.es/estadEstudios/estadisticas/encuestaNacional/encuesta2011.htm) (Spanish Ministry of Health and Social Policies, 2013).

Our population sample was restricted to cases that met the following criteria: 1) household had a child questionnaire, 2) where the child was aged between 2-14 years inclusive, 3) the child was overweight or obese, and 4) the person responding to the questionnaires was their parent.

Exclusion criteria included cases where child weight perception status was missing. Ceuta and Melilla were also excluded as they are extra-metropolitan Spanish cities in North Africa with different demographic characteristics to peninsula Spain. After exclusions criteria were applied, the total sample size was 914. For analyses investigating the parental characteristics associated with underestimation of child obesity, only cases where the adult surveyed was the same as the

informant were used (i.e. the adult questionnaire was filled out by the person themselves and not their spouse or partner). The sample size for these final analyses was 544.

Variables

Data on Body Mass Index (BMI) were derived from parent reported height and weight in cm and kg. BMI for sex and age was categorized as obese, overweight, normal weight or underweight as per the latest World Obesity Federation definitions for BMI cut-offs for under the age of 18 (World Obesity Federation, 2013). The National Health Survey reports ages in year, and therefore for the purpose of this calculation all children were assumed to be at the midpoint of their age-year.

Parental perception of child weight status was measured using a single question - "And, in relation to his/her height, you would say their weight was_____ : 1) Significantly higher than normal, 2) Somewhat higher than normal, 3) Normal, and 4) Lower than normal. This variable was parent-reported. This variable was then combined with BMI status to create the binary primary outcome variable: parental underestimation of child´s weight - yes/no. Underestimation was defined as case where a child with a BMI in the overweight or obese range whose parents considered their weight in relation to height to be normal.

Independent factors for analysis were chosen based on literature search of factors associated with child obesity, adult obesity and factors associated with perception and stigma of obesity (Gray, Kahhan, & Janicke, 2009; Hardus et al., 2003; Jain et al., 2001; Warschburger, 2005). The factors were divided into child and adult factors then further categorized into: General Characteristics, Perceived Health, Social and Mental Health, Exercise and Rest, and Food Behaviors.

Parental education level was approximated using the highest education level achieved by either parent or legal guardian. Education levels were coded to correspond with education levels according to the International Standard Classification of Education (ISCED)(United Nations Educational Scientific and Cultural Organization, 2014) and grouped into the following

categories: 1) Illiterate/no formal education, Primary level education, and 2) Secondary level and non-university education, and University.

Statistical analysis

Data were analysed using SPSS version 20. General demographic details for the sample population were calculated, including percentages of male vs. female parents, level of education of parents, nationality, child gender and mean parental age and BMI. Obesity and overweight combined overall prevalence and prevalence for the different age groups were calculated.

Using only cases with obese or overweight children, percentage of children whose weight was correctly identified and under-perceived was calculated. Next percentages of misperceived excess weight were calculated for males and females separately and for each age group.

Finally crude and then adjusted analyses were performed using binary logistic regression for each of the factors analyzing any association with underestimation. Effect size of each factor on underestimation of excess weight for each variable was reported.

Ethics statement

As per the National Health Survey guidelines, parental/guardian consent to participation was required prior to collecting data on minors. All National Health Survey data files consist of anonymous data and cases for analysis and are freely available for public use online.

Results

Characteristics of the sample population after exclusion of cases with normal weight and underweight children are shown in Table 1. Total sample size was 914 cases, 88.5% Spanish parents with an average age of 39.2 years, an average BMI of 26.4, 53.3% were female, and 66.1% had a minimum of secondary or tertiary education. Children were male in 55.9% of cases. Overall 29.8% of males suffered from excess weight and 26.8% of females. Breakdown of characteristics by child age group and parental gender can be found in Table 1.

Amongst overweight children, 75.9% were misperceived as being normal weight or underweight and 73.5% of children with obesity were underestimated as being normal weight or underweight. Table 2 shows the overall frequency of misperceived excess weight, and its distribution by child age and sex. 2-5 year olds have the highest prevalence of misperceived overweight or obesity with 93.9% of overweight boys and 95.4% of overweight girls having their weight status underestimated and 87.8% and 91.2 % of obese males and females having their weight status underestimated. The 10-14 year old age group had less risk of having their weight status underestimated with approximately 63% of overweight males and females being misperceived as normal weight and 35.7% and 40% of obese males and females having their weight status under-estimated.

