Universitat Autònoma de Barcelona

Overweight in Preschool Children: Behavioral Problems and Early Risk Factors

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Doctoral Thesis

Overweight in Preschool Children: Behavioral Problems and Early Risk Factors

by

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To Manel,

You are the love of my life

I will go everywhere with you

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I would like to express my heartfelt gratitude to all those who helped me to complete this thesis.

First, my thanks go to my parents, Immaculada Bonaventura Ibars and Anastasi Pérez Peral. They were the first to stress the importance of doing a research project and completing a Doctoral Thesis in the area that I was passionate about. Since I was little they taught me to study, to read, to sum up the important concepts while I was learning. I have been a happy, cheerful, energetic person from the day I was born. But it was my parents who really helped me develop my natural talents as much as possible by encouraging me every day to learn, and made me the person I am today. I love reading, writing and studying because of you. You have always loved me, supported me and encouraged me to find my own way in life.

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ACRONYMS

ADHD	Attention-deficit/hyperactivity disorder
APQ	Alabama Parenting Questionnaire
ASR	Adult Self Report
BMI	Body mass index (weight / height^2)
CBQ	Children's Behaviour Questionnaire
CDC	Center for Disease Control and Prevention
DICA	Diagnostic Interview for Children and Adolescents for Parents of Preschool and Young Children
IOTF	International Obesity Task Force
OECD	Organization for Economic Co-operation and Development
SES	Socio-Economic Status
SD	Standard Deviation
SDQ	Strengths and Difficulties Questionnaire
SRF	Schedule of Risk Factors
WHO	World Health Organization

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PROLOGUE

This thesis, presented in the International Ph.D. framework, is a part of a major project focused on psychopathology and risk for behavioral problems in preschool children. The general goal of this thesis is to study relevant factors related to overweight at an early stage of development, the preschool years, in a southern European country, Spain. Despite overweight being a complex health issue, this thesis tries to address two fundamental questions: 1) Is there a relationship between overweight and behavioral problems as early as in the preschool years? 2) What are the factors contributing to overweight in preschool years? Each one of the research questions leads to two exhaustive investigations presented in this dissertation:

1) Analysis of the relationship between behavioral problems and overweight in preschool children.
2) Assessment of the risk factors for overweight in preschool children.

The findings of the first study carried out in this dissertation have been published in the Journal of Pediatric Psychology:

- Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2015) The Relationship Between Weight Status and Emotional and Behavioral Problems in Spanish Preschool Children. *Journal of Pediatric Psychology*, *40*(4), 455-463. doi: 10.1093/jpepsy/jsu107

The findings of the second study carried out in this dissertation are currently in the process of revision:

- Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2016) *Risk Factors for Overweight in early ages: longitudinal design with Spanish Preschoolers.* Manuscript submitted for publication.

The findings of the first and the second study have been presented and discussed in the following academic events:

- Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2014, October). *A cross-sectional and longitudinal study of the relationship between weight status and*

psychological problems in children. Poster presented at the 10th Congress of the Catalan Society of Child Psychiatry, Barcelona, Spain.

- Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2014, October). T*he relationship between weight status and emotional and behavioral problems among Spanish preschoolers*. Poster presented at the Strategic Research Community in Mental Health, Barcelona, Spain.

The investigation carried out in this thesis has been awarded:

- Best research poster. Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2014, October). A cross-sectional and longitudinal study of the relationship between weight status and psychological problems in children. Poster presented at the 10th Congress of the Catalan Society of Child Psychiatry, Barcelona, Spain.

Furthermore, during the development of the thesis, a grant from Alicia Koplowitz Foundation facilitated a stay at Yale University School of Medicine, United States, for 5 months in 2014. Wendy Silverman, from the Yale Child Study Center, supervised the stay and provided substantial training in research and clinical fields in child clinical psychology.

ABSTRACT

Childhood overweight is a public health concern that poses serious threats to children's health and is being found at ever younger ages. **Objectives:** To examine cross-sectional and longitudinal associations between behavioral problems and weight status, and to identify risk factors in early life for overweight in preschoolers. **Methods:** A community sample of *n*=622 three-year-olds was followed until the age of 5, their height and weight and psychopathology were registered annually. The Strengths and Difficulties Questionnaire, the Diagnostic Interview for Children and Adolescents, and the Schedule of Risk Factors were administered to their parents. Weight status considered body mass index (BMI) and overweight status defined by World Health Organization standards. Statistical analysis included general linear models and binary logistic regressions. **Results:** Children who were overweight and had a higher BMI were at increased risk of having peer problems and attention-deficit/hyperactivity disorder (ADHD) symptoms. Prospective analyses showed that a higher BMI at the age of 3 years was predictive of higher scores in the peer problems dimension at ages 4 and 5 years and higher scores in the hyperactivity dimension and ADHD symptoms at the age of 4 years. Furthermore, two strong risk factors for overweight and a higher z-BMI in the preschool years were a family's low socioeconomic status and high birth-weight. **Conclusions**: This is the first study using a psychological diagnostic-based instrument that shows a relationship between weight status and ADHD symptoms in preschoolers. Overweight children might benefit from screening for behavioral disorders and peer relationship problems. Moreover, identification in early life of groups of children at higher risk of becoming overweight offers the potential for early prevention programs.

CHAPTER ONE:

INTRODUCTION

1. INTRODUCTION

1.1. Overweight and Obesity in children

1.1.1. Definition and terminology

In medical sciences, obesity is a term used to describe the abnormal or excessive accumulation of fat in adipose tissue to the extent that it presents a risk to health (World Health Organization, 2000). Adipose tissue is an essential part of the human body located beneath the skin and around internal organs. It consists of fat cells, called adipocytes, which store and mobilize essential and non-essential lipids of the human body. Moreover, adipocytes are also active endocrine organs, with multiple metabolic roles in regulating whole-body physiology (Greenberg & Obin, 2006). In addition to multiple external factors, many proteins secreted by the adipocytes may be of a key importance in the regulation of fat storage and total body energy balance (Frayn, Karpe, Fielding, Macdonald, & Coppack, 2003). However, since the amount of adipose tissue is a continuous trait, determining excessiveness or identifying a specific cut-off point after which the associated adverse health consequences would emerge is difficult. Thus, giving a specific definition of obesity and overweight is problematic in that there is no clearly defined point at which body fat becomes excessive. Furthermore, individuals differ not only on the amount of fat but also in the distribution of that fat within the body.

While obesity refers to excess adipose tissue, overweight can be defined as body weight above a pre-defined reference level. In children and adolescents the terminology has not been well established, and, consequently, terms such as “overweight”, “obesity”, and “at risk of overweight” have erroneously been often used interchangeably, despite the fact they are not identical (Kain, Uauy, Vio, & Albala, 2002). Clinically, overweight and obesity imply different conditions where obesity is a severe form of overweight.

In the preschool years, the World Health Organization (WHO) has implied that the term overweight is the term that should be used to address research regarding weight issues in children below 5 years old (World Health Organization, 2006). The WHO cut-off is considered to be suitable for international research. It is also considered to be a

conservative cut-off given that various definitions of overweight in preschool years all apply lower cut-offs than the one WHO uses. For purposes of this research, the term overweight will be used in preschool years, whereas the terms obesity and overweight will be used in school-aged children, adolescents and adults.

Obesity and overweight are complex, multifactorial and chronic conditions that involve the interaction of both genotype and environment. Obesity and overweight have also been defined as a result of a long-term imbalance between an individual's food intake habits and physical activity levels (World Health Organization, 2012).

1.1.2. Incidence and prevalence

1.1.2.1.The global picture

Over the last 30 years, there has been a worldwide increase in the prevalence of overweight and obesity, becoming a major public health concern that requires urgent action (Ogden et al., 2006; Wang & Lobstein, 2006).

Recently, the WHO (2014) reported that 39% of adults aged more than 18 years are overweight (39% men and 40% of women) and 13% are obese (11% of men and 15% of women). Thus, alarmingly, nearly 2 billion adults worldwide are overweight and, of these, more than half a billion are obese.

The prevalence of overweight and obesity is highest in the WHO regions of the Americas (61% for overweight in both sexes, and 27% for obesity) and lowest in the WHO region for South East Asia (22% overweight in both sexes and 5% for obesity). In the WHO region of the Americas and European and Eastern Mediterranean regions over 50% of women are overweight. In all three of these regions, roughly half of overweight women are obese (25% in Europe, 24% in the Eastern Mediterranean, 30% in the Americas). In all WHO regions women are more likely to be obese than men. In the WHO African, Eastern Mediterranean and South-East Asia regions, women have roughly double the obesity prevalence of men. The prevalence of raised body mass index increases with the income level of countries. The prevalence of overweight in high income countries is more than double that of low and lower middle income countries. For obesity, the overall prevalence is over four times higher in high income

countries compared to low income countries. Women's obesity is markedly higher than men's, with the exception of high income countries where it is similar. In low and lower middle income countries, obesity among women is more than double that among men. Figure 1 and Figure 2 shows the mean body mass index (BMI) in all the countries of the world.

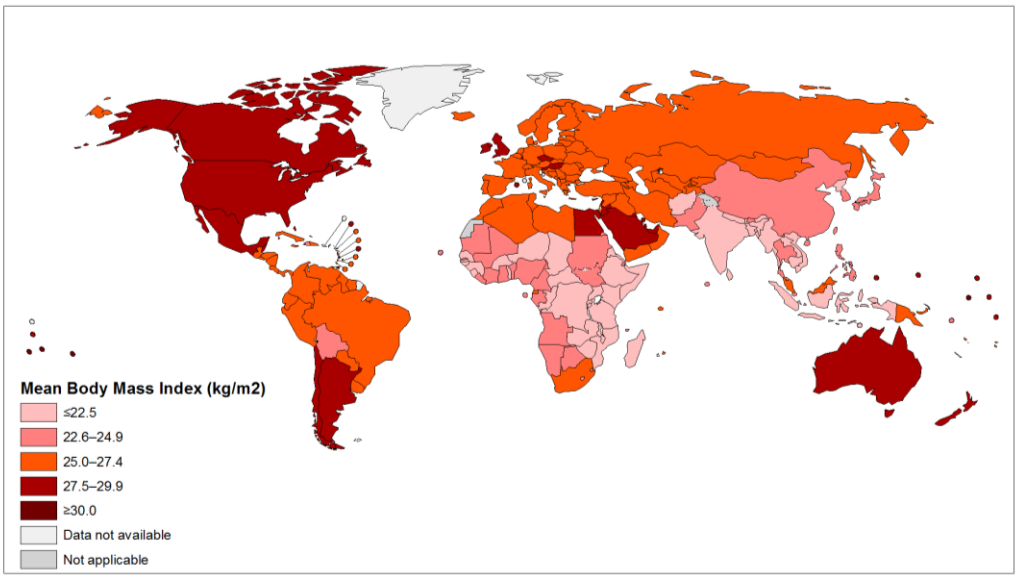

Figure 1. Mean body mass index (kg/m^2) for men ages 18+ by the World Health Organization (2014).

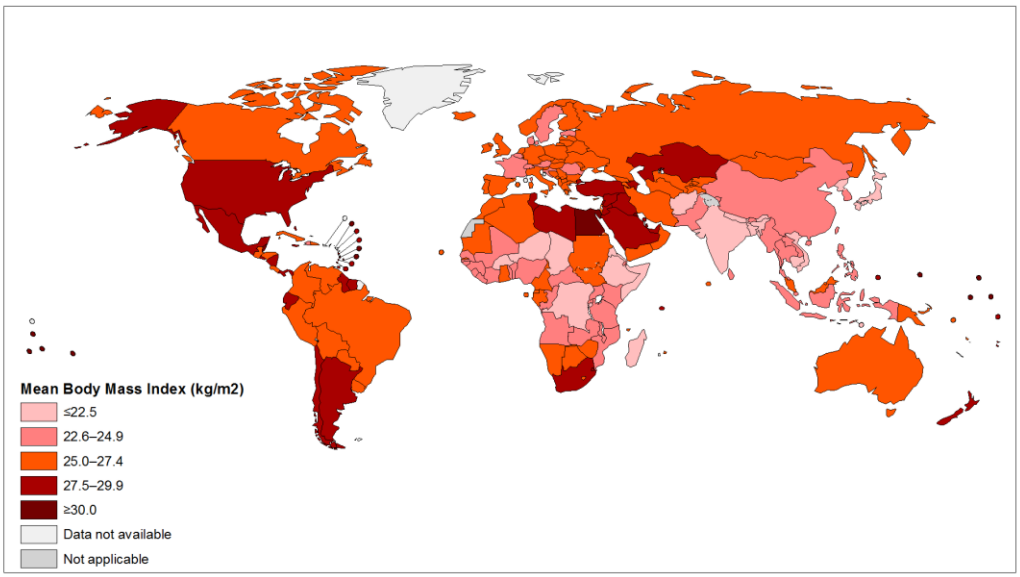

Figure 2. Mean body mass index (kg/m2) for women ages 18+ by the World Health Organization (2014).

Obesity in children has followed the same trend as adults. Alarmingly, childhood overweight and obesity has increased dramatically throughout the world over the last thirty to forty years (de Onis, Blössner, & Borghi, 2010).

In developed countries, trend data is more readily available for school-aged children. The International Obesity Task Force (IOTF) estimates that 10% of children age 5 to 17 are overweight or obese worldwide (Lobstein, Baur, & Uauy, 2004). This equates to 155 million children, 30-45 million of which are obese. Nevertheless, the issues with prevalence data in children are compounded by the lack of consensus on defining obesity, which means that this is likely to be an underestimate. Whilst the highest rates of obesity in children are in developed areas of the world such as North America and Western Europe, developing countries are facing rising rates of obesity. This is particularly seen in countries undergoing rapid socioeconomic growth such as Brazil and China, where the prevalence of overweight and obesity in children and adolescents has risen sharply in recent years. Figure 3 demonstrates the increase in prevalence of combined overweight and obesity seen in a number of countries between 1970 and 2005. Significant variation exists between countries in both absolute prevalence rates and the rate of change, however the Figure 3 demonstrates increasing rates in both developed (New Zealand, USA, Canada, England, Australia) and developing (Brazil and China) countries.

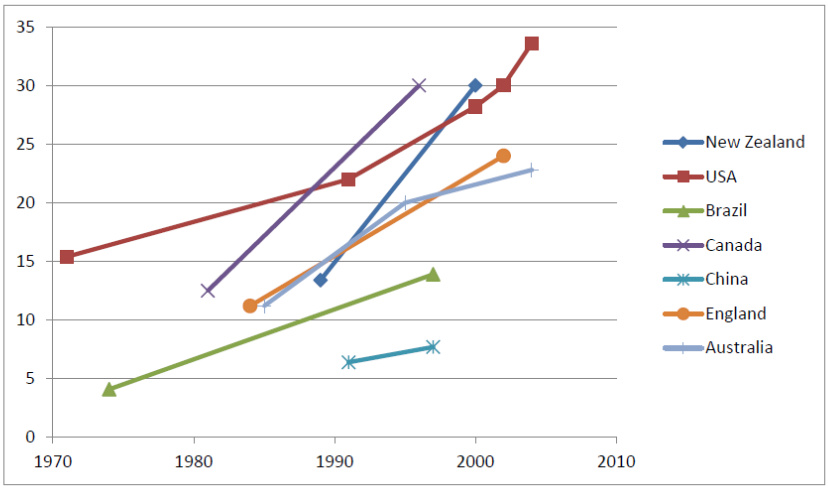

Figure 3. International trends in the prevalence of overweight (including obesity) in school-aged children 1970-2005 by IOTF (2015).

In the developed world, the USA provides an example of the severity of the obesity problem (Figure 4). In US children, obesity prevalence has risen from 6% in 1980 to 17% in 2008 (Division of Health and Nutrition Examination Surveys, 2012).