Table 3 shows the child characteristics that were associated with underestimation of excess weight. Child gender did not affect underestimation, whereas a younger age did. In terms of child social and mental health odds of weight status underestimation decreased if the child had frequent headaches, was a loner, is teased frequently by other children, gets along better with adults and is easily frightened. Short sleep duration decreased odds of underestimation of excess weight, whereas exercise amount had no effect on underestimation. A child that never watched weekday television was more likely to have their weight status underestimated; however weekend TV and videogames were not associated with underestimation. A child´s food habits were also not associated with underestimation of weight status.

Adult parent characteristics associated with underestimation of child weight status are shown in Table 4. Adult males were more likely to misperceive their child´s weight status, however age did not affect underestimation rates. A non-smoker was less likely to misperceive their child´s weight status, as is a parent who is overweight or obese themselves. Parental exercise and sleeping habits did not show any association with underestimation. Parents who never eat fast food had lower odds of misperceiving their child's weight compared with those that eat fast food once or more per week (0.67, p=0.03). The odds of underestimation were 0.43 for parents that were on a diet compared with parents who were not.

Discussion

This study showed high rates of parental underestimation of child excess weight status. Child age, factors associated with child social/mental health, child sleep duration, child TV watching, parental gender and parent being on a diet were found to be significant moderators of this effect. Child gender, exercise levels and diet did not appear to moderate weight status underestimation.

Several international studies have shown similarly high misperception rates, with 63% of parents incorrectly perceiving their overweight child to be within the normal weight range in a study including 8 European countries, and a recent meta-analysis reporting 50.7% of parents under-estimated their overweight child's weight (Eli et al., 2014; Lundahl et al., 2014). These studies also report larger percentages of misperception for younger children (Carnell, Edwards, Croker, Boniface, & Wardle, 2005; He & Evans, 2007; Lundahl et al., 2014). Parental education levels and child's gender show varying results as moderators of this effect (He & Evans, 2007). Our findings are slightly higher than the misperception rates in Spain in 2006/2007 found by Salcedo (Salcedo et al., 2010), who found that approximately 60% of parents misperceived their overweight child as being normal weight for children aged 5-15. However, this is consistent with the increasing trend of misperception of child weight status found by Salcedo in the afore-mentioned study (Salcedo et al., 2010).

The high percentage of misperception of excess weight is thought to be due to a "generational shift in social norms related to body weight" (Hansen, Duncan, Tarasenko, Yan, & Zhang, 2014). Individuals, or parents, gauge their weight status comparing with others rather than assessing their weight status on an absolute scale (Hansen et al., 2014). As obesity prevalence has increased over time so has the perceived normal weight, and a corresponding increase in misperception of child obesity amongst parents has been measured (Salcedo et al., 2010). Parents may also be rejecting the possibility of obesity in their children due to stigma and ideas of victim and parent blaming which appear pervasive in our societies (Eli et al., 2014; Hardus et al., 2003). Concepts of chubbiness in preschool-age children being normal, healthy and a sign of good parenting is also widely accepted and may also contribute to the overall high

misperception of excess weight as the largest proportion of misperception occurs in younger children (Eli et al., 2014; Falconer et al., 2014; Hansen et al., 2014; Hudson et al., 2012; Lundahl et al., 2014).

Child age is strongly associated with underestimation of excess weight with increasing odds of underestimation with a decreasing age. This association is consistent with international studies with younger obese children being less likely to be correctly identified as such (Eli et al., 2014; Hudson et al., 2012; Lundahl et al., 2014). This age related phenomenon is partly associated with visual comparison and partly due to the belief that a little extra chubbiness in early childhood is normal, healthy, a sign of good parenting and will be grown out of (Eli et al., 2014; Falconer et al., 2014; Hansen et al., 2014; Hudson et al., 2012; Lundahl et al., 2014). Interestingly, child gender was not associated with underestimation of excess weight in our study. Other studies have found this association (He & Evans, 2007; Hudson et al., 2012).

In general, there is a negative stigma associated with obesity and there has been much research exploring the psychosocial impact of obesity (Warschburger, 2005). Public perception of obesity often includes judgements of lazy, unintelligent, poor diet, excess food consumption, fewer friends, anxious and other psychosocial impairments (Gray et al., 2009; Hardus et al., 2003; Warschburger, 2005). In this study we included aspects of these and found that aspects of parental psychosocial evaluation of their child were strongly associated with the likelihood of underestimation of excess weight status. Few studies deal with factors outside of child age, gender and socio-economic status when considering parental underestimation of child weight status. However, our results are consistent with a study by Jain *et al* who demonstrated that mothers were not concerned about the weight status of their children if they were physically active and socially accepted (Jain et al., 2001). These results also correspond with studies that demonstrate psychosocial impairment associated with obesity (Warschburger, 2005). These results need further confirmation with specifically designed studies.

Other factors shown to be make up lay perception of child obesity causes include diet, physical activity and modern technology such as television (Hardus et al., 2003). Interestingly in our study these factors overall were not associated with parental perception of the excess weight status of their child. The most likely reason for this difference is that our study measures perceptions of obesity and perceptions of associated factors rather than objective weight status and objectively measured associated factors. Potentially, alongside underestimation of weight status is also a misperception of the lifestyle factors associated with obesity. Therefore if a parent does not identify obesity risk factors in their child the likelihood of misperception of obese status may increase. Perceptions of short sleep duration and weekday television viewing were the only two factors which were associated with an increased correct identification of the overweight or obese status of their child. Videogames, diet and physical activity were not associated. Potentially population obesity education strategies, which have often cited television and sedentary activity is factors to reduce to combat child obesity, have as yet not focused on or included videogames. While parents and the public in general are very aware that diet is a major factor in child obesity (Hardus et al., 2003), a child's diet is influenced by their parents and is likely to be very similar to the parental diet, especially in younger children (Salvy, Elmo, Nitecki, Kluczynski, & Roemmich, 2011). Perceptions of one's own diet are often skewed (Stubbs et al., 2014), and perceptions of their child's weight status may affect reporting of their child's diet (Livingstone, Robson, & Wallace, 2004). Potentially, a parent who considers their own diet to be healthy will also consider their child's diet to be healthy or parents may be unaware they are creating an obesogenic dietary environment. Furthermore, parents may reject the possibility that what they consider occasional treats could be contributing to their child's weight status and maybe too frequent. This also ties into parental blaming and stigma and parents may be resistant to the diagnosis of child obesity when considering family diet (Eli et al., 2014). The statistically significant associations seen in the crude analysis, disappeared when adjusted for age, suggesting that diet patterns observed in our data are more a reflection of age and the decreasing influence of parents and their knowledge of the child's diet with increasing maturity (Livingstone et al., 2004).

Our study showed a number of parental characteristics that were associated with underestimation of child obesity. The odds of underestimation were less than 1 if the parent was female or with excess weight themselves. This is consistent with findings in other studies (He & Evans, 2007; Hudson et al., 2012). Parents who are overweight themselves may be more aware of the potential of obesity in their children and the lifestyle factors influencing that. This was further corroborated by the strong association between parents on a diet and correct perception of their child's excess weight status. The existence of an association between level of education and perception of child excess weight is inconsistent in literature with varying results (Carnell et al., 2005; He & Evans, 2007; Hudson et al., 2012; Salcedo et al., 2010) . In our study the odds of underestimation were less than 1 if the level of parent education was of primary level, this is similar to the findings by Salcedo et al (Salcedo et al., 2010). Non-smokers were also more likely to misperceive their child's excess weight status; possibly because non-smoking status has been shown to be associated with higher health literacy (von Wagner, Knight, Steptoe, & Wardle, 2007).

Overall parental diet, sleep and exercise characteristics were not associated with underestimation of child excess weight. The lack of association with parental dietary factors has been touched on above. However, frequency of fast-food in the parent's diet was associated with underestimation of child's excess weight. Potentially parents are aware of the unhealthy nature of fast food and potential consequences of frequent consumption. This needs further investigation and may tie into health literacy.

We should note some of the study's weaknesses and how they may impact on the interpretation of this study. Firstly, the cross-sectional nature of this study, which does not allow for causal analysis or interpretation and so, all the associations seen in this study could go in either direction. The data were also collected in a subjective manner so all characteristics reflect parental opinion and may be subject to bias. However, the large sample does remove some of this bias and when considering factors influencing parental perceptions of child weight their perceptions of other child characteristics may be more important than objective characteristics.

This study used secondary analysis using data from the Spanish National Health survey. Therefore this is not a study specifically designed to investigate parental underestimation of excess weight in their children. This caused problems with design, its cross-sectional nature, and residual confounding. Lastly we should note that this study is in a Spanish population and therefore some of the parental perceptions may be influenced by cultural nuances and therefore caution should be applied when generalizing results to other populations.