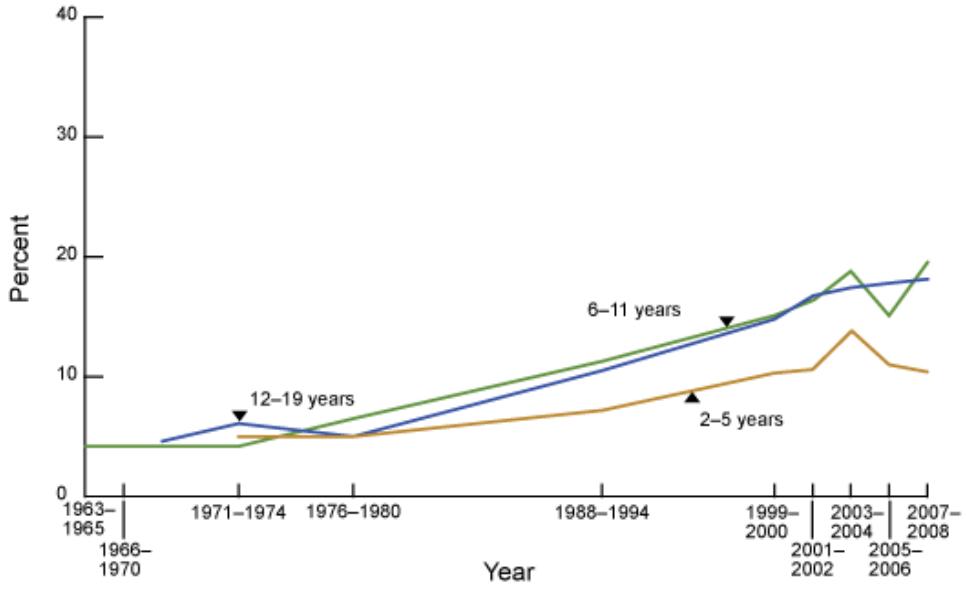

Figure 4. Trends in obesity among children and adolescents: United States, 1963-2008 by the National Health Examination Surveys and National Health and Nutrition Examination Surveys (2008).

In Europe, the trend of childhood obesity is following the US, with prevalence increasing across all European countries. About 20% of children is identified as overweight and obese according to the IOTF classification and 28.4% is identified as overweight and obese when using the WHO classification. However, there is a clear North-South gradient with the highest prevalence being in southern European countries. The highest proportions are observed in southern Italy, followed by Cyprus and Spain (Ahrens et al., 2014).

Amongst children aged less than five years, the global prevalence of overweight (including obesity), defined as weight for height greater than two Standard Deviations (2SD) above the WHO Child Growth Standard median (World Health Organization, 2006), is estimated to have increased from 4.2% in 1990 to 6.7% in 2010, a relative increase of 60% (de Onis, Blössner, & Borghi, 2010). Prevalence rates are higher in developed countries than developing countries (11.7% compared to 6.1% in 2010), however the rate of increase over this period is greater in developing countries. These

figures equate to 43 million infants (aged 1 month to 5 years) worldwide who are overweight or obese and 92 million are at risk of becoming overweight. The vast majority of overweight or obese children live in developing countries, where the rate of increase has been more than 30% higher than that of developed countries. If current trends continue, the number of overweight or obese infants and young children globally will increase to 70 million by 2025 (de Onis, Blössner, & Borghi, 2010).

1.1.2.2.National trends

Adult's obesity rates are high in Spain compared to the Organization for Economic Co-operation and Development (OECD) countries. The OECD consists of 34 member countries around the globe, from North and South America to Europe and Asia-Pacific. Nowadays, one in 6 adults is obese in Spain, and more than 1 in 2 is overweight (Organization for Economic Co-operation and Development, 2014). The latest data show that the proportion of adults who are overweight has generally increased over recent years although at a slower pace than foreseen by previous OECD projections (Figure 5).

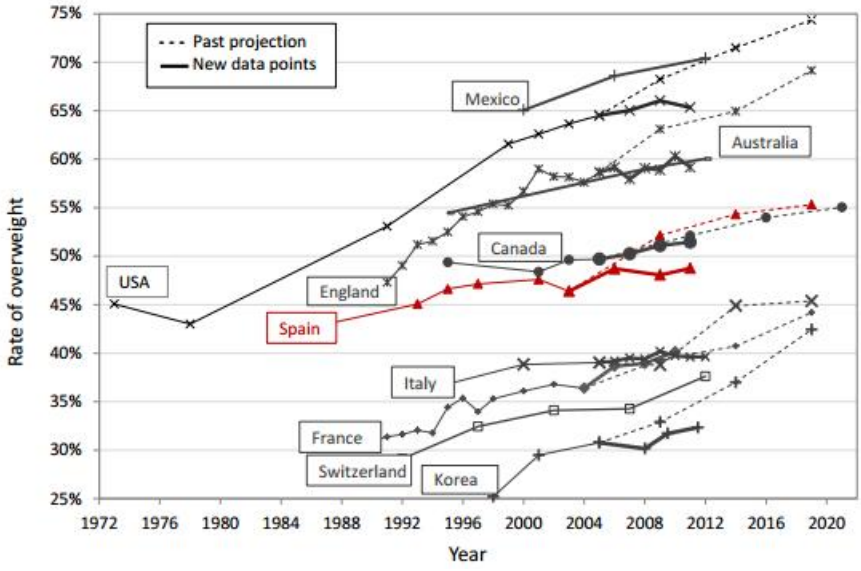

Figure 5. Trends in the prevalence of overweight (including obesity) in adults, projections and recent estimates, selected OECD countries by OECD estimates based on national health surveys (2014).

Recent research has found that in the last 10 years the trend towards obesity in adults and children has begun to stabilize in most rich countries. Specifically, the epidemic of childhood obesity had leveled off in Australia, United Kingdom, Denmark, Switzerland, New Zealand, France, Greece, Netherlands, Sweden and the United States (Olds et al., 2011; Rokholm, Baker, & Sørensen, 2010). A recent study in Spain has found that, from 1987 to 2007, the prevalence of overweight and obesity in boys and girls aged 5 to 9 years has levelled off across Spain (Miqueleiz et al., 2014). Nevertheless, the prevalence of children with either obesity or overweight is still alarming.

Child overweight rates are high in Spain, in comparison to other OECD and key partner countries (Figure 6). International data collated by the International Association for the Study of Obesity show that 26% of boys and 24% of girls are overweight in Spain, compared with 23% of boys and 21% of girls, on average, in OECD countries (OECD, 2014).

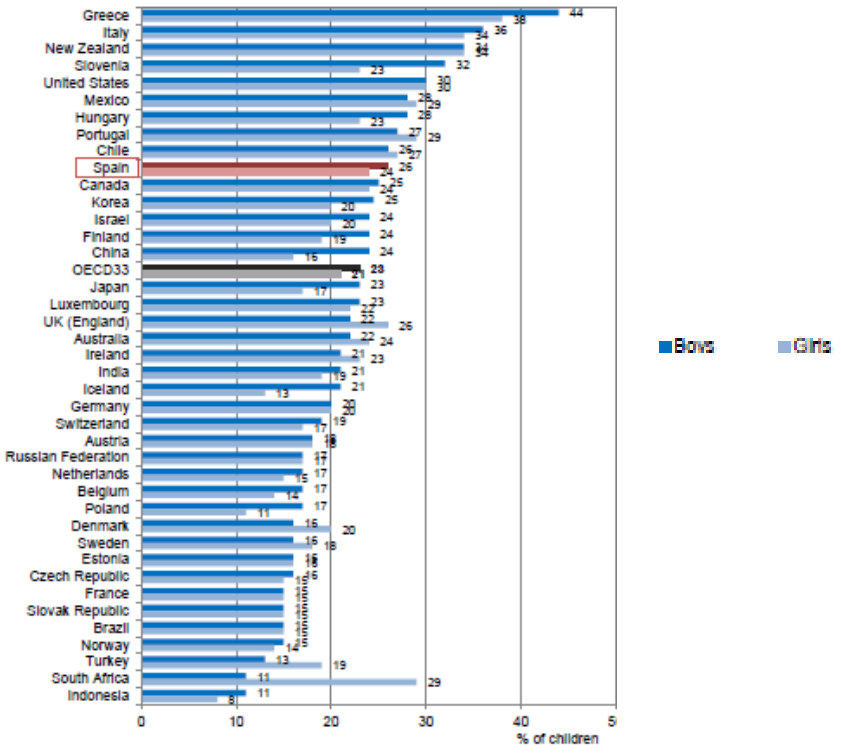

Figure 6. Measured overweight (including obesity) among children at different ages, 2010 or nearest year by the International Association for the Study of Obesity (2013).

Table 1 shows that, in Europe, Spain is the third country with the highest prevalence of overweight and obesity in children aged from 2 years to 10 years (Ahrens et al., 2014). Several studies reveal that children residing in southern European countries show the highest prevalence of overweight and obesity.

Table 1. Prevalence of weight categories by sex and country

Region	*Italy*		*Estonia*		*Cyprus*		*Belgium*		*Sweden*		*Germany*		*Hungary*		*Spain*		*All*	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Boys																		
Thin	72	5.7	120	11.9	164	11	180	15.1	121	12.9	120	10.8	262	16.9	63	8	1102	11.8
Normal weight	672	53.5	750	74.3	993	66.7	914	76.7	720	77	829	74.8	1033	66.5	579	73.4	6490	69.6
Overweight	261	20.8	103	10.2	211	14.2	76	6.4	72	7.7	118	10.6	158	10.2	103	13.1	1102	11.8
Obese	250	19.9	36	3.6	121	8.1	22	1.8	22	2.4	42	3.8	100	6.4	44	5.6	637	6.8
All	1255	100.0	1009	100.0	1489	100.0	1192	100.0	935	100.0	1109	100.0	1553	100.0	789	100.0	9331	100.0
Girls																		
Thin	51	4.4	143	13.5	180	12.4	152	13.1	102	11.5	101	9.3	266	16.6	63	8.4	1058	11.5
Normal weight	602	51.5	757	71.6	916	63	883	76.1	680	76.5	783	72.2	1048	65.3	508	67.7	6177	67.4
Overweight	284	24.3	114	10.8	231	15.9	92	7.9	88	9.9	140	12.9	191	11.9	128	17.1	1268	13.8
Obese	232	19.8	44	4.2	126	8.7	33	2.8	19	2.1	61	5.6	101	6.3	51	6.8	667	7.3
All	1169	100.0	1058	100.0	1453	100.0	1160	100.0	889	100.0	1085	100.0	1606	100.0	750	100.0	9170	100.0

Source: Ahrens et al. 2014

Amongst children aged less than five years, the prevalence of overweight and obesity in Spain has risen in the last thirty years. Nowadays, obesity has reached epidemic proportions in Spain. According to a recent systematic review of studies from the 27 countries in the European Union, Spain had the highest rate (just over 32%) and Romania had the lowest rate, about 12% (Cattaneo et al., 2014).

In 2012, the researchers from the ToyBox-study reported that kindergarten children in Spain top the league for the most overweight and obese preschool youngsters (van Stralen et al., 2012). The team of ToyBox examined over 7000 children in 300 kindergartens in six sample countries: Poland, Spain, Greece, Bulgaria, Germany and Belgium. They found that 16% of the children aged 3-5 years were overweight or obese in Spain (Table 2).

Table 2. Percentage of overweight or obesity in children aged 3.5-5.5 years

	Germany	Belgium	Poland	Bulgaria	Spain	Greece
Overweight	8.0%	9.5%	10.4%	11.0%	11.9%	14.0%
Obese	1.9%	2.1%	2.4%	4.2%	4.1%	5.7%
Total	*9.9%*	*11.6%*	*12.8%*	*15.2%*	*16.0%*	*19.7%*

Source: ToyBox study (2012)

Furthermore, the researchers also found that nearly a quarter (24%) of all children aged 5-6 years old were overweight or obese in Spain, in contrast with Germany where fewer than 10% carried excess weight.

1.1.3. Measurement

Measuring the level of adipose tissue and determining when it is likely to affect health is not an easy task. There are a range of techniques of body fat assessment in children, classified in direct methods and indirect methods (Table 3). Direct or criterion methods measure a property of the body, such as its density, or describe amounts and distributions of skeletal, muscle, and adipose tissues via X-ray or magnetic imaging techniques. However, most of these methods require costly equipment meaning that their use is very limited. Indirect methods provide estimates or indices of body composition based on results from direct or criterion methods. Indirect methods depend on biological interrelationships among direct or criterion measured body components and tissues and their distribution among normal individuals (Duren et al., 2008).

Table 3. Methods for measuring body composition.

Direct methods
Underwater body density measurement
Dual-Energy X-ray Absorptiometry (DXA)
Computer tomography (CT)
Magnetic resonance imaging (MRI)
Air displacement plethysmography
Indirect methods
Bioelectrical impedance analysis (BIA)
Antrophometric measures
Weight
Weight-for-height
Body Mass Index (BMI)
Skinfold thickness
Waist circumference
Waist-to-hip ratio (WHR)
Other weight/height indices

Because the direct measures of body fat are expensive and of limited access (Cole & Rolland-Cachera 2002; Pietrobelli, Heo, & Faith, 2001), and bioelectrical impedance analysis requires highly standardized measurement conditions (Pietrobelli, Heo, & Faith, 2001), they are not easily applicable in large-scale epidemiological studies. In addition, the use of computer tomography in children is limited by the radiation exposure (Lohman & Going, 2004). On the contrary anthropometric measurements are relatively inexpensive, non-invasive and quick to obtain (Cole & Rolland-Cachera, 2002), and therefore, generally practical methods in large epidemiological studies. Of the anthropometric measures, skinfold thickness measurements suffer from high inter- and intra-user variation, and waist circumference and waist-to-hip ratio measure fat distribution rather than general adiposity (Cole & Rolland-Cachera, 2002). The use of waist-to-hip ratio may be problematic in childhood due to the changing body proportions (Lobstein, Baur, & Uauy, 2004). As waist circumference seems to be a good indicator of visceral adiposity and the associated health risk in adults, it is presently under investigation whether it might serve as a better indicator of obesity than BMI in children and adolescents. However, the evidence of the

association between waist circumference and adverse health effects as well as reference values in children are scarce so far (Lohman & Going, 2006).

For all these reasons mentioned above, BMI is used as a universal measure of obesity and overweight in both younger and older populations (World Health Organization, 2015). The BMI is calculated by dividing weight in kilograms (kg) by height in meter squared (kg/m^2; Quetelet index). BMI is internationally recognized as an index for proportional adiposity in children and adults based on extensive associations between higher BMI values with increased risk of chronic disease and mortality (World Health Organization, 2015). Moreover, BMI has been widely recommended for both clinical and epidemiological use (Hall & Cole, 2006). BMI has been shown to correlate strongly with fat mass measured by dual x-ray absorptiometry (DXA), with a number of studies demonstrating correlation coefficients of 0.83 to 0.95 (Dencker et al., 2007; Eisenmann, Heelan, & Welk, 2004).

Classifying overweight and obesity is needed to provide comparisons of weight status within and between populations, to predict health risks and to target and evaluate obesity prevention and interventions (Lobstein, Baur, & Uauy, 2004; World Health Organization, 2000). In adults, it is widely accepted that a BMI cut-off equal to or greater than $25kg/m^2$ is classified as overweight, and a cut-off equal to or greater than 30 kg/m^2 is classified as obese (World Health Organization, 2015). However, the use of BMI to ascertain levels of obesity in children and adolescents is much more complicated. Adults BMI cut-off cannot be applied in children due to the fact that their weight fluctuates differentially with developmental growth across age and gender. Therefore, BMI reference values and percentile curves for children have been developed based on gender and age, ranging from 2 to 18 years. Although there is no specific international standard to define overweight and obesity among children, there are several organizations that use age- and gender-specific references for identifying obesity among the youths. The three reference standards more used are: the World Health Organization (WHO) standard, the Center for Disease Control and Prevention (CDC) standard, and the International Obesity Task Force (IOTF) references.