Aside from these weaknesses, this study also has some strengths. The data were collected as part of a large national survey and is representative of the Spanish population. The large sample size is also a strength of this study.

While public health campaigns have raised awareness of child obesity (Hardus et al., 2003), this isn't translating into correct identification of the weight status of parents' own children. Understanding the why, who and how parents misperceive the weight status of their children may be an important aspect in tackling the issue of child obesity. One cannot fix a problem that one does not know exists (Katz, 2015). However, care must be taken not to increase parental awareness and as a result cause issues of stigma or victim blaming. Raised awareness must go hand in hand with combating the stigma, social images and underestimation of the causes of child obesity. This study identifies some characteristics not previously studied, of both the parents and the child, which are associated with under-estimation of child excess weight. These characteristics can be used for consideration in primary care, prevention strategies and for further research. However, more research with specifically designed studies to investigate these associations is needed.

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Table 1: General Characteristics of our sample population **in Spain 2011-12** (Only overweight/obese children; Source: Spanish National Health Survey 2011-12)

	Overall N=914 % (n)	**2-5year olds N=293 % (n)**	**6-9 year olds N=320 % (n)**	**10-14 year olds N=301 % (n)**
General Demographics				
Max Education Level Parents				
Primary	33.0 (302)	28.3 (83)	31.2 (100)	39.5 (119)
Secondary/Tertiary	67.0 (612)	71.7 (210)	68.8 (220)	60.5 (182)
Adult Characteristics				
Responder Nationality				
Spanish	88.5 (809)	85.7 (251)	89.4 (286)	90.4 (272)
Other	11.5 (105)	14.3 (42)	10.6 (34)	9.6 (29)
Age	39.17	37.02	39.05	41.38
BMI	26.43	26.08	26.32	26.89
Sex				
Male	46.7 (427)	51.2 (151)	40.6 (130)	48.5 (146)
Female	53.3 (487)	48.5 (142)	59.4 (190)	51.5 (155)
Father				
Nationality (n=427)				
Spanish	89.2 (381)	86.1 (130)	90.0 (117)	91.8 (134)
Other	10.8 (46)	13.9 (21)	10.0 (13)	10.8 (12)
Age	39.10	37.64	39.43	40.25
BMI	27.4	27.38	27.26	27.55
Mother (n=487)				
Nationality				
Spanish	87.9 (428)	85.2 (121)	88.9 (169)	89.0 (138)
Other	12.1 (59)	14.8 (21)	11.1 (21)	11.0 (17)
Age	39.22	36.3	38.79	42.47
BMI	25.56	24.68	25.66	26.26
Child Characteristics				
Sex				
Male	55.7 (509)	50.5 (148)	53.8 (172)	62.8 (189)
Female	44.3 (405)	49.5 (145)	46.2 (148)	37.2 (112)
BMI (n=3219)				
Male - overweight	19.8 (338)	13.3 (66)	22.6 (111)	22.4 (161)
Male - obese	10.0 (171)	16.5 (82)	12.4 (61)	3.9 (28)
Female-overweight	16.6 (251)	14.8 (65)	20.1 (89)	15.3 (97)
Female - obese	10.2 (154)	18.3 (80)	13.3 (59)	2.4 (15)

Table 2: Under-estimated excess-weight per Age and Sex of children **in Spain 2011-12** (Source: Spanish National Health Survey 2011-12)

		Overall	**2-5 year olds**	**6-9 year olds**	**10-14 year olds**
		% under-estimated (n), 95% CI	% under-estimated (n), 95% CI	% under-estimated (n), 95% CI	% under-estimated (n), 95% CI
Males					
	Overweight	75.7 (256), 70.9, 80.0	93.9 (62), 84.9, 97.7	83.8 (93), 75.8, 89.5	62.7 (101), 55.1, 69.8
	Obese	69.6 (119), 62.3, 76.0	87.8 (72), 79.0, 93.2	60.7 (37), 48.1, 71.9	35.7 (10), 20.7, 54.2
Females					
	Overweight	76.1 (191), 70.4, 81.0	95.4 (62), 86.2, 98.4	76.4 (68), 66.6, 84.0	62.9 (61), 53.0, 71.8
	Obese	77.9 (120), 70.7, 83.8	91.2 (73), 83.0, 95.7	69.5 (41), 56.8, 79.8	40.0 (6) 19.8, 64.3

Table 3: Child characteristics in Spain 2011-12 associated with underestimation of excess weight status (Spanish National Health Survey 2011-12**)**