Several studies compare the three approaches to identifying overweight and obesity among children and adolescents. Wang and Wang (2002) performed a longitudinal study that compares the CDC, WHO, and IOTF references to identify overweight and obesity among children and adolescent 6 to 18 years of age. The data came from China, the United States, and Russia. The study concludes that the WHO and

IOTF references are the best and most useful for identifying overweight and obesity in children.

In the present thesis we decided to use the WHO standards for two main reasons. On the first hand, the WHO child growth standards are among the most internationally accepted classifications and are extensively used in the Spanish setting. The WHO standards are based on data from many countries through the world, while the IOTF only uses data from six different countries (Cole, Bellizzi, Flegal, & Dietz, 2000); and the CDC only uses data from the United States. On the other hand, there is an international accepted cut-off point for delimitating overweight specifically in preschool children.

1.1.3.1.The World Health Organization Standards

In 2006, the World Health Organization established a growth standard for healthy children from 0 to 5 years old that is internationally applicable (World Health Organization, 2006). The WHO Multicultural Growth Reference Study (MGRS) included children from around the world: Brazil, Ghana, India, Norway, Oman and the USA. The study defines children growth by calculating length/height-for-age, weight-for-age, weight-for-length/height, and BMI-for age by using Box-Cox-power-exponential method with curve smoothing by cubic splines for constructing the growth curves followed boys and girls aged 0 to 60 months percentile and z-score curves for length/height-for-age, weight-for-age, weight-for-length/height, and BMI-for age (World Health Organization, 2006). The WHO Child Growth Standards depict normal growth under optimal environmental conditions and can be used to assess children everywhere, regardless of ethnicity, socio-economic status and type of feeding.

Specifically for preschool-aged children and based on the WHO international age- and sex-specific child growth standards, overweight is defined as having a BMI greater than two standard deviations from the mean weight in the WHO reference population (de Onis, Blössner, & Borghi, 2010).

For purposes of this research, the definition of overweight will correspond to the definition used by the WHO. Under that definition, amongst children aged less than five

years, overweight is defined as weight for height greater than two Standard Deviations (2SD) above the WHO Child Growth Standard median.

1.1.4. Etiology

The etiology of overweight and obesity is complex and multifactorial. There are a large numbers of potential risk factors for overweight and obesity covering genetic, biological, physical, lifestyle, and environmental conditions. For the majority of children, the risk of being overweight or obese is associated with a number of these factors each of which is likely to have a small and varying contribution to the overall risk. Moreover, some risk factors are more modifiable than others, which have implications in terms of prevention and treatment strategies for overweight and obesity.

1.1.4.1.Genetics

A small proportion of obesity (less than 5%) arises from identifiable hormonal, syndromic, neurological, or single gene defect conditions such as Down syndrome and Prader-Willi syndrome (Silventoinen, Rokholm, Kaprio, & Sorensen, 2010). Apart from those with identifiable conditions, there is strong evidence that some children may have a genetic predisposition to obesity, as twin studies have reported a high correlation of BMI in identical twins that have been brought up apart (Kipping, Jago, & Lawlor, 2008).

Obesity tracks in families, and one of the strongest predictors of child overweight is the BMI of the mother and the father. In recent years, progress was made in identifying genes that may contribute to this effect. Nowadays, the fat mass and obesity-associated gene (FTO) and the melanocortin 4 receptor gene (MC4R) are the most investigated genes. The FTO (fat mass and obesity-associated) gene is a large gene on chromosome 16. In 2007, three independent studies identified associations between single nucleotide polymorphisms on FTO and BMI (Loos & Bouchard, 2008). A defect in the melanocortin 4 receptor gene (MC4R) is associated with a severe, early form of monogenic obesity in children. MC4R deficiency is characterized by hyperphagia, hyperinsulinemia, and increased fat mass (Farooqi et al., 2000). In a study of MCR4 and FTO genetic variants in adolescents, the gene effects were additive but, were modifiable by physical activity (Cauchi et al., 2009).

1.1.4.2.Early life risk factors

Early childhood is increasingly seen as a critical period for the development of overweight and obesity (Gillman, 2008; Ong, 2006). There is increasing evidence that the intrauterine environment is of particular importance for the development of the child and therefore, it may be an important condition for later overweight and obesity. Hales and Barker described the so called "thrifty phenotype hypothesis" (Hales & Barker, 2001). This hypothesis proposes that the associations between poor fetal growth and the development of symptoms of metabolic syndrome in later life (for example obesity, type 2 diabetes mellitus, and hypertension) result from prenatal malnutrition, which is related to permanent metabolic changes. Other authors have described the perinatal programming as the process that environmental factors (and not primarily genetic factors) affect the metabolic and hormonal system in such a way that the development of diseases in later life is more likely (Plagemann, 2005). Environmental influences during specific periods of life affect developmental processes inducing ongoing changes in organ structures, metabolism, gene expression and therefore, in the risk of disease (Waterland, 2009).

Beside a prenatal (mal-)nutrition, maternal smoking during pregnancy is discussed as being one potential risk factor for later obesity (Reilly et al, 2005; von Kries, Toschke, Koletzko, & Slikker, 2002). In particular, smoking during the first trimester of pregnancy seemed to have negative consequences for the child. Among women who smoked during pregnancy a higher prevalence of obesity in the offspring occurred with increasing cigarette consumption (von Kries et al., 2002). One suggested mechanism is the effect of nicotine exposure, via the placenta, on fetal growth and appetite control (Oken, Levitan, & Gillman, 2008).

Weight gain in pregnancy is another factor that influences the intrauterine environment. It was observed that excessive weight gain during pregnancy is a risk factor for overweight in the offspring at age 3 (Oken, Taveras, Kleinman, Rich-Edwards, & Gillman, 2007; Olson, Strawderman, & Dennison, 2009) and at age 7 (Wrotniak, Shults, Butts, & Stettler, 2008). There are a number of possible mechanisms responsible for this association. From a life course perspective, intrauterine development may be a critical time period during which maternal weight gain may contribute to the programming of future risk of childhood overweight, perhaps through insulin resistance (Wrotniak, Shults, Butts, & Stettler, 2008). An alternative explanation

for the association of gestational weight gain with offspring overweight is that mothers with greater gestational weight gain may have children who gain more weight through shared mechanisms that may include genetics, dietary preferences, and physical activity patterns.

Birth weight is a common indicator for prenatal growth. A number of studies showed that birth weight, which is a marker for intra-uterine growth, is positively related to subsequent obesity in later life (Eriksson, Forsen, Tuomilehto, Osmond, & Barker, 2001; Reilly et al., 2005) and a recent review confirmed this association (Harder, Schellong, Stupin, Dudenhausen, & Plagemann, 2007). The Barker Hypothesis (Barker, Bull, Osmond, & Simmonds, 1990) posits that compromised growth in uterus may be associated with differential organ development with increased allocation of nutrients to adipose tissue during development. This may then result in an accelerated weight gain during childhood, which could contribute to a relatively greater risk of various illnesses (including cardiovascular diseases) later in life.

Recent studies addressed the role of growth and weight gain during infancy as a predictor of obesity in later life. Excess weight gain in early life (until the age 2 years) is a strong predictor for the occurrence of overweight, obesity, or higher fat mass in later life (Botton, Heude, Maccario, Ducimetiere, & Charles, 2008). Another risk factor for overweight and obesity in early life is the so called "adiposity rebound". Body fat mass, as estimated by BMI for example, increases during the first year of life and then decreases. About the age of 6 years BMI rises again. This raise is called the adiposity rebound. An early adiposity rebound, which is before the age of 5.5 years, is associated with higher BMI levels in later life compared to those with a later rebound, after the age of 7 years (Rolland-Cachera et al., 1984). A recent review concluded that a considerable body of literature confirmed that early adiposity rebound increased the risk of obesity in later life (Taylor, Grant, Goulding, & Williams, 2005).

Breastfeeding has been discussed to be a protective factor concerning obesity in later. It was observed that children who were breastfed are less often obese in later life Reilly et al., 2005; von Kries et al., 1999). A meta-analysis estimated that breastfeeding reduced the risk for overweight by 25% compared to non-breastfed children (Plagemann & Harder, 2005). Another review concluded that breastfeeding seems to have a small but consistent protective effect against obesity in later life (Arenz, Ruckerl, Koletzko, & von Kries, 2004). There are several possible explanations for why breastfeeding appears to reduce the risk for overweight, but conclusive evidence is not yet available. One

possible explanation is that mothers who breastfeed choose a healthier lifestyle, including a healthy diet and adequate physical activity for themselves and their children. This healthier lifestyle could result in a spurious relationship between breastfeeding and reduced risk of overweight. Another explanation is that there are biological mechanisms by which breastfeeding may reduce the risk of overweight. First, because breastfed infants control the amount of milk they consume, their self-regulation of energy intake, which involves their responding to internal hunger and cues that they are full, may be better than that of bottle fed infants, who may be encouraged by external cues to finish a feeding (Fisher, Birch, Smiciklas-Wright, & Picciano, 2000). A second possibility pertains to insulin concentrations in the blood, which vary by feeding mode. Formula-fed infants (infants who don't breastfed) have higher plasma insulin concentrations and a more prolonged insulin response. Higher insulin concentrations stimulate more deposition of fat tissue, which in turn increases weight gain, obesity, and risk of type 2 diabetes (Odeleye, de Courten, Pettitt, & Ravussin, 1997). A third possibility is that concentrations of leptin (the hormone that is thought to inhibit appetite and control body fatness) may be influenced by breastfeeding (Singhal et al., 2002)

1.1.4.3.Demographic associations

Data from different countries confirms that there are differences in fatness in children that reflect the ethnic origin of their parents. In the US and in the countries from the European Union, ethnic minorities have seen an increase in overweight and obesity higher than the white majority. Obesity levels are higher in Hispanic and African American children compared to Caucasian children (Ogden, Yanovski, Carroll, & Flegal, 2007).

In industrialized countries people with low socio-economic status (SES) are more often overweight and obese than those with high SES (McLaren, 2007; World Health Organization, 2000) while in developing countries overweight and obesity more often occur in higher SES groups. Research on the mechanisms between low SES and increased risk of obesity in industrialized countries has failed to produce a clear conclusion, but some hypothesis related to access to food and leisure-time physical activities as well as behavioral skills and knowledge about weight maintenance have been suggested (Lobstein et al, 2004; Sarlio-Lähteenkorva, 2007). However, in

industrialized countries, the association between social deprivation and increased overweight appears less consistent in children than in adults (Stamatakis, Primatesta, Chinn, Rona, & Falascheti, 2005). A number of methodological issues exist which may contribute to apparent inconsistencies in the results of differing studies. Firstly these relate to the variety of measures of socio-economic status (SES) used, which can include income, parental education and/or occupation and household address-based measures of deprivation. Secondly the timing of when SES is measured relative to the onset of overweight and lastly, questions concerning the stability of such measures over time.

Low parental education has been positively associated with overweight and obesity rates. In preschool children, increased maternal education was correlated with decrease risk of obesity (Kersey et al., 2005). Education about nutrition knowledge may play a role in tackling overweight and obesity. Lack of basic nutrition knowledge among parents with low education may contribute to this disparity. Parental nutrition knowledge is related to food shopping, preparation, and delivery to their children (Cluss et al., 2013). Parental education is also related to the amount of television viewed by children. Children with parents with more education (some college or more) watched the least amount of television and spent more time being physically active (Proctor et al., 2003).

1.1.4.4.Life style factors

There is a convincing positive association between obesity, sedentary lifestyle, and high intake of energy dense food.

Physical activity is important to the overall health of children. Evidence has pointed to the association of level of physical activity and overweight and obesity. Jago et al. (2005) observed that physical activity (> 140 bpm/h was considered moderate to vigorous physical activity, measured with a heart rate monitor) predicted BMI in 6 year old children after 3 years. Nonetheless, physical activity is hard to compare among different studies because the methods for data collection are not the same and is still a subject of controversial discussions.

Technical advances during the last decade and the widespread and easy access to electronic media (television, video games, and internet) have caused the leisure time

activity to change essentially with an increased time spent on electronic media consumption. Even preschool children have a remarkable consumption of electronic media. For instance, 82% of children aged 3-4 years watched television on a typical day for approximately 90 minutes in average (Vandewater et al., 2007). Several studies showed a consistent positive association between time of electronic media consumption (i.e., television and computer time) and risk for overweight or obesity. Media use has been associated with a reduction in metabolic rate, increased snacking during media use, increased exposure to food marketing, and a reduction in discretionary time that may have been allotted to physical activity (Coon & Tucker, 2002; Institute of Medicine, 2005; Lowry, Wechsler, Galuska, Fulton, & Kann, 2002).

Food intake is the factor that determines energy intake and therefore substantially influences energy balance. Previous research has indicated that eating patterns that include frequent meals away from home, large portions, consumption of pre-prepared and pre-packaged food, the consumption of sugar-sweetened beverages and frequent snacking have all been linked to increased rates of overweight (Ludwig, Peterson, & Gortmaker, 2001).

Several studies showed that an inadequate duration of sleep is associated with a higher prevalence of obesity among children and adolescents (Reilly et al., 2005; von Kries, Toschke, Wurmser, Sauerwald, & Koletzko, 2002). Metabolic changes (for example changes in carbohydrate metabolism) and endocrine changes (for example in the secretion of leptin, a hormone that regulates appetite) have been discussed as possible explanations (von Kries et al., 2002). It is possible that the duration of sleep also reflects a certain lifestyle. So, the extent of physical activity could influence tiredness and therefore the duration of sleep (Reilly et al., 2005). Several reviews have found a stronger association between obesity and sleep duration in younger children, at least when compared to adults (Cappuccio et al., 2008). However, the causal relationship remains unclear, since all these studies are cross-sectional. It may also be possible that a shorter duration of sleep is a consequence of obesity.

1.1.4.5. Parental Factors

The influence of parental fatness represents the combined result of genetics, lifestyle effects and behaviors which may also be both learned and inherited. A number

of cross-sectional studies have shown an increased risk of obesity in childhood for children of obese parents, with a dose-response effect of the number of overweight parents (Reilly et al., 2005; von Kries, Toschke, Koletzko, & Slikker, 2002). The Avon Longitudinal Study of Parents and Children found an increased risk of the child being obese at age seven if either parent was obese, with the greatest risk being for children of two obese parents (Reilly et al., 2005).

Parents play a critical role in their children's lifestyle habits. Several studies reported a relationship between parenting style and childhood obesity, especially non-authoritative parenting style (Hubbs-Tait, Dickin, Sigman-Grant, Jahns, & Mobley, 2013). Research on parenting style has long documented that authoritative parents are more attuned and responsive to child needs and behavior (Pratt, Kerig, Cowan, & Cowan, 1988) and that is necessary for parents to set appropriate limits in the feeding situation.

1.1.5. Tracking obesity into adulthood

It is well known that obesity in adults is associated with premature mortality and a wide range of serious health risks (Haslam & James, 2005). If childhood obesity strongly predicts adult obesity, the rising prevalence in children will have far reaching implications for the health of future adult population. This has led to a wealth of research into the tracking of obesity into adulthood.

A systematic review published in 2008 reported that overweight and obese children are at considerably more risk of becoming overweight or obese adults than healthy weight children (relative risks varied between 2 and 10 for overweight, and were as high as 20 for obese children). Estimates of the proportion of overweight and obese children becoming overweight and obese adults ranged from 34% to 83% (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008). Research evidence suggests that childhood obesity, established before adolescence, is a strong risk factor for adult obesity (Wardle, Brodersen, Cole, Jarvis, & Boniface, 2006). Therefore, studying and preventing the development of obesity and overweight in childhood may reduce the likelihood of obesity in adulthood and its related health consequences.

1.1.6. Physical health consequences

During decades, it has been known that being overweight or obese carries many serious health risks for adults. Nowadays, due to the epidemic of overweight and obesity in children, the research of how weight affects the health already in children has intensified. Many health conditions once thought applicable only to adults are now being seen in children. Even if the conditions do not appear as symptoms until adulthood, they may appear earlier than usual in a person's lifetime if the person had weight problems in childhood. Further, children are also more vulnerable to a unique set of obesity-related health problems because their bodies are growing and developing.

Obesity can cause great damage to the cardiovascular system and being overweight or obese during childhood can accelerate the development of obesity related cardiovascular disease. There is evidence of an association between overweight and obesity and hypertension, left ventricular hypertrophy and atherosclerosis (Berenson et al., 1998; Yoshinaga et al., 1995). Likewise, obesity is linked with many disorders of the metabolic system. There is a positive relationship between obesity and insulin resistance, dyslipidemia and the metabolic syndrome (Cook, Weitzman, Auinger, Maffeis, Pietrobelli, Grezzani, Provera, & Tato, 2001; Nguyen, & Dietz, 2003; Steinberger, Moran, Hong, Jacobs & Sinaiko, 2001). The metabolic syndrome is a clustering of risk factors including deranged lipid profiles, impaired glucose metabolism, hypertension and central adiposity, which predicts both type 2 diabetes and cardiovascular disease. Such disorders, seen primarily in adulthood, are now appearing in children. Even when the disorders do not present themselves in childhood, childhood obesity or overweight increases the risk of their developing in adulthood. Much the same generalization applies to the obesity-related disorders in the other bodily systems. Obesity can also cause damage to the pulmonary system. Studies have demonstrated a link between obesity and asthma and obstructive sleep apnea (Luder, Melnik, & DiMaio, 1998; Mallory, Fiser, & Jackson, 1989). Regarding the gastrointestinal and skeletal system, recent research has verified that obesity can contribute to liver disease, gastroesophageal reflux disease and orthopedic problems (Lavine & Schwimmer, 2004; Murray et al., 2003).

In the last years, there has been increasing recognition that the effects of overweight and obesity go far beyond the physical health consequences, and so psychosocial well-being and its relationship to overweight and obesity in children has

received recently much attention. The impact of childhood obesity and overweight on aspects of social and psychological functioning are outlined in the next section.

1.2. Psychological problems in children with overweight and obesity

Childhood overweight and obesity plays a significant negative role in the social and psychological aspect of a child's life. In the past decades, researchers tended to focus only on the psychological consequences in adults. However, now this focus has changed as a growing body of scientific literature is demonstrating that the psychosocial effects that accompany obesity and overweight are already seen at a very young age.

1.2.1. Psychological issues in pediatric overweight and obesity

Some psychosocial factors have been identified and studied. However, research usually examines each construct independently with little consideration for the relationship between excess weight and a broad range of psychosocial constructs concurrently (Gibson, 2011). Moreover, the direction of the relationship between mental health and excess weight certainly remains unclear as most of the studies are cross-sectional (e.g., Wardle, & Cooke, 2005). Of the limited longitudinal data available, some studies find evidence that mental distress predicts overweight or weight gain (e.g., Anderson, Cohen, Naumova, & Must, 2006; Goodman & Whitaker, 2002), others find no associations between weight status and mental health (e.g., Stice, Presnell, Shaw, & Rhode, 2005; Tanofsky-Kraff et al., 2006), and one found that behavioral issues predicted becoming overweight (Lumeng, Gannon, Cabral, Frank, & Zuckerman, 2003). Furthermore, most of studies focus only on school-aged children and adolescents. Despite the inconsistencies and uncertainties arising from the current evidence base, there appears to be some consensus that obesity and overweight are a potential risk factor with regard to children's and adolescents' psychological and emotional well-being (Russell-Mayhew, McVey, Bardick, & Ireland, 2012).

1.2.1.1.*Internalizing and Externalizing Disorders*

Higher rates of internalizing and externalizing symptoms and/or disorders have been documented in obese youth compared to healthy weight peers (Pulgarón, 2013). In comparison to a sample of children with diabetes, children who were obese displayed significantly higher internalizing and externalizing symptoms (on parent report questionnaires (Vila et al., 2004). In a prospective study Anderson and colleagues (2006) found that the presence of internalizing and externalizing disorders in females, but not males, was associated with increases in z-BMI. The extent of behavioral problems in overweight children can be quite severe. For instance, in one study using data from a nationally representative sample of kindergartners in the United States (n = 9949) overweight girls had over 81% greater odds of having substantial teacher-reported externalizing behavior problems compared with girls who were not overweight (Datar & Sturm, 2004). As with many of the associated comorbidities of childhood obesity, it is difficult to determine the temporal relationship between obesity and behavioral problems. Many propose that behavioral problems are a result of the stigmatization associated with childhood obesity, but there is also evidence to support that behavioral problems may precede overweight status in some children (Lumeng, Gannon, Cabral, Frank, & Zuckerman, 2003). In a sample of 629 youth significant behavior problems in normal-weight children were independently associated with becoming overweight 2 years later after adjusting for covariates.

1.2.1.2.Attention Deficit Hyperactivity Disorder (ADHD)

A number of recent studies have assessed the relationship between obesity and ADHD and many researchers suggest that the dysregulation these children experience with their behavior extends into their eating habits. Diagnoses of ADHD have been found to be more prevalent in obese children than their healthy weight peers (Agranat-Meged et al., 2005; Kim, Mutyala, Agiovlasitis, & Fernhall, 2011). For instance, Erhart and colleagues (2012) found that after controlling for age, gender, and socio-economic status, overweight/obese children were found to be twice as likely to have an ADHD diagnosis. However, not all studies have found an association between obesity and ADHD (Mirza et al., 2004).

1.2.1.3.*Depression and Anxiety*

A recent review concluded that the majority of studies find a prospective relationship between eating disturbances and depression, especially in adolescents (Rawana, Morgan, Nguyen, & Craig, 2010). However, this relationship is not unidirectional; depression may be both a cause and a consequence of obesity. Additionally, in a clinical sample of obese adolescents, a higher lifetime prevalence of anxiety disorders was reported compared to non-obese controls (Britz et al., 2000) although some studies demonstrate no significant relationship between increased BMI and increased anxiety symptoms (Tanofsky-Kraff et al., 2004). Thus, the relationship between obesity and anxiety may not be unidirectional and is certainly not conclusive. In fact, the relationship between BMI percentile and depression/anxiety could be due to several plausible mechanisms. First, elevated depressive or anxious symptoms could exacerbate the likelihood of weight gain over time (Anderson, Cohen, Naumova, & Must, 2006). For example, depression or anxiety could affect diet or activity levels that could lead to elevations in sedentary behavior, increase in emotional eating, and decrease in exercise. Second, depression, anxiety, and weight could be influenced by additional social and biological risk factors. Obesity might not directly cause depression or anxiety in children, but stressful life events such as peer victimization and weight-based teasing might biologically predispose youth to depression/anxiety and may be a factor that leads to depression/anxiety in obese youth. It is crucial to better understand the social pressures for thinness and consequential effects on mood.

1.2.1.4.Self-Esteem

Research findings comparing overweight/obese children with normal-weight children in regards to self-esteem have been mixed (Zametkin, Zoon, Klein, & Munson, 2004). Some studies find that obese children have lower self-esteem (Ackard, Neumark-Sztainer, Story, & Perry, 2003) while others do not (Jansen, van de Looij-Jansen, de Wilde, Brug, 2008). Differences in age, race, and income among studies may account for the discrepant findings.

1.2.1.5.Body Dissatisfaction

Research has consistently found that body satisfaction is higher in males than females at all ages (O'Dea, 2005). Gender differences may reflect the Westernized cultural ideals of beauty in that thinness is the only culturally defined ideal for females, while males are encouraged to be both lean and muscular. Thus, there is a linear relationship between body dissatisfaction and increasing BMI for girls; while for boys a U-shaped relationship suggests that boys with BMIs at the low and high extremes experience high levels of body dissatisfaction (Austin, Haines, Veugelers, 2009).

1.2.1.6.Eating Disorder Symptoms

Traits associated with eating disorders appear to be common in adolescent obese populations, particularly for girls. A number of studies have shown higher prevalence of eating-related pathology (i.e., binge eating episodes, drive for thinness, impulse regulation) in obese children and youth (Decaluwxe & Braet, 2003).

1.2.1.7.Psychological impact of being overweight

In one of the few studies to investigate the psychological impact of being overweight or obese in children, Cornette (2008) reviewed 10 published studies over a 10-year period (1995–2005) with sample sizes greater than 50 and concluded that all participants reported some level of psychosocial impact as a result of their weight status. Being younger, female, and with an increased perceived lack of control over eating seemed to heighten the psychosocial consequences.

1.2.2. Mediating factors between overweight and psychological problems

The literature has described two main mediating factors for understanding how overweight impacts psychosocial health and wellness and vice versa: weight-based stigmatization and concern about weight and shape. The majority of studies have been carried out in adolescents.

Weight-based stigmatization is defined as a negative weight-related attitudes and beliefs that are manifested through stereotypes, bias, rejection, and prejudice toward children and adolescents because they are overweight or obese (Cornette, 2008). Nowadays, the negative views of obese children are even higher than 40 years ago (Latner, & Stunkard, 2003). The visible nature of obesity (i.e., it is not something that you can hide) as well as the assumption that obesity can be controlled (i.e., eat less and move more) are important determinants of weight bias. Nowadays, obesity is considered to be one of the most stigmatizing and least socially acceptable conditions in childhood. Puhl and Latner (2007) completed a comprehensive literature review on childhood weight-based stigmatization and found that children demonstrate weight bias by associating obesity with a number of undesirable traits and preferring to associate with non-obese peers. Children with more negative attitudes towards weight, more likely rate an obese peer negatively and tease and bully children who appear overweight (Puhl & Latner, 2007). Experiences of weight-based teasing have been hypothesized as a mediating variable in the development and maintenance of overweight and obesity (Adams & Bukowski, 2008). Not only do overweight and obese children have increased risk of experiencing significant victimization, but peer victimization has been linked to negative psychosocial and health outcomes as well (Janicke et al., 2007). Obese children are almost twice as likely to be the victim of peer victimization, with girls more often reporting relational issues and boys reporting overt issues as both the victim and the perpetrator (Gray, Kahhan, & Janicke, 2009). Being teased about weight is predictive of binge eating among adolescents (Haines & Neumark-Sztainer, 2006) and is cross-sectionally associated with higher levels of disordered eating (Neumark-Sztainer et al., 2002). In addition to triggering body dissatisfaction and disordered eating, weight-based teasing has been linked to suicide attempts, implicated as a predictor of depressive symptoms, positively associated with anxiety, loneliness, social isolation, and parent reports of internalizing and externalizing behaviour problems and experiences of shame and negatively associated with physical activity (Russell-Mayhew, McVey, Bardick, & Ireland, 2012).

A number of recent studies indicate that perceived overweight or concern about weight, rather than actual weight status, is predictive of the psychosocial/emotional fall-out of overweight and obesity (Perrin, Boone-Heinonen, Field, Coyne-Beasley, & Gordon-Larsen, 2010). In a sample of 7- to 13-year-old boys and girls, Allen et al. (2006) found that overweight children were more concerned about weight than were

healthy weight children and regardless of weight status, children with high weight and shape concern, reported lower levels of self-esteem and higher levels of body dissatisfaction and depression than children with low weight and shape concern.

CHAPTER TWO:

RATIONALE FOR THE STUDY

2. RATIONALE FOR THE STUDY

There has been a dramatic global increase in childhood obesity and overweight in the past decades. Combating childhood obesity and overweight has become one of the major public health issues facing industrialized and developing nations (Ogden, Carroll, Kit, & Flegal, 2012). Alarmingly, throughout the world a large number of children are already overweight by the preschool years. Nowadays, 43 million children aged less than 5 years are overweight and obese, while an additional 92 million are at risk of becoming overweight (de Onis, Blössner, & Borghi, 2010). In Europe, the prevalence of early overweight and obesity in children remains high, although there are striking differences between European regions (Pigeot et al., 2009). Children residing in southern European countries show the highest prevalence of overweight and obesity. Therefore, the highest proportions are observed in southern Italy, followed by Cyprus and Spain (Ahrens et al., 2014). Nonetheless, in spite of this alarmingly high prevalence, little research around obesity and overweight has been conducted in Spain when compared to the extensive research done in the United States, Australia, and northern European countries. Thus, further research is needed on childhood overweight and obesity in Spain.

Children who are overweight or obese often maintain their body composition into adulthood (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008), and an elevated BMI in childhood is associated with a wide range of serious complications, including hypertension, type 2 diabetes, metabolic syndrome and hypercholesterolemia (Bjørge, Engeland, Tverdal, & Smith, 2008; Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Reilly et al., 2003). However, attention has recently been focused not only on the physical consequences of obesity, but also on understanding the reciprocal relationships between being overweight or obese and mental health. Previous research has revealed several associations between overweight or obesity in children and health-related quality of life (Williams, Wake, Hesketh, Maher, & Waters, 2005), risk of bullying (Janssen, Craig, Boyce, & Pickett, 2004), social isolation (Strauss & Pollack, 2003), and behavioral problems (Mustillo et al., 2003). Nevertheless, most studies only focus on school-aged children. Moreover, the direction of the relationship between mental health and weight status remains unclear, as most of the studies are cross-sectional. Finally, the psychopathology is based only on dimensional measures: no

study has used a Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000) diagnosis as an outcome. Thus, the longitudinal study of overweight and psychological problems in early childhood might further clarify the relationship between mental health and weight status.

Recently, increasing evidence points to a significant association between ADHD and both obesity and higher-than-average BMI standard deviation scores. This link has been established in adults, adolescents, and children (Cortese & Vincenzi, 2012). However, most studies have examined this association in clinical samples while none has studied it in a community sample of preschoolers using a diagnostic interview to identify ADHD symptoms. Thus, research on this association in a population-based sample may help to establish whether children with overweight are more likely to have ADHD symptoms.

The preschool years are a critical window for obesity prevention, as rapid weight gain in early childhood is associated with later obesity (Baker, Olsen, & Sørensen, 2007) and lifestyle changes made during this period are more durable (Olstad & McCargar, 2009). As such, there is clearly a need for studies that focus on the preschool years (Garthus-Niegel, Hagtvet, & Vollrath, 2010).

Unfortunately, extensive research and large-scale campaigns designed to reduce overweight/obesity in children and adolescents have yielded little success (Latzer et al., 2009). Therefore, considerable effort has been placed on identifying risk factors in order to target appropriate interventions. With childhood overweight and obesity rates higher than in previous years, it is important to identify the early factors that are associated with overweight and obesity in order to reverse this trend. At present, no study has ever been carried out to study the risk factors for the development of childhood overweight in a community sample of Spanish preschoolers. Thus, identifying in early life groups children at higher risk for becoming overweight might help to design prevention policies and intervention programs in Spain.

To the best of our knowledge, in this thesis, we study for the first time in a large community sample of preschoolers in Spain, the relationship between weight status and behavioral problems using a diagnostic interview. Also for the first time, we examine a variety of risk factors for overweight in Spanish preschoolers.

CHAPTER THREE:

AIMS AND HYPOTHESIS

3. AIMS AND HYPOTHESIS

The empirical research presented in this thesis has been focused in two main areas:

1) Analysis of the relationship between behavioral problems and overweight in preschool children.
2) Assessment of the risk factors for overweight in preschool children.