Child Characteristics	n	Crude OR	P	Adjusted OR*	P
Sex (female reference)	914	0.846	0.280	0.988	0.943
Age (10-14yr reference)	301				
6-9yr old	320	2.039	0.000	***2.010***	***0.000***
2-5yr old	293	7.745	0.000	***7.599***	***0.000***
Perceived Health					
Perceived Health (ok/poor/very poor reference)	73				
Good/very good	841	1.529	0.105	1.718	0.059
Social/Mental Health					
Frequent headache/stomach ache (Yes, somewhat reference)	144				
No	624	1.642	0.011	***1.494***	***0.048***
Loner, plays alone (absolutely, somewhat reference)	163				
No	604	1.718	0.004	***1.743***	***0.004***
Is constantly moving (yes reference)	469				
No	299	0.506	0.000	***0.622***	***0.005***
Cries/is sad frequently (Yes reference)	79				
No	688	1.593	0.059	1.592	0.071
Teased by other children (Yes/Somewhat reference)	152				
No	612	1.538	0.002	***1.871***	***0.002***
Gets along better with adults (Yes reference)	269				
No	499	1.573	0.006	***1.451***	***0.029***
Easily frightened/scared of many things (yes, somewhat reference)	311				
No	457	1.538	0.008	***1.794***	***0.001***
Exercise and Rest					
Sleep duration (adequate reference)	720				

Short	194	0.979	0.910	***1.616***	***0.018***
Exercise (never, occasionally, few times per month reference)	792				
Few times per week	121	1.148	0.531	0.924	0.736
TV weekdays (1+hours daily reference)	631				
Less than an hour	214	1.609	0.014	***1.632***	***0.018***
never	67	3.368	0.003	***3.152***	***0.007***
TV weekends (more than 1 hour)	721				
Less than hour	139	1.814	0.013	1.598	0.064
Never	51	3.483	0.009	1.815	0.054
Videogames weekdays (more than 1 hour)	215				
Less than 1 hour	229	1.495	0.048	1.161	0.488
never	469	2.756	.000	1.430	0.085
Videogames weekends (more than 1 hour reference)	388				
Less than 1 hour	170	1.296	0.203	0.950	0.813
never	353	2.606	0.000	1.192	0.408
Food Habits					
Frequency soft drinks (Never, less than once per week reference)	570				
Few times per week	265	0.732	0.067	1.080	0.679
Daily	78	0.507	0.008	0.750	0.294
Frequency fast foods (daily/few times per week reference)	351				
Never, less than per week	562	1.384	0.036	1.072	0.674
Frequency fruits (daily Reference)	526				
Less than daily	388	0.904	0.515	1.082	0.632
Frequency vegetables (daily reference)	328				
Less than daily	586	1.228	0.193	1.345	0.078

* adjusted for: sex, age, SES

Numbers in bold indicate significant p value.

Table 4: Adult parent characteristics in Spain 2011-12 associated with underestimation of child excess weight status (Source: Spanish National Health Survey 2011-12**)**

Adult Characteristics	**n**	**Crude OR**	**P**	**Adjusted OR***	**P**
Sex (female reference)	362				
male	182	1.975	0.002	**2.101**	**0.001**
Age[#]	544	0.974	0.083	1.035	0.085
SES Household (secondary/tertiary Reference)	366				
Illiterate/Primary	178	0.638	0.025	**0.609**	**0.017**
Health/Quality of Life					
Perceived QoL	543	1.026	0.000	**1.024**	**0.000**
Smoking (smoker reference)	207				
No/ex-smoker	337	1.793	0.003	***1.779***	***0.004***
Weight Status (obese/overweight reference)	299				
Underweight/normal weight	232	1.686	0.010	***1.904***	***0.003***
Exercise/Rest					
Sleep duration (<8hours reference)	302				
8 or more hours	242	0.780	0.200	0.826	.333
Activity during Free time (several times per week reference)	41				
None, occasionally	502	0.987	0.971	1.208	.617
Food Habits					
Frequency sugary drinks (once or more per week reference)	246				
Never, less than 1 per week	297	0.995	0.978	1.099	.639
Frequency Fast food (once or more reference)	183				
Never, less than once per week	361	0.526	0.003	***0.603***	***0.025***

Frequency vegetables	521				
Never, less than once per week	23	1.051	0.918	1.173	0.749
Frequency fruit	489				
Never, less than once per week	55	0.672	0.187	0.665	0.190
On Diet (no reference)	505				
Yes	39	0.400	0.007	***0.423***	***0.013***

*Adjusted for sex, age, and educational level

#Adjusted for sex, child age, and household educational level

Numbers in bold indicate significant p value.