3.1. Association between behavioral problems and overweight in preschool children

3.1.1. Objectives

The overarching objective of this study is to examine the association between weight status (BMI and overweight status) and behavioral problems in a large community sample of Spanish preschool children aged 3–5 years. Specifically the objectives of this study are:

a. To investigate the cross-sectional association between weight status (BMI and overweight status) and behavioral problems in preschool children.
b. To examine the cross-sectional association between weight status (BMI and overweight status) and peer problems in preschool children.
c. To prospectively investigate whether overweight and higher BMI at three years old contribute to behavioral problems at five years of age.
d. To examine longitudinally if overweight and higher BMI at three years old contribute to peer problems at five years of age.
e. To determine the prevalence of overweight in a population-based sample of Spanish children born over a twelve month period in 2006/2007 as they reached their third birthday.

3.1.2. Hypothesis

a. Children with a higher BMI (quantitative measure) at age three will be more likely to have more behavioral symptoms at age three.

b. Children with overweight (qualitative measure based on the WHO child growth standards for preschoolers) at age three will be more likely to have more behavioral symptoms at age three.
c. Children with overweight and a higher BMI at age three will be more likely to have more peer problems at age three.
d. BMI and overweight at age three will predict behavioral problems at ages four and five years.
e. BMI and overweight at age three will predict peer problems at ages four and five.
f. Overweight prevalence in preschool children in Spain will be as high as other European countries (11.7%, de Onis, Blössner, & Borghi, 2010).

3.2.Risk factors for overweight in preschool children

3.2.1. Objectives

The overarching objective of this study is to identify risk factors for the development of overweight in early childhood in a population-based sample of preschoolers in Spain. The risk factors studied in this project include family structure, pregnancy, birth, postnatal period, medical history, school and neighborhood. The findings from this study could help the public health community identify areas for targeted interventions to help prevent and reverse the trend toward early onset overweight.

Specifically the objectives of this study are:

a. To obtain a predictive model with the best predictors of overweight and higher BMI at children's age 3 years-old.
b. To prospectively investigate which factors contribute to the risk of overweight and higher BMI at four and five years old.

3.2.2. Hypothesis

a. Early life risk factors, including high birth weight and mother smoking during pregnancy, will be associated with an increased risk of overweight and higher BMI at age three, four and five.

b. Demographic factors, including socioeconomic status and ethnicity, will be associated with an increased risk of overweight and higher BMI at age three, four and five.
c. Parental factors, including parenting style and parent mental health, will be associated with an increased risk of overweight and higher BMI at age three, four and five.
d. Children factors, including attention focus, will be associated with an increased risk of overweight and higher BMI at age three, four and five.
e. Potentially modifiable factors, such as screen time, will be associated with an increased risk of overweight and higher BMI at age three, four and five.

CHAPTER FOUR:

METHODS

4. METHODS

4.1. Participants

The data analyzed in this work are derived from the first assessment of a large-scale longitudinal project on psychopathology risk factors specifically focused on behavioral problems in preschool children (Ezpeleta, de la Osa, & Doménech, 2014). The initial sample consisted of 2,283 children from 54 schools (25.9 % semi-public and 74.1 % public) randomly selected from the census of preschoolers in grade P3 (3 years old) in Barcelona (Spain) for 2009–10. The measures were applied in a double-phase design. In the first phase, 1,341 families (58.7%) agreed to participate. There were no significant differences by gender among the participants and those who declined to participate (p=.951). However, the proportion of refusals was statistically higher in low socioeconomic status families (SES; Hollingshead, 1975) groups (p< .001). The screening for children with possible behavioral problems was carried out by administering, to parents, four items from the version for ages 3-4 Strengths and Difficulties Questionnaire (SDQ; Ezpeleta, Granero, de la Osa, Penelo, & Doménech, 2013) conduct problems scale plus four questions derived from the Diagnostic and Statistical Manual of Mental Disorders-IV diagnostic criteria for Oppositional Defiant Disorder. Based on the results of the screening process, two groups were formed. The positive screen group (n=205; 51.2% boys) included all children who reached the threshold for behavioral problems while the negative screen group (n =417; 49.4% boys) included a random sample from the 30% of children who did not reach the threshold.

In the second phase, n=622 children and their parents agreed to participate although 11 children were excluded due to missing data on height or weight. Consequently, the sample for this thesis was n=611 three-year-old children and their parents. Children's mean age was 3.0 (SD=0.16) years, 311 were boys (50%) and 89.5% were Caucasian, while 33% were of high socioeconomic status, 45% middle, and 23% low. Children were followed-up at age 4 (n=596) and 5 (n=564). Drop-outs were statistically equal by gender (p=.188) and SES (p=.062).

Figure 7 shows graphically the study design of the thesis. Excluded were children with intellectual disability or pervasive developmental disorder, without a primary caregiver that could report about the child, parental lack of fluency in Spanish or Catalan, or family relocating outside study area within 12 months (*n*=75, all them in the first phase of the design).

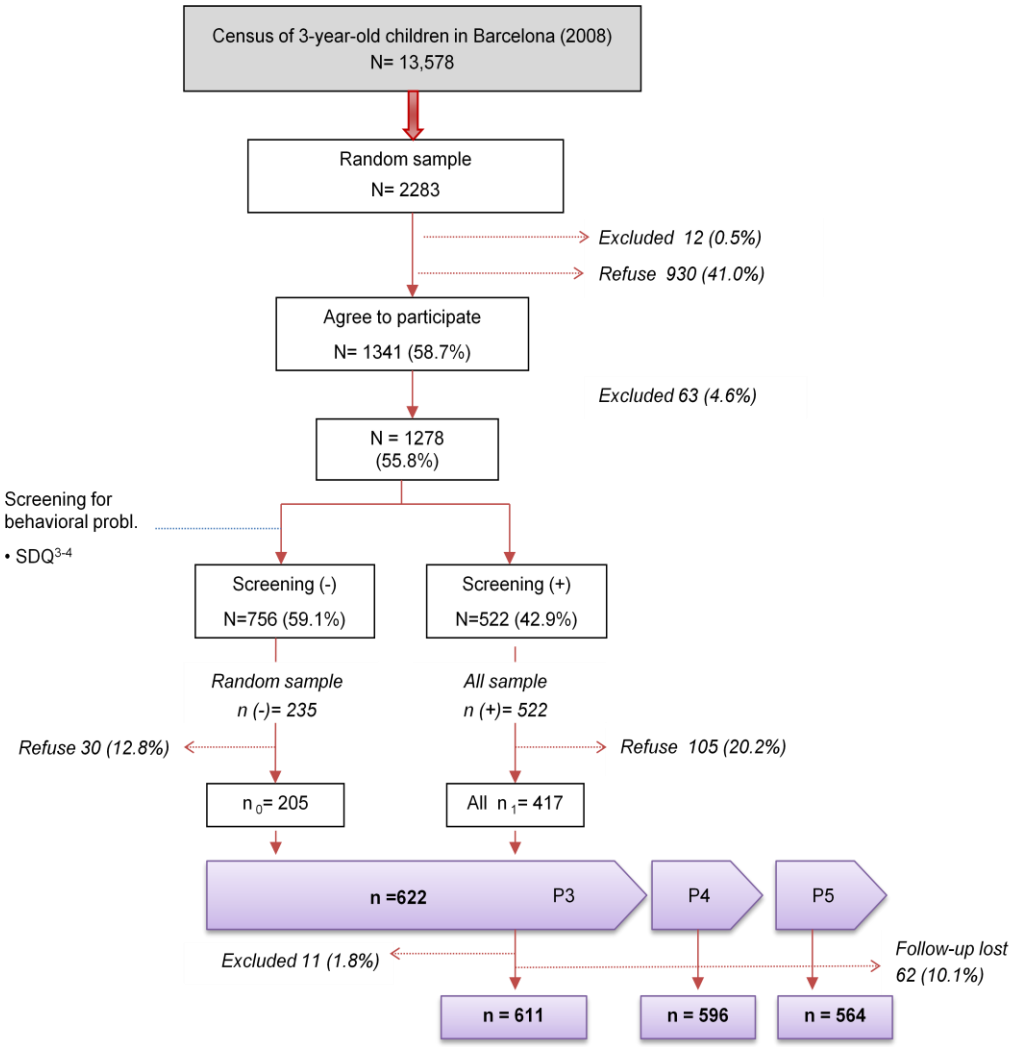

Figure 7. Study Design

4.2.Measures

4.2.1. Psychopathology

The *Strengths and Difficulties Questionnaire* (Goodman, 1997) is a widely-used brief questionnaire for parents designed to assess children's behavioral and emotional difficulties. It contains 25 items, 5 in each of the five subscales: emotional symptoms, conduct problems, hyperactivity, peer problems and prosocial behavior. Response options are: "not true", "somewhat true" or "certainly true", scoring 0, 1, and 2 respectively. Higher scores indicate more problems on all five subscales. An overall emotional-behavioral difficulties score is generated by summing the subscale scores, with the exception of the prosocial behavior subscale. The total difficulties score ranges, for the remaining twenty questions, from 0 to 40, with higher scores indicating greater difficulties. The Spanish version of the SDQ has well-established psychometric properties (Ezpeleta, Granero, de la Osa, Penelo, & Doménech, 2013). The study sample alpha values for each subscale were as follows: .51 for the emotional subscale, .59 for conduct problems, .74 for hyperactivity, .53 for peer problems, .56 for prosocial behavior and .80 for the total difficulties scale (low consistency for first-order scales must be interpreted with caution as there were only 5 items).

The *Diagnostic Interview for Children and Adolescents for Parents of Preschool and Young Children* (DICA-PPY; Reich & Ezpeleta, 2009) is a computerized semi-structured diagnostic interview for parents of children between 3 and 7 years old. The instrument is administered by a clinician and used to assess the most common psychological disorders according to DSM-IV-TR criteria (American Psychiatric Association, 2000). Diagnoses are generated through computerized algorithms, and disorders are assessed over the lifetime. The instrument has been translated into Spanish and validated. Validation has shown acceptable test-retest reliability and moderate convergence with other psychopathology measures, as well as the ability to differentiate preschoolers and young children who had used mental health services (Ezpeleta, de la Osa, Granero, Doménech, & Reich, 2011).

The *Children's Behaviour Questionnaire* (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001) is designed to assess temperament in 3 to 7-year-old children. Completed by parents, it contains 94 items over 15 scales clustered in 3 broad dimensions of temperament: negative affectivity (anger-frustration, discomfort, fear, sadness, falling

reactivity-soothability), effortful control (attention focusing, inhibitory control, low-intensity pleasure, perceptual sensitivity), and surgency-extraversion (activity level, high-intensity pleasure, impulsivity, shyness). The study sample alpha values ranged between α = .50 for sadness and α = .79 for shyness (Osa, Granero, Penelo, Doménech, & Ezpeleta, 2014).

The *Adult Self Report* (ASR; Achenbach & Rescorla, 2003) is a self-report questionnaire that assesses behavioral problems in adults aged 18 to 59. The emotional and behavioral problems section includes 8 empirical syndromes that can be classified as internalizing problems, externalizing problems and total problems. Internal consistency for mothers' reports in this sample ranged between .83 for externalizing problems and .92 for the total score while, for fathers, it ranged between .86 for externalizing problems and .93 for the total score.

4.2.2. Sociodemographic and parenting factors

The *Schedule of Risk Factors* (SRF; Unitat d'Epidemiologia i de Diagnòstic en Psicopatologia del Desenvolupament, 2009) is a semistructured interview answered by parents and conceived of as a compendium of the main areas of psychopathology risk in children. It provides information on the child (e.g., gender and ethnicity), the family (e.g., family structure and maternal smoking during pregnancy) and the community (e.g., distance to a traffic dense route and proximity to school) that could have an impact on the children's psychological status. Inter-rater reliability and concurrent validity are acceptable in Spanish populations.

The *Four-Factor Hollingshead Index of Social Status* (Hollingshead, 1975) based on parents' educational level and occupation was used to code the SES into five levels: a) high; (b) mean-high; (c) mean; (d) mean-low; and (e) low.

The *Alabama Parenting Questionnaire-Preschool version* (APQ-Pr; Osa, Granero, Penelo, Domènech, & Ezpeleta, 2014) assesses the behavior of parents of children with externalizing disorders. It contains 42 items, clustered in 5 subscales: parental involvement, positive parenting, poor monitoring/supervision, inconsistent discipline and corporal punishment. In the Spanish version of the APQ-Pr, two subscales were added: norms and autonomy, this version shows moderate to very good internal consistency in our study sample.

4.2.3. Weight and height measures

The *WHO international age- and sex-specific child growth standards* (World Health Organization, 2006) are based on an international growth standard statistical distribution, which describes the growth of children ages 0 to 59 months.

In our study, children were weighed and their height was measured while they were barefoot and wearing light clothes. Weight and height measurements were taken by nurses at outpatient pediatric primary care units during each child's annual visit to the pediatrician. These values were recorded in the child's medical records and were recovered annually during the course of this study. BMI was calculated as the ratio between weight (kg) and height (m^2). In this study, standardized BMI z-scores were calculated, according to the WHO reference curves (World Health Organization, 2006). Children were classified in binary fashion as non-overweight or overweight according to the WHO international age- and sex-specific child growth standards (World Health Organization, 2006). Based on the WHO recommendations specifically for preschool-aged children, overweight was defined as having a BMI greater than two standard deviations from the mean weight in the WHO reference population (de Onis, Blössner, & Borghi, 2010). The WHO child growth standards are among the most internationally-accepted classifications and are extensively used in the Spanish setting. Classifying children based on BMI criteria has the potential to produce different results according to distinct clinical and public health contexts (Jansen, Mensah, Nicholson, & Wake, 2013). As such, two measures were used through the study: (a) a qualitative, binary variable (overweight status); and (b) a quantitative variable (BMI z-score).

4.3. Procedure

The main project from which the two empirical works of the present thesis derive were approved by the ethics review committee at the authors' institution. Families were recruited at the schools and, following a study description, parental consent was obtained. Parents of children in Grade P3 (three-year-olds) at the participating schools were invited to complete the SDQ at home and return it to the schools. Families who agreed and met the screening criteria were contacted by telephone and interviewed at the school. Interviewers were all experienced graduate students who received an intensive training on the developmental psychology and

psychopathology of preschool children. All interviews were audio-recorded and supervised. Researchers conducted a face-to-face interview with the children's parents and, afterwards, they filled the questionnaires. Participants and their families followed the same procedures at each annual assessment. Data were collected between November 2009 and July 2010; November 2010 and July 2011; and November 2011 and July 2012.

4.4. Statistical Analyses

The statistical analysis was carried out with SPSS20 for Windows. To handle the multistage design (the sample analyzed in this work was selected through a screening procedure), the Complex Samples (CS) module was used defining a planning file with weights for each child equal to the inverse of the probability selection in the screening phase of sampling.

The child weight was analyzed and interpreted in both a categorical-binary scale and a dimensional scale. The binary categorization non-overweight versus overweight was based on the WHO (2006) criterion. The dimensional weight measure was defined as the standardized BMI z-score.

In order to carry out the analysis of the relationship between behavioral problems with weight status, cross-sectional and longitudinal associations were performed. This was achieved by using General Linear Models (GLM) for quantitative outcomes (SDQ scores) and binary logistic regression for binary outcomes (presence *vs*. absence of DSM-IV disorders). Due to the strong association between children's weight status and SES (Stamatakis, Wardie, & Cole, 2010), as well as the relationship between SES and behavioral problems in preschoolers in developed countries (Sawyer, Harchak, Wake, & Lynch, 2011), all the analyses were controlled by including the SES covariate. For the analyses of longitudinal data, one additional variable was included as a covariate, SDQ scores at baseline (age 3), to obtain the specific risk of psychopathology attributable to the child's weight, independent of psychological baseline state.