6. Discussion

6. Discussion

In this chapter we will consider the principal findings of the studies presented in this thesis, reflect on the findings and their implications, and discuss some of the methodological considerations. This chapter is not intended to be exhaustive as much of the findings have already been discussed in each of the individual studies presented.

6.1 Methodological considerations

The articles presented in this thesis use two different datasets. There are similarities between the two however their design purposes differ significantly. While the methods and their strengths and weaknesses were briefly discussed in each of the studies presented, as was the specific methodological limitations specific to the study, a few points should be discussed again here in more detail.

The principal and most important difference between the two datasets is their purpose. The NHS dataset is collected for national health status and statistics. Whereas the data used in the first article came from a data collected in a study designed specifically to investigate childhood obesity. This did cause issues with study design and may have caused residual confounding. However, the use of two different data sets proved beneficial in that the prevalence of excess weight in the childhood obesity specific dataset confirmed and was consistent with that of the NHS.

Despite the NHS data not being specifically collected for childhood obesity research, the secondary data analysis and results are likely to be valid and provide a good base (or bird's eye view) for national obesity research for a number of reasons (González Montero de Espinosa, Herráez, and Marrodán Serrano 2013). Firstly, the large sample size and representativeness of the Spanish population – an important consideration for external validity. Secondly, due to

questions being standardised and consistent over time. Use of secondary data sets also avoid issues with cost and limited study/PhD time (Smith et al. 2011).

Other short comings of the NHS data are the subjective nature of the data collected. All data are collected in a subjective manner possibly introducing bias. However, the large sample size does attenuate somewhat this bias. Of particular note is that the anthropometric data were collected in a subjective manner in this study. Parent-reporting of child's height and weight may over-estimate obesity in younger children and underestimate in adolescents (Weden et al. 2013b). However, this method is widely used and considered to have an acceptable level of validity in population-based studies (Garcia-Marcos et al. 2006). A study of Spanish children reported a sensitivity and specificity of obesity diagnosis based on parental reported weight and height to be 78 and 96% (Garcia-Marcos et al. 2006). The subjective nature of these measurements will not change the trends observed, unless the over/under estimation bias changes over time. Furthermore, the first article presented uses objective anthropometric data and corroborates to some extent the prevalences measured in the other articles. In the fourth article the subjective response of parents was the desired variable and hence not a shortcoming for that study.

The use of national survey data allowed for analysis of nationally representative data collected with standardised methodology over two decades. This was also a strength for the articles investigating trends. The same questions were used in each survey year for height and weight measurements, increasing comparability between surveys. This study was also able to demonstrate trends over a 24 year time period, from those born in 1973 to those born in 2009. However, the proportion of missing data was higher in the early survey years. Although study samples were large, we cannot rule out a non-responder effect which may explain the larger fluctuations seen during this time period. Sample sizes were variable for different survey years and the sub-sample autonomous communities. Furthermore, there is an association between

autonomous community and excess weight prevalence; this was adjusted for in global prevalence calculations.

The short comings of cross-sectional studies are well-documented. The most important being the inability for causal analysis and interpretation. Theoretically all associations found could go in either direction. Also any causation with time lag may be missed. Associations found may also be due to a common upstream cause or confounding. Nevertheless these study types do provide useful information and a point from which to base further research. Additionally, this study type maybe the only feasible or practical one for a specific research question or due to study time constraints.

The definition of socio-economic status (SES) may influence study results and associations found. In three of the studies presented in this thesis highest level of parental education was used as an indicator of SES rather than income or occupation. While there are clearly connections between these three, this indicator was used for consistency across surveys, ease of use and due to evidence that education level may have greater influence on healthy lifestyle choices than income level (Galobardes et al. 2006; Kvaavik et al. 2012); especially considering the employment and economic climate in Spain following the recent economic crisis.

6.2 Summary of main findings and reflections

6.2.1 Trends and prevalences

The studies presented in this thesis demonstrate that overall prevalence of excess weight has not increased from 1987 to 2012. However, there were fluctuations and the trends differ between sexes and age groups. The prevalence measured in 2010/2012 in the articles using either dataset showed similar prevalences and highlighted particular demographic groups of concern.