In order to assess the risk factors for overweight in preschool children, longitudinally associations between early risk factors before age 3 (independent variables) and weight status at 3, 4 and 5 years-old (dependent variables) were carried out. This was achieved by using binary logistic regressions through *stepwise* procedures

to select the best discriminative models of the children's weight group (non-overweight *vs.* overweight) and *stepwise* multiple linear regressions to select the best predictors of the child's z-BMI score. Due the large set of risk factors considered, seven independent models were built for groups of variables: child's characteristics, temperament CBQ-scales, family characteristics, mother psychopathology (ASR), father psychopathology (ASR), parenting style (APQ-Pr) and community. Additionally, all the analyses were controlled by SES and child's gender.

CHAPTER FIVE:

RESULTS (MANUSCRIPTS)

5. RESULTS (manuscripts)

The results of the research done in the present thesis lead to two scientific manuscripts, the first is published in an indexed journal with impact factor, and the second one is currently under revision. Therefore, the results section is composed by two distinct studies, each one focused on the stated objectives and hypothesis, respectively.

Study 1:

Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2015). The relationship between weight status and emotional and behavioral problems in Spanish preschool children. *Journal of Pediatric Psychology*, *40*(4),455-463. doi: 10.1093/jpepsy/jsu107

Study 2:

Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2016) *Risk factors for overweight in early ages: longitudinal design with Spanish preschoolers.* Manuscript submitted for publication.

5.1. Study 1: The relationship between weight status and emotional and behavioral problems in Spanish preschool children

Pérez-Bonaventura, I., Granero, R., & Ezpeleta, L. (2015). The relationship between weight status and emotional and behavioral problems in Spanish preschool children. *Journal of Pediatric Psychology*, *40*(4),455-463. doi: 10.1093/jpepsy/jsu107

ISSN: 0146-8693 FI ISI: 2.472 (2014)

Category Name	**Total Journals in Category**	**Journal Rank in Category**	**Quartile in Category**
PSYCHOLOGY, DEVELOPMENTAL	68	21	Q2

The Relationship Between Weight Status and Emotional and Behavioral Problems in Spanish Preschool Children

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Objective To examine cross-sectional and longitudinal associations between behavioral problems and weight status, considering body mass index (BMI) z-scores and overweight status, in a community sample of preschoolers. **Methods** The Strengths and Difficulties Questionnaire and the Diagnostic Interview for Children and Adolescents were administered to 611 parents. Adjusted general linear models and binary logistic regressions were used. **Results** Children who were overweight and had a higher BMI were at increased risk of peer problems and attention-deficit/hyperactivity disorder (ADHD) symptoms. Prospective analyses showed that a higher BMI at the age of 3 years was predictive of peer problems at ages 4 and 5 years and hyperactivity and ADHD symptoms at the age of 4 years. **Conclusion** This is the first study using a diagnostic-based instrument that shows a relationship between weight status and ADHD symptoms in preschoolers. Overweight children might benefit from screening for behavioral disorders and peer relationship problems.

Key words behavioral problems; BMI; children; overweight; peer problems; preschool.

Throughout the world, childhood obesity is a public health concern that poses serious threats to children's health and is being found at ever younger ages (Kim et al., 2006). At present, 43 million children aged ≤5 years are overweight and obese, while an additional 92 million are at risk of becoming overweight (de Onis, Blössner, & Borghi, 2010).

Childhood obesity is associated with increased risk of numerous physical health conditions and a greater risk of obesity in adulthood (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008). There is growing interest not only in knowing the physical consequences of obesity but also in understanding the relationship between obesity and mental health. Research has revealed several associations between overweight or obesity in children and health-related quality of life (Williams, Wake, Hesketh, Maher, & Waters, 2005), risk of bullying (Janssen, Craig, Boyce, & Pickett, 2004), social isolation (Strauss & Pollack, 2003), and behavioral problems (Mustillo et al., 2003). Nevertheless, most studies are cross-sectional and only focus on school-aged children. It is unclear how relevant these findings are for children <5 years of age.

The preschool years are a critical window for obesity prevention, as rapid weight gain in early childhood is associated with later obesity (Baker, Olsen, & Sørensen, 2007) and lifestyle changes made during this period are more durable (Olstad & McCargar, 2009). As such, there is a need for studies that focus on the preschool years, especially on early adiposity rebound (Garthus-Niegel, Hagtvet, & Vollrath, 2010).

Few community studies have examined the cross-sectional association between overweight, body mass index (BMI), and mental health in young children. Five studies found positive associations, reporting that behavioral problems were positively related to a higher BMI and

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overweight (Anderson, He, Schoppe-Sullivan, & Must, 2010; Datar & Sturm, 2004; Griffiths, Dezateux, & Hill, 2011; Olsen et al., 2013; Sawyer et al., 2006), although one found rather small effect sizes (Sawyer et al., 2006) and three found none (Garthus-Niegel et al., 2010; Lawlor et al., 2005; Mackenbach et al., 2012). However, correlating these studies is difficult owing to the age ranges of their subjects (2–5 years) and the studies' differing behavioral constructs. Moreover, in existing studies, psychopathology is usually based only on dimensional measures; no study has used a diagnosis from the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000) as an outcome. Most of the limited research in this area has been carried out in the United States, Australia, and northern European countries. Given the high prevalence of overweight and obesity across Southern Europe (van Stralen et al., 2012), further research is needed on preschoolers in these countries, including Spain. Finally, although often overlooked, increasing evidence points to a significant association between attention-deficit/hyperactivity disorder (ADHD) and both obesity and higher-than-average BMI standard deviation scores. This link has been established in adults, adolescents, and children (Cortese & Vincenzi, 2012). However, most studies have examined this association in clinical samples while none has studied it in a community sample of preschoolers using a diagnostic interview to identify ADHD symptoms.

Accordingly, the aim of this study is to investigate cross-sectional and longitudinal associations between weight status (BMI z-scores and overweight status) and behavioral problems in a large community sample of Spanish preschool children aged 3–5 years. The study's longitudinal design allows us to examine whether early overweight signals the likelihood of psychological problems later in life. To ensure a comprehensive assessment, behavioral problems were assessed with standardized questionnaires to capture dimensionally scored symptoms and a diagnostic interview to identify psychological disorders according to the DSM-IV-TR criteria.

It was hypothesized that children who had a higher BMI z-score (quantitative measure) and were overweight (qualitative measure based on the World Health Organization [WHO] child growth standards for preschoolers) would be more likely to have more externalizing symptoms (Hypothesis 1). Specifically, given the body of literature (Cortese & Vincenzi, 2012), we hypothesized that children who had a higher BMI z-score and were overweight would be more likely to have ADHD symptoms (Hypothesis 2). Additionally, this study examined the relationship between peer problems and overweight. Based on theoretical and community studies (Griffiths et al., 2011), it was hypothesized that a higher BMI z-score and overweight would be associated with peer problems in the preschool years (Hypothesis 3). Finally, we hypothesized that BMI z-score and overweight at age 3 years would predict behavioral problems and peer problems at ages 4 and 5 years (Hypothesis 4).

Methods

Participants

The participants were 622 three-year-old children and their parents. The data were derived from the assessment of a large-scale longitudinal project on psychopathology and risk factors specifically focused on behavioral problems in preschool children (Ezpeleta, de la Osa, & Doménech, 2014). A community sample of 2,283 children in the first year of preschool education was randomly selected from the census of preschool facilities centers in Barcelona, Spain, in 2009. In the first phase, 1,341 families (58.7%) agreed to participate. There were no significant sex differences between the participants and those who declined to participate ($p = .951$). However, the proportion of refusals was statistically higher for families in low socioeconomic status (SES; Hollingshead, 1975) groups ($p < .001$).

The screening procedure for the selection of children with possible behavioral problems was carried out by administering, to parents, four items from the Strengths and Difficulties Questionnaire (SDQ; Ezpeleta, Granero, de la Osa, Penelo, & Doménech, 2013) conduct problems scale plus four questions derived from the DSM-IV-TR diagnostic criteria for Oppositional Defiant Disorder (ODD). Based on the results of the screening process, two groups were formed. The positive screen group ($n = 205$; 51.2% boys) included all the children who reached the threshold for behavioral problems as defined by SDQ ≥ 4 on the conduct problems scale, corresponding to Percentile 90 in community samples (Ezpeleta et al., 2014), or any "certainly true" responses to any of the eight parent's self-reported oppositional defiant symptoms. The negative screen group ($n = 417$; 49.4% boys) included a random sample from the 30% of children who did not reach the threshold (the percentage of negative screen participants guaranteeing adequate statistical power for the analysis planned in the research). At this stage, in 135 cases (10.6%), the parents declined to continue with the study and follow-up; these cases did not differ in sex ($p = .815$) or type of school ($p = .850$) from those who agreed to continue, but the parents who agreed to participate were of a higher SES ($p = .007$). Exclusion criteria were (a) child with

intellectual disability or pervasive developmental disorder; (b) parental lack of fluency in Spanish or Catalan; (c) no parent to provide reports on the child; or (d) family relocating outside the study area within 12 months. In all, 75 families were excluded.

Of the 622 families that agreed to take part in the follow-up (considered the second phase of the study), 11 children were excluded due to missing height or weight measurement data. Consequently, the sample for this study comprised 611 three-year-old children and their parents. Children were followed up yearly at age 4 ($N = 596$) and 5 ($N = 564$) years. Dropouts were statistically equal by gender ($p = .188$) and SES ($p = .062$).

Measures

Psychopathology

The SDQ (Goodman, 1997) is a widely used brief questionnaire for parents designed to assess children's behavioral and emotional difficulties. It contains 25 items, five in each of the five subscales: emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behavior. Response options are "not true", "somewhat true", or "certainly true", scoring 0, 1, and 2, respectively. Higher scores indicate more problems on all five subscales. An overall emotional-behavioral difficulties score is generated by summing the subscale scores, with the exception of the prosocial behavior subscale. The total difficulties score ranges, for the remaining 20 questions, from 0 to 40, with higher scores indicating greater difficulties. The Spanish version of the SDQ has well-established psychometric properties (Ezpeleta et al., 2013). The study sample alpha values for each subscale were as follows: .51 for the emotional subscale, .59 for conduct problems, .74 for hyperactivity, .53 for peer problems, .56 for prosocial behavior, and .80 for the total difficulties scale (low consistency for first-order scales must be interpreted with caution, as there were only five items).

The Diagnostic Interview for Children and Adolescents for Parents of Preschool and Young Children (DICA-PPY; Reich & Ezpeleta, 2009) is a computerized semistructured diagnostic interview for parents of children between 3 and 7 years old. The instrument is administered by a clinician and used to assess the most common psychological disorders according to the DSM-IV-TR criteria (American Psychiatric Association, 2000). Diagnoses are generated through computerized algorithms, and disorders are assessed over the lifetime. The instrument has been translated into Spanish and validated. Validation has shown acceptable test–retest reliability and moderate convergence with other psychopathology measures, as well as the ability to differentiate preschoolers and young children who had used mental health services (Ezpeleta, de la Osa, Granero, Doménech, & Reich, 2011). This study only analyzed disruptive disorders including ADHD, ODD, and conduct disorder.

Weight Measures

Children were weighed and their height was measured while they were barefoot and wearing light clothes. Weight and height measurements were taken by nurses at outpatient pediatric primary care units during each child's annual visit to the pediatrician. These values were recorded in the child's medical records and were recovered annually during the course of this study. BMI was calculated as the ratio between weight (kg) and height (m^2). The BMI z-scores were calculated from WHO reference curves (World Health Organization, 2006). Children were classified in binary fashion as nonoverweight or overweight according to the WHO international age- and sex-specific child growth standards (World Health Organization, 2006). Based on the WHO recommendations specifically for preschool-aged children, overweight was defined as having a BMI greater than two standard deviations from the mean weight in the WHO reference population (de Onis et al., 2010). The WHO child growth standards are among the most internationally accepted classifications and are extensively used in the Spanish setting. Classifying children based on the BMI criteria has the potential to produce different results according to distinct clinical and public health contexts (Jansen, Mensah, Nicholson, & Wake, 2013). As such, two measures were used through the study: (a) a qualitative, binary variable (overweight status), and (b) a quantitative variable (BMI z-score).

Family Demographic Characteristics

Parents' responses included information on social, demographic, and health characteristics. SES was coded according to the Hollingshead index (1975). With the combination of education and occupation, five categories emerged: (a) high, (b) mean-high, (c) mean, (d) mean-low, and (e) low.

Procedure

This study was approved by the ethics review committee at the authors' institution. Families were recruited at the schools and, following a study description, parental consent was obtained. Parents of children in Grade P3 (3-year-olds) at the participating schools were invited to complete the SDQ at home and return it to the schools. Families who agreed and met the screening criteria were contacted by telephone and interviewed at the school. Interviewers

were all experienced graduate students who received 1 week's intensive training from the third author on the developmental psychology and psychopathology of preschool children and the use of the DICA-PPYC interview and the SDQ assessment instrument. To ensure the reliability and validity of the tests, all the interviews were audio-recorded and supervised. Researchers conducted a face-to-face interview with the children's parents and gave the parents the SDQ to fill out. Participants and their families followed the same procedures at each annual assessment. Data were collected between November 2009 and July 2010, November 2010 and July 2011, and November 2011 and July 2012.

Statistical Analyses

The statistical analysis was carried out with SPSS20 for Windows, specifying the list-wise procedure to manage the missing data. To handle the multistage design (the sample analyzed in this work was selected through a screening procedure), the Complex Samples module was used to draw up a planning file with weights inversely proportional to the probability of the participant's selection.

The comparison of the sample children's weight with a reference population (World Health Organization, 2006) is based on the creation of a binary variable (nonoverweight vs. overweight). The BMI z-score as a dimensional score variable has also been analyzed since a dimensional measure allows more statistical power and accuracy.

Cross-sectional and longitudinal associations between weight status and behavioral problems were assessed. This was achieved by using general linear models (GLM) for quantitative outcomes (SDQ scores) and binary logistic regression for binary outcomes (presence vs. absence of DSM-IV disorders). Owing to the strong association between children's weight status and SES (Stamatakis, Wardie, & Cole, 2010), as well as the relationship between SES and behavioral problems in preschoolers in developed countries (Sawyer, Harchak, Wake, & Lynch, 2011), all the analyses were controlled by including the SES covariate. For the analyses of longitudinal data, one additional variable was included as a covariate, SDQ scores at baseline (age 3 years), to obtain the specific risk of psychopathology attributable to the child's weight, independent of baseline. Children's sex was not included as a covariate owing to the absence of a statistical association in the sample: (a) χ^2 comparing the prevalence of overweight by gender obtained $p = .99$, $p = .81$, $p = .08$, at ages 3, 4, and 5 years; (b) t test comparing the BMI means by gender obtained $p = .75$, $p = .62$, $p = .14$ at ages 3, 4, and 5 years.

All the effect sizes for the relationships analyzed in the work have been estimated. For comparisons of means and proportions, effect sizes were measured through Cohen's d coefficient (small $|d| < .5$, moderate $|d| > .5$, and large $|d| > .8$) and with the 95% confidence interval (95% CI) for mean differences and odds ratio (*OR*). The effect size for linear and logistic regressions was measured through the 95% CI for the B (slope) and *OR*.

Results

Descriptives

Demographic characteristics at baseline stratified by weight group are shown in Table I. Differences between weight groups were found for ethnicity and SES: The prevalence of overweight children was higher for Hispanics (from families of Latin American origin), other ethnic minority groups, and families with lower SES.

Overall, 7.2% of children at age 3 years were overweight (equal prevalence for boys and girls), 8.2% at age 4 years (boys: 7.9%; girls: 8.5%), and 8.7% at age 5 years (boys: 6.7%; girls: 10.8%). No statistical association emerged for gender and children's overweight status (age 3 years: $p = 1.00$; age 4 years: $p = .814$; age 5 years: $p = .083$) or for gender and BMI (age 3 years: $p = .754$; age 4 years: $p = .619$; age 5 years: $p = .143$).