The prevalence plateau found using the NHS data is consistent with both national and international studies. The most well-known national study is the Estudio Cuenca which showed a large increase in overweight prevalence from 1992 to 2004 (24% to 31%) (Martinez-Vizcaino et al. 2009). However, this study is limited to children in the province of Cuenca and aged 6-10 years and therefore may not be comparable to Spain as a whole due to regional differences. The different age range also makes comparison more difficult. Martinez-Vizcaìno et al published a further study in 2015 demonstrating a reversal of excess weight between 2000 and 2008 (Martínez-Vizcaíno et al. 2015). Another study undertaken in central Spain showed similar results to the study presented in this thesis (Gonzalez Garcia et al. 2015). When comparing results we need to keep in mind the age groups and ranges studied, the definition of obesity used, the region, and the inclusion/exclusion criteria. Each of these can influence results and make comparison difficult or impossible, i.e. comparing apples with oranges.

Internationally the trend results are consistent with data published from many countries showing an unexpected stabilization of trends and even a reversal of trends (Switzerland). These countries include Denmark, France, Sweden, Australia, New Zealand, the USA as well as others. A 2014 study compiled the data of numerous different developed countries all which showed an as yet unexplained stabilization of obesity rates, the data from the US also showed the biggest decrease in the trend occurring in the pre-school age group (2-5 year olds)(Wabitsch, Moss, and Kromeyer-Hauschild 2014). Despite these findings being documented for many years, obesity research and prevention strategies continue to be sold and promoted with alarmist rhetoric such as 'child obesity is increasing exponentially'.

Despite a plateau in childhood obesity prevalence, childhood obesity remains a significant public health problem and need urgent strategies to reverse as the prevalence plateau is at too high a level. With obesity in childhood and adolescence having been shown to be associated with pre-diabetes and cardiovascular risk profiles (Ram Weiss et al. 2003) and strongly

associated with cardiovascular outcomes and mortality in middle age (Twig et al. 2016a) early life years are an important time for research and prevention of excess weight and its consequences. More importance needs to be placed on primary prevention with focus on modifiable risk factors, extending primary intervention into childhood and adolescence.

6.2.2 Factors associated with child obesity in Spain

In this thesis the findings of three studies present various factors associated with childhood obesity. Some of these factors are known and well established and our findings reiterate their importance. When considering these factors and prevention strategies there are two questions to consider: 1) how modifiable are they? And 2) what level are they - individual, environment? As mentioned in previous chapters children are very dependent on the adults around them in terms of lifestyle choices. This includes the family, school and neighbourhood environments.

Factors presented here include diet, exercise and perceptions of the neighbourhood. While dietary and exercise do fit into the energy balance equation this explanation is still too simplistic and is intertwined with other variables. However this is a good base for promoting healthy populations and obesity prevention. The lack of association found in article 1 may be due to the subjective nature of questionnaires and the study being cross-sectional. Also the factors were integrated rather than studied individually. Furthermore other early life exposures may be more important and modify these associations, e.g. antibiotics, endocrine disruptors, epigenetics. These are beyond the scope of this thesis and still require a lot of research.

Socio-economic status is a factor often cited in relation to obesity. The relationship between SES and obesity is complex and not entirely consistent between developed countries although it is generally thought that low SES is associated with higher prevalence of obesity due to consumption of a high calorie diet. However this does not hold true for some western

countries. A recent editorial discusses this complexity and bidirectional nature(Wang and Lim 2012), citing studies that show how this association depends on gender, age and country, and concludes that with the obesity epidemic may come a weakening of this association or even a reversal. This may explain some of the differences found in this association in international literature. The definition used may also impact on any associations found.

6.2.3 Trends in sleep duration and association with child obesity

Sleep duration is a potentially modifiable factor focused on in particular in this thesis. We presented findings showing that sleep duration in Spain has decreased over the last decades, is less than other European children and is associated with childhood obesity. While sleep duration may on the one hand be an individual factor, on the other it is affected by cultural and societal beliefs and practices regarding bedtimes and sleep requirements. However, physiological sleep requirements for children are not an exact science and still not well established. What may be considered "normal" or "common" sleep duration may not necessarily be sufficient.

While our findings of an association between sleep duration and obesity is consistent with international literature (World Health Organization 2015a; Ekstedt et al. 2013; Nixon et al. 2008), there are still many questions regarding mechanisms, nature of the association and an apparent variability of sleep requirements internationally. Potentially circadian rhythm and sleep timing at different ages are more important than actual sleep duration (Golley et al. 2013b; Miller et al. 2014), with the seen association between sleep duration and obesity being a partial reflection on this; later bedtimes are associated with shorter sleep duration (L Matricciani, Olds, and Petkov 2012). A more recent article also showed that a regular routine in bedtime at an early age was associated with less obesity at age 10, suggesting self-control behaviours as a potential pathway between the two (Anderson et al. 2017).

While a lot of research still needs to be done, it is clear that ensuring regular and sufficient sleep hours during childhood is a behaviour that can be promoted to combat child hood obesity.

6.2.4 Parental underestimation of child excess weight status

The final study presented found that parents in Spain have difficulty correctly identifying excess weight in their children. This misperception is associated with various characteristics of both the parents and the child. While parents alone are not enough to combat childhood obesity (I.Family Study 2017) their involvement is crucial(Hansen et al. 2014; Shrewsbury et al. 2011). For parents to make the required changes first they need to correctly identify obesity in their children and subsequently be motivated and have the resources and support to intervene. The last article presented shows high rates of misperception of child obesity in Spain. Furthermore, rates of misperception are associated with parental perceptions of their children, their behaviours and also parental characteristics. Younger obese children are more likely to be considered normal weight than older children. A finding consistent internationally and likely due to the common misperception that a chubby child is well fed and the result of good parenting (Falconer et al. 2014; Eli et al. 2014).

The study presented goes on to show factors associated with misperception and underestimation of child obesity in Spain. Aside from demographic factors which are consistent with international studies, a parent's perception of their child s social and mental health is also associated with misperception and underestimation of child obesity. A happy social child with obesity is less likely to be perceived as overweight or obese by their parent. This is somewhat consistent with results published in the UK however that study did not go into as much detail and was more qualitative in nature focusing on parental comments that they may recognise obesity if their child suffered from negative social consequences(Eli et al.

2014). As far as I am aware this is the first study that investigates this and these concepts tie into stigma and societal beliefs and views of obesity. However, a specifically designed study is needed to investigate this more and detangle parents' beliefs and expectations of their own children with regards to obesity. Especially as increased public awareness of child obesity and its consequences is not translating to correct identification of child obesity in one's own children. Understanding this would enormously in designing prevention and treatment programmes at individual, family and population levels.

7. Conclusions

7. Conclusions

Childhood obesity in Spain has overall remained relatively stable over the last two decades with some fluctuations. However, some sub-groups have experienced an increase in obesity prevalence. While the obesity plateau is consistent with findings in other developed and European countries, the prevalence is at too high a level and remains a major public health concern. Particularly when considering the potential lifelong consequences and resulting health burden, both from an individual and country-level perspective.

Childhood obesity does not result from a simple energy balance equation, but has a multi-factorial etiology which is still not fully understood. Many studies point to early exposures, obesogenic environments and gene-environment interactions. As further demonstrated by the studies included in this thesis, as well as many of those referenced, there are many modifiable factors associated with childhood obesity. These factors include dietary aspects, physical activity and sleep duration. Public health strategies need to focus on modifiable behaviours and environments with strategies appropriately developed and targeted at the most effective level (individual, family, school, at risk population or population).

Sleep duration is a modifiable factor associated with childhood obesity, as mentioned above, which was demonstrated in articles included in this thesis as well as many international studies. Child sleep duration has deceased overall in Spain over the last two decades: a trend similar to international trends. The long term implications of this are still unclear. However, with the association between lack of sleep and long term poor health outcomes, in particular obesity, sleep duration should be considered a modifiable lifestyle factor and public health issue. Further investigation is required into physiological sleep requirements and influencing factors as there is large variation in individual and inter-country sleep duration. What may be considered “normal” or “common” sleep duration may not necessarily be sufficient.

To successfully combat childhood obesity the involvement of parents is crucial. Children, especially younger children, are dependent on their parents for diet, modeling of healthy behaviours, and the provision of an environment conducive to exercise and sleep (as much as their own situation SES allows). However, we don't fix what we don't know is broken. If parents are not aware of their child's excess weight status they are unlikely to implement measures to help. In Spain, rates of misperception of child obesity are very high particularly with younger children. Not only do demographic characteristics of parents affect the likelihood of correctly identifying their children with excess weight, but also their perception of their child affects correct identification. Considering a child to be active, happy and few social issues decreases the likelihood of parents to correctly identify obesity in that child. More work and research is needed in this area.

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