Table I. *Descriptives for the Sample (Age 3 Years)*

	Nonoverweight (N = 558)	Overweight[a] (N = 53)	p[b]
Gender (male); *n* (%)	278 (49.8)	27 (50.9)	.876
Ethnicity; *n* (%)			
White	505 (90.5)	40 (75.5)	.006
Hispanic	37 (6.6)	10 (18.9)	
Other	16 (2.9)	3 (5.7)	
SES; *n* (%)			
High	194 (34.8)	9 (17.0)	.005
Mean-high	178 (31.9)	14 (26.4)	
Mean	77 (13.8)	9 (17.0)	
Mean-low	81 (14.5)	15 (28.3)	
Low	28 (5.0)	6 (11.3)	
One single parent; *n* (%)	27 (4.8)	2 (3.8)	.769
Number of family members; *mean (SD)*	4.00 (0.86)	4.19 (0.94)	.139
Body mass index; *mean (SD)*	15.5 (1.59)	20.7 (2.79)	<.001

Notes. [a]Children were classified as nonoverweight or overweight according to the World Health Organization international age- and sex-specific criteria. [b]p-value obtained through for categorical measures and t test for quantitative measures. SES = socioeconomic status based on education and occupation (Hollingshead, 1975); SD = standard deviation.

Cross-Sectional Associations Between Weight Status and Behavioral Problems

Table II shows the descriptive statistics (means and percentages) for the behavioral problems stratified by age and weight status (BMI z-score and overweight) and the results of the GLM and binary logistics adjusted for the SES covariate. At age 3 years, children who were overweight had a higher prevalence of ODD than nonoverweight children. At age 4 years, being overweight was associated with higher percentages of ADHD. At age 5 years, children who were overweight had significantly higher mean scores for peer relationship problems than nonoverweight children. The effect sizes for the comparisons were low. At age 3 years, a higher BMI z-score was associated with more severe conduct problems and lower pro-social behavior scores. At age 4 years, a higher BMI z-score was related to higher scores on the hyperactivity and total problems scale, and to higher percentages of ADHD and conduct disorder. At age 5 years, there was no association between BMI z-score and behavioral problems.

Longitudinal Associations Between Weight Status and Behavioral Problems

Table III presents the results of GLM models that evaluate the association between BMI z-score and overweight status at age 3 years and subsequent behavioral problems at ages 4 and 5 years, after controlling for SES and SDQ scores at baseline. Overweight status at age 3 years predicted higher scores in hyperactivity problems at age 4 years. There was no association between being overweight at age 3 years and having behavioral problems at age 5 years. A higher BMI z-score at age 3 years was related to higher mean scores in hyperactivity problems, peer relationship problems, and total difficulties and to higher percentages for ADHD at age 4 years. A higher BMI z-score at age 3 years also predicted more peer relationship problems at age 5 years.

Discussion

This study was designed to investigate the association between weight status and behavioral problems in preschool children selected from the general population. The results suggest, as hypothesized, that a higher BMI and overweight status are associated with specific behavioral problems at young ages.

In accordance with previous findings (Anderson et al., 2010), conduct problems and ODD were associated cross-sectionally with overweight and a higher BMI at age 3 and 4 years. Given the body of literature (Cortese & Vincenzi, 2012), a specific association, confirmed by this study, was

Table II. *Cross-Sectional Associations Between Group of Weight and Psychological Measures*

	Age 3 years								Age 4 years								Age 5 years							
	Independent variable					Independent variable			Independent variable					Independent variable			Independent variable					Independent variable		
	Overweight					BMI			Overweight					BMI			Overweight					BMI		
						$n = 611$						$n = 541$	$n = 55$	$n = 596$				$n = 508$	$n = 56$	$n = 564$				
SDQ; *mean*	No $n = 558$	Yes $n = 53$	MD	|d|	95%CI MD	B	95%CI B		MD	|d|	95%CI MD	B	95%CI B		No	Yes	MD	|d|	95%CI MD	B	95% CI B	
Emotion	1.44	2.06	−0.46	0.40	−0.95, 0.03	0.011	−0.060, 0.081		0.93	1.44	−0.54	0.30	−1.27, 0.19	0.067	−0.002, 0.136		1.01	1.07	−0.02	0.04	−0.44, 0.40	0.026	−0.064, 0.115	
Conduct	2.57	3.44	−0.64	0.47	−1.28, 0.00	**0.092***	0.006, 0.179		1.84	1.87	−0.04	0.02	−0.52, 0.43	0.036	−0.052, 0.124		1.42	1.53	−0.05	0.07	−0.57, 0.47	−0.012	−0.113, 0.088	
Hyperactivity	3.87	4.62	−0.35	0.31	−1.06, 0.37	0.049	−0.057, 0.154		2.98	3.72	−0.57	0.27	−1.52, 0.37	**0.151***	0.026, 0.275		3.10	3.21	0.07	0.05	−0.64, 0.79	0.088	−0.064, 0.241	
Peer	1.30	1.69	−0.18	0.22	−0.76, 0.40	−0.037	−0.136, 0.062		0.85	1.38	−0.51	0.30	−1.22, 0.21	0.068	−0.004, 0.139		0.79	1.38	**−0.50***	0.42	−1.00, 0.00	0.067	−0.013, 0.147	
Pro-social	2.12	2.02	0.01	0.06	−0.52, 0.54	**−0.113***	−0.218, −0.009		1.67	2.03	−0.44	0.19	−1.18, 0.30	0.023	−0.089, 0.136		1.60	1.62	−0.05	0.01	−0.54, 0.43	0.007	−0.088, 0.101	
Total	9.18	11.74	−1.54	0.49	−3.37, 0.28	0.109	−0.117, 0.335		6.59	8.40	−1.67	0.31	−3.90, 0.57	**0.322***	0.083, 0.561		6.32	7.20	−0.50	0.18	−1.96, 0.97	0.169	−0.127, 0.464	
DICA-PPY; %			OR	|d|	95%CI OR	OR	95%CI OR				OR	|d|	95%CI OR	OR	95%CI OR				OR	|d|	95%CI OR	OR	95%CI OR	
Any disruptive	9.4	20.6	1.92	0.32	0.87, 4.21	1.06	0.90, 1.25		8.3	17.3	1.79	0.27	0.80, 4.03	1.04	0.92, 1.18		9.6	7.4	0.66	0.08	0.27, 1.65	1.00	0.79, 1.27	
ADHD	3.3	8.3	1.67	0.22	0.60, 4.68	0.95	0.70, 1.29		4.4	13.6	**2.68***	0.33	1.02, 7.02	**1.17***	1.03, 1.34		4.3	3.7	0.58	0.03	0.16, 2.07	0.95	0.66, 1.37	
ODD	6.3	16.5	**2.40***	0.33	1.02, 5.67	1.12	0.96, 1.31		5.1	6.2	0.89	0.05	0.33, 2.37	1.01	0.87, 1.18		6.5	4.9	0.73	0.07	0.24, 2.19	1.01	0.71, 1.43	
Conduct	1.3	2.8	1.58	0.11	0.32, 7.90	1.11	0.93, 1.32		0.1	1.2	7.16	0.14	0.67, 76.81	**1.23***	1.01, 1.50		0.6	0.0	–	–	–	1.13	0.92, 1.39	

Notes. Results for GLM (SDQ scores) and binary logistic regressions (DICA diagnoses) adjusted for socioeconomic status. *Bold, significant result (.05 level). MD = mean difference (no vs. yes); OR = odds ratio; |d| = Cohen's d coefficient; – = not estimated due to small sample size. SDQ = Strengths and Difficulties Questionnaire; DICA-PPY = Diagnostic Interview for Children and Adolescents for Parents of Preschool and Young Children.

Table III. *Longitudinal Associations Between Group of Weight at Age 3 Years and Psychological Measures at Ages 4 and 5 Years*

	Psychological measures at age 4 years							Psychological measures at age 5 years						
	Independent variable: overweight					Independent variable: BMI		Independent variable: overweight					Independent variable: BMI	
						$n = 593$							$n = 526$	
SDQ; *mean*	NO $n = 540$	YES $n = 53$	MD	$\|d\|$	95%CI MD	B	95% CI B	NO $n = 478$	YES $n = 48$	MD	$\|d\|$	95%CI MD	B	95% CI B
Emotion	0.91	1.62	−0.54	0.42	−1.17, 0.08	0.057	−0.009, 0.123	0.99	1.32	−0.14	0.24	−0.55, 0.26	0.021	−0.055, 0.097
Conduct	1.81	2.26	−0.20	0.26	−0.69, 0.29	−0.010	−0.088, 0.069	1.42	1.53	0.11	0.07	−0.44, 0.66	−0.039	−0.131, 0.053
Hyperactivity	2.95	4.15	**−0.77***	0.50	−1.47, −0.06	**0.114***	0.021, 0.207	3.04	3.91	−0.54	0.37	−1.16, 0.08	0.075	−0.042, 0.193
Peer	0.87	1.25	−0.30	0.24	−0.93, 0.33	**0.078***	0.015, 0.142	0.81	1.12	−0.13	0.24	−0.49, 0.23	**0.071***	0.005, 0.137
Pro−social	1.66	2.14	−0.59	0.25	−1.25, 0.08	0.075	−0.012, 0.162	1.59	1.78	−0.27	0.12	−0.71, 0.17	0.056	−0.013, 0.125
Total	6.54	9.28	−1.56	0.51	−3.40, 0.28	**0.229***	0.022, 0.436	6.27	7.89	−0.46	0.35	−1.87, 0.95	0.116	−0.120, 0.351
DICA-PPY; %			OR	$\|d\|$	95%CI OR	OR	95%CI OR			OR	$\|d\|$	95%CI OR	OR	95%CI OR
Any disruptive	8.7	13.7	0.89	0.16	0.28, 2.80	1.02	0.88, 1.18	9.0	14.1	1.05	0.16	0.32, 3.39	0.95	0.79, 1.16
ADHD	4.5	13.7	2.35	0.32	0.80, 6.90	**1.20***	1.06, 1.36	4.1	7.1	0.94	0.13	0.29, 3.04	0.98	0.76, 1.28
ODD	5.1	6.9	0.63	0.08	0.22, 1.80	0.96	0.82, 1.13	6.0	9.9	1.16	0.14	0.27, 5.00	0.95	0.67, 1.33
Conduct	0.1	1.4	–	–	–	2.20	0.65, 7.38	0.5	1.4	1.12	0.09	0.09, 14.05	1.16	0.81, 1.64

Notes. Results for GLM (SDQ scores) and binary logistic regressions (DICA diagnoses) adjusted for socioeconomic status and SDQ scores at baseline. *Bold, significant result (.05 level). MD = mean difference (no vs. yes); OR = odds ratio; $|d|$ = Cohen's-d coefficient; – = not estimated due to small sample size. SDQ = Strengths and Difficulties Questionnaire; DICA-PPY = Diagnostic Interview for Children and Adolescents for Parents of Preschool and Young Children.

expected between weight status and ADHD. This result is consistent with previous findings (Waring & Lapane, 2008) but, to the best of our knowledge, this is the first community-based study to reveal this relationship in preschool children using a diagnostic interview. The literature has suggested three possible explanations for this correlation. First, ADHD symptoms may lead to deficient inhibitory control and delay aversion, which may foster poor planning and difficulties in adherence to regular patterns, leading to abnormal eating behaviors and consequent weight gain (Cortese et al., 2008). However, in the preschool years, the timing, structure, and content of the meals are largely determined by parents, although it is conceivable that young ADHD children are relatively inattentive to internal signs of hunger and satiety cues, as indicated by Davis, Levitan, Smith, Tweed, and Curtis (2006). Second, being overweight may contribute to ADHD symptoms via neural or other mechanisms, possibly through sleep-disordered breathing (Bass et al., 2004). It may be that excessive daytime sleepiness, secondary to sleep-disordered breathing, leads to inattention via hypoxemia, which, in turn, contributes to altered prefrontal functioning (Bass et al., 2004). Finally, ADHD and overweight status may be two manifestations of a common biological mechanism. Although the mechanism underlying the association is still unknown, preliminary evidence suggests the role of the dopaminergic reward system (Liu, Li, Yang, & Wang, 2008) or melanocortin system (Agranat-Meged et al., 2008).

As hypothesized, overweight status in young children was associated cross-sectionally with higher scores in peer relationship problems at ages 4 and 5 years. This result is consistent with previous research (Griffiths et al., 2011), and one study found this relationship to be even stronger in children 8–9 years of age (Sawyer et al., 2011). A number of related mechanisms might explain the link between overweight and peer relationship problems. Teasing and stigmatization of overweight children may play an important role because they can lead to social marginalization and low self-esteem (Storch et al., 2007). Several studies have shown that this stigmatization begins early in life. Children as young as 3 years old attribute negative and positive adjectives to overweight and nonoverweight individuals, respectively (Lowes & Tiggemann, 2003). Children aged 3–5 years even display a preference for the thin figure compared with one that is average (Harriger, Calogero, Smith, & Witherington, 2010).

In prospective analysis, we found that having a higher BMI z-score at age 3 years was associated with peer relationship problems at ages 4 and 5 years. Together, these data suggest that relationships with peers may become a problem for young overweight children.

Prospective analyses also revealed that the probability of having ADHD symptoms at age 4 years was higher for children who had a higher BMI score at age 3 years. However, after controlling for potential confounding factors such as SES and behavioral problems at baseline, the magnitude of the differential odds was small and not clinically significant. Moreover, this association was not found in the overweight group analysis, and this relationship was not found at age 5 years. Our prospective results might point to specific temporal precedence of overweight

status over ADHD; however, cross-sectionally at age 3 years, children with higher weight had a tendency to score higher on hyperactivity scales and have a greater probability of suffering from ADHD. Indeed, ADHD is a neurodevelopmental disorder that starts early in life, and its detection is based on clinical features that may only become evident as the child grows. Further research is needed to provide more insight into the longitudinal pathways of this relationship. Early detection and treatment of children with both diagnosis (ADHD and overweight) is also important, as it could lead to a reduction in the negative long-term consequences of overweight and ADHD in young people.

In our study, the overall proportion of overweight children was 9%, which is a figure that is consistent with European data for 2010 (11.7%, 95% CI 8.9–15.3; de Onis et al., 2010). Furthermore, in line with previous studies (Anderson et al., 2010; Stamatakis et al., 2010), we found higher rates of child overweight status among ethnic minorities and families in low SES categories. This finding suggests that targeted intervention programs for children in low-income and minority-group families are needed as early as the preschool years.

This study has a number of strengths and makes some significant contributions to the field. A sample of Spanish preschoolers from the general population was followed prospectively. In contrast to similar studies, ADHD and other DSM-IV-TR disorders were assessed using a standardized, validated, strictly DSM-based instrument with good diagnostic properties designed specifically for use with preschoolers (Ezpeleta et al., 2011).

Some of the study's limitations should also be considered when interpreting the results. Firstly, we relied on parents' reports of their child's behavior, which may introduce bias (Seifer, 2005). For example, it is possible that perceptions and judgments of the children's behavior are influenced by their weight status (Anderson et al., 2010). Nonetheless, parents' reports on child behavior have considerable value because they are based on their observations in a naturalistic setting over a long period. Another limitation concerns the measurement of the children's weight and height. Rather than taking the anthropometrical measures in person for research purposes, we took the measures from the children's medical records. Nevertheless, the measures were taken using standardized protocols at all periods and at all sites. In fact, routine weight measurements have been found to be highly accurate, which supports their usefulness for both clinical practice and research (Howe, Tilling, & Lawlor, 2009). Finally, two subscales of the Spanish version of the SDQ had low alphas in the current sample, although this must be interpreted with caution owing to the small number of items. Despite these limitations, this study fills an important gap in the literature of preschool psychopathology. Knowledge of the age at which the association between behavior and weight status becomes significant may be crucial for preventive interventions.

Conclusion

To the best of our knowledge, this is the first study to assess the relationship between weight status and behavioral problems in a large and representative sample of preschoolers, using a diagnostic interview based on DSM-IV-TR taxonomy. The results show that children who are overweight and have a higher BMI have increased odds of presenting ADHD symptoms, peer relationship problems, and other behavioral issues. These findings suggest the need to screen for psychological problems and for difficulties with their peers in children who are overweight. Further studies are needed to examine the modifiers and mediating factors in the relationship between weight status and mental health with a view to improving healthy child development.

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5.2. Study 2: Risk factors for overweight in early ages: longitudinal design with Spanish preschoolers

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Risk Factors for Overweight in early ages: longitudinal design with Spanish Preschoolers

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Running title: Risk Factors for Overweight

Abstract

Background: Previous studies have shown that there are several significant early-life risk factors associated with childhood overweight. However, research has mainly focused on school-aged children. The aim of this study is to identify risk factors in early life for overweight in a community sample of Spanish preschoolers.

Methods: A sample of 622 three-year-olds was monitored until the age of 5, and their height and weight were registered annually. Overweight status was defined by World Health Organization standards. A large set of risk factors including sociodemographic variables, family structure, pregnancy, birth, postnatal period, school and neighborhood were measured through semi-structured interviews. Stepwise logistic regressions created predictive models with the best predictors of overweight for each age group.

Results: Several potential early risk factors in preschool children were associated with later overweight. Two powerful factors were low socioeconomic status (odds ratio=1.47 at age 3, 1.59 at age 4, and 1.43 at age 5) and high birth-weight (odds ratio=1.89 at age 3, 1.87 at age 4, and 2.35 at age 5).

Conclusions: This is the first longitudinal study to examine a large set of risk factors among Spanish preschoolers. Identification in early life of groups of children at higher risk for becoming overweight offers the potential for early prevention and intervention programs.

Key words: BMI, overweight, preschool children, risk factor, Spain.

Risk Factors for Overweight in early ages: longitudinal design with Spanish Preschoolers

Childhood overweight continues to be a major challenge worldwide, associated with serious health consequences and psycho-social outcomes [1]. Alarmingly, one out of four Spanish children is already overweight or obese by age five [2]. This prevalence is of considerable concern owing to the adverse consequences of childhood overweight and the fact that weight status at 5 years of age is a good indicator of the future health of a child [3]. Furthermore, overweight during childhood tends to persist into adulthood [4] with resultant long-term consequences that are difficult to treat successfully in the long term. Therefore, prevention of the onset of overweight is a public health priority and should be a primary target[5]. Indeed, the key to prevention is to examine and fully characterize the factors involved in the development of overweight.

Overweight is a multi-factorial condition influenced by diverse factors operating across the lifespan: genetic, neuroendocrine, metabolic, psychological, environmental and socio-cultural. To develop evidence-based policy and program decision-making, it is crucial to identify the risk factors associated with pediatric overweight. In a recent systematic review of thirty prospective studies from developed countries, several significant early-life risk factors were identified for childhood overweight: maternal pre-pregnancy overweight, high infant birth-weight, early infant rapid weight gain and maternal smoking during pregnancy[6].However, research has mainly focused on school-aged children and adolescents, although the preschool years are a critical period for obesity prevention[7]. Given the high prevalence of overweight across Southern Europe[8], research is particularly needed on preschoolers in these countries, including Spain.

This study explores the main risk factors for the development of childhood overweight in a large community sample of Spanish preschoolers longitudinally assessed from ages 3 to 5 years-old. The set of potential risk factors includes variables of the main areas associated with overweight during childhood and adolescence, including family structure, pregnancy, birth, postnatal period, medical history, school and neighborhood.

Methods

Participants

The data were derived from a large-scale longitudinal project on psychopathology and risk factors specifically focused on behavioral problems in preschool children. A full description of the inclusion criteria, recruitment, and retention strategies is provided elsewhere[9]. In the first phase of two-phase sampling, a community sample of 2,283 children in the first year of preschool education was randomly selected from the census of preschool center facilities in Barcelona, Spain, in 2009. The families were contacted and 1,341 (58.7%) agreed to participate. There were no significant differences by gender among the participants and those who declined to take part (p=.951). However, the proportion of refusals was statistically higher in low socioeconomic status families (SES; Hollingshead index)[10] groups (p< .001). Screening of children with possible behavioral problems was carried out by administering, to parents, four items from the Strengths and Difficulties Questionnaire (SDQ)[9] conduct problems scale plus four questions derived from the Diagnostic and Statistical Manual of Mental Disorders diagnostic criteria for Oppositional Defiant Disorder. Based on the results of the screening process, two groups were formed. The positive screen group (n = 205; 51.2% boys) included all children who reached the threshold for behavioral problems while the negative screen group (n = 417; 49.4% boys) included a random sample from the 30% of children who did not reach the threshold (the percentage of negative screen participants guaranteeing adequate statistical power for the analysis planned in the research).In the second phase, n= 622 children and their parents agreed to take part although 11 children were excluded due to missing height or weight measurement data. Consequently, the sample for this study was n= 611 three-year-old children and their parents. Children were followed-up at age 4 (N = 596) and 5 (N = 564). Drop-outs were statistically equal by gender (p=.188) and SES (p=.062). Excluded were children with intellectual disability or pervasive developmental disorder, no parent to provide reports on the child, parental lack of fluency in Spanish or Catalan, or family relocating outside study area within 12 months.

Measures

Sociodemographic and health characteristics

The Schedule of Risk Factors (SRF)[11] is a semistructured interview answered by parents and conceived of as a compendium of the main areas of psychopathology risk in children. It provides information on the child (e.g., gender and ethnicity), the family (e.g., family structure and maternal smoking during pregnancy) and the community (e.g., distance to a traffic dense route and proximity to school) that could have an impact on the children's psychological status. Inter-rater reliability and concurrent validity are acceptable in Spanish populations. Study variables are detailed in Table 1-online (including the level scale and codification form).

The *Children's Behaviour Questionnaire* (CBQ)[12] is designed to assess temperament in 3 to 7-year-old children. Completed by parents, it contains 94 items over 15 scales clustered in 3 broad dimensions of temperament: negative affectivity (anger-frustration, discomfort, fear, sadness, falling reactivity-soothability), effortful control (attention focusing, inhibitory control, low-intensity pleasure, perceptual sensitivity), and surgency-extraversion (activity level, high-intensity pleasure, impulsivity, shyness). The study sample alpha values ranged between $\alpha = .50$ for sadness and $\alpha = .79$ for shyness.

The *Adult Self Report* (ASR)[13] is a self-report questionnaire that assesses behavioral problems in adults aged 18 to 59. The emotional and behavioral problems section includes 8 empirical syndromes that can be classified as internalizing problems, externalizing problems and total problems. Internal consistency for mothers' reports in this sample ranged between .83 for externalizing problems and .92 for the total score while, for fathers, it ranged between .86 for externalizing problems and .93 for the total score.

The *Alabama Parenting Questionnaire-Pr* (APQ-Pr)[14] assesses the behavior of parents of children with externalizing disorders. It contains 42 items, clustered in 5 subscales: parental involvement, positive parenting, poor monitoring/supervision, inconsistent discipline and corporal punishment. In the Spanish version of the APQ-Pr, two subscales were added: norms and autonomy, this version shows moderate to very good internal consistency in our study sample.

The *Four-Factor Hollingshead Index of Social Status*[10] based on parents' educational level and occupation was used to code the SES into five levels.

Finally, the *Diagnostic Interview of Children and Adolescents for Parents of Preschool and Young Children* (DICA-PPYC)[15] is a semi-structured interview designed to assess the most common psychological disorders at ages 3–7 years according to DSM-IV-TR criteria. Parents were interviewed about the presence of feeding problem symptoms.

Anthropometric variables

Children were weighed and their height was measured while barefoot and wearing light clothes. Measurements were taken and noted in the child's medical record by nurses at outpatient pediatric primary care units during each child's annual visit. These values were recorded in the child's medical records and were recovered annually during the course of this study. BMI (Body Mass Index) was calculated as the ratio between weight (kg) and height (m^2). Children were classified as non-overweight or overweight (obesity included) according to the World Health Organization (WHO) international age- and sex-specific child growth standards specifically for preschool-aged children[16]. Based on the WHO recommendations specifically for preschool-aged children, overweight was defined as having a BMI greater than two standard deviations from the mean weight in the WHO reference population[17]. However, categorizing children based on BMI criteria can produce different classifications with varying clinical and public health implications[18]. Therefore, the BMI z-scores were also calculated from WHO reference curves[16]. As such, throughout the study, two measures were analyzed: (a) a binary variable (non-overweight status vs overweight) extensively used in clinical settings; and (b) a quantitative variable (BMI z-scores) (online) mainly used for research purposes.

Procedure

This longitudinal project was approved by the ethics review committee at the authors' institution. Heads of the participating schools and parents were provided with a full description of the study. Families were recruited at the schools, and parental consent was obtained. Parents of children in Grade P3 (three-year-olds) at the participating schools were invited to answer the SDQ at home and return it to the schools. Families who agreed and met the screening criteria were contacted by telephone and interviewed at the school. Interviewers were all experienced graduate students who received training on the developmental psychology and psychopathology of preschool children and on the use of the DICA-PPYC and the Schedule of Risk Factors. To ensure the reliability and

validity of the tests, all the interviews were audio-recorded and supervised. Researchers conducted a face-to-face interview with the children's parents before the parents answered the questionnaires. Participants and their families followed the same procedures at each annual assessment. Data were collected annually between November, 2009 and July, 2012.

Statistical analysis

The statistical analysis was carried out with SPSS20 for Windows. Due to the multi-sampling design (the data analyzed in this work were selected through a sampling procedure including a screening tool), the Complex Samples module (CS) was used, assigning to each child a weight inversely proportional to the probability of the participant's selection in the second phase of the design (after the screening).

We longitudinally assessed associations between early risk factors (independent variables) before age 3 and weight status (presence of overweight and z-BMI scores; dependent variables) at 3, 4 and 5 years-old. This was achieved by using binary logistic regressions through *stepwise* procedures to select the best discriminative models of the children's weight group (non-overweight *vs.* overweight) and *stepwise* multiple linear regressions to select the best predictors of the child's z-BMI score. Due the large set of risk factors considered (Table 1-online), seven independent models were built for groups of variables: child's characteristics, temperament CBQ-scales, family characteristics, mother psychopathology (ASR), father psychopathology (ASR), parenting style (APQ-Pr) and community. Additionally, due to the strong association between children's weight status and SES[19], all the analyses were controlled by family SES. The analyses were also controlled for child's gender. This was carried out entering in a first block of the multiple and logistic regressions the covariates family SES and child's gender. The predictive capacity of the risk factors selected in the final models was measured through the change in the R^2 coefficient (linear regressions) and the change in Nagelkerke's-R^2 (logistic regressions) (ΔR^2), comparing the first block with the covariates and the second block with the selected risk factors.

Results

Sample characteristics

Table 1 includes the characteristics of the sample at baseline (age 3 years-old) stratified by children's weight group. Overall, 7.2% of children at age 3 were overweight (7.2% boys and 7.2% girls, p=1.00), 8.2% at age 4 (7.9% boys and 8.5% girls, p=.814) and 8.7% at age 5 (6.7% boys and 10.8% girls, p=.083). No statistical association emerged for gender and z-BMI (p=.754, p=.619 and p=.143 at ages 3-4-5).

Statistical differences related to overweight emerged for ethnicity and SES; prevalence of overweight was higher for Hispanics (Latin American origin), other ethnic minority groups and families with lower SES.

--- Insert Table 1 ---

Risk Factors for child's overweight

Table 2 presents the results for the second block/step of the final stepwise logistic regressions selecting the main risk factors for child's overweight at ages 3, 4 and 5. These results are adjusted for the family's SES and child's sex covariates. The presence of overweight at age 3 was related to lower CBQ-attention focusing score, higher birth weight, more developmental delays, lower SES, smoking during pregnancy and higher scores in the APQ-inconsistent discipline scale.

Being over-weight at age 4 was predicted by non-Caucasian ethnicity, higher birth weight, more hours watching TV, the absence of feeding symptoms, more developmental delays, lower SES and lower scores in the parenting style norms scale before age 3.

Overweight at age 5 was predicted by non-Caucasian ethnicity, higher birth weight, more visits to the doctor, daily medication, lower SES and higher ASR-father-total score before age 3.

The predictive capacity of the final logistic regressions selecting the best overweight risk factors was low to moderate. The lowest ΔR^2 corresponded to the models; parenting style at age 3 (1.9%), CBQ at age 3 (2.4%) and ASR-father at age 5 (2.9%). The highest ΔR^2 was for the child characteristics models at age 4 (10.1%) and 5 (8.5%).

--- Insert Table 2 ---

Table 2-online shows the results for the second block/step of the final stepwise multiple regressions selecting the main variables related to the z-BMI score, adjusted for the family's SES and child's sex covariates. The set of predictors selected was similar to that obtained with the logistic regressions for the dependent variable child's overweight. However, for the dependent variable z-BMI score, at age 3 the variable "living near to a dense street" was selected, at age 4 the variable "teasing for appearance" was a significant predictor, and at ages 4 and 5 "being clumsy" was an additional predictor.

Discussion

To the best of our knowledge, this is the first community-based study to examine a variety of risk factors for overweight in a sample of Spanish preschoolers. The stepwise regression analysis revealed several risk factors, especially low socioeconomic status and high birth weight. These were independently associated with overweight, and this pattern remained for both genders over the 3-year assessment. As in other studies[19], we observed a gradient whereby children of socioeconomically disadvantaged families were more likely to be overweight. That this is seen in preschool years suggests that differences in adiposity by socioeconomic status may emerge early in life. Moreover, studies have demonstrated an association between high birth weight and overweight in children[6], underlining the importance of weight monitoring from postpartum.

In this study, American-Hispanic children had tripled the prevalence of overweight found in Caucasian children. Ethnic minorities have been shown to be more prone to overweight in many European countries[20].

Lower scores in the CBQ attention focusing scale were associated with overweight at age 3 supporting studies linking attention deficit with excess weight in childhood. Faith and Hittner[21] found that among boys, poorer attention span at the age of 1 year predicted greater weight gain at 6 years of age. Results obtained in a previous study using the same sample showed that ADHD symptoms were associated with overweight as early as the preschool years[22]. It might be that reduced attention span interferes in the development of self-regulatory eating and satiety recognition, leaving the child relatively inattentive to hunger and satiety cues.

Maternal smoking during pregnancy was associated with overweight at age 3. The relationship between maternal smoking and childhood obesity has been described as catch-up growth following low birth weight caused by smoking during pregnancy or the poorer eating habits of smoking mothers[23].

In line with other reports[24], excess television screen time, before the age of 3 years-old was associated with overweight at 4 years-old. Various mechanisms may explain this association; prolonged periods of inactivity, the opportunity to eat snacks, a decline in energy expenditure, and the influence of commercials on food choices and nutrition. Consequently the American Academy of Pediatrics[25], has recommended for over a decade that parents limit television viewing to no more than 2 h per day.

This study showed that when a child presented symptoms of DSM-IV feeding disorder of infancy before the age of 3 (a child's refusal to eat certain food groups, textures, solids or liquids or refusal to accept new foods), there was a negative association with overweight.

Some aspects of early parenting style were associated with later excess of body weight such as inconsistent discipline, fewer rules and corporal punishment. Whitaker et al.[26] reported that the odds of obesity for 3-year-old children were 50% higher for those who experienced neglect in the previous year. In another study, those adults who reported experiencing harsh physical punishment during childhood had a higher likelihood of obesity[27]. Moreover, lack of effective rules in families with obese children often interferes with the development of regulated eating patterns.

Among fathers, some psychological symptoms scales, such as externalizing symptoms and total number of symptoms, were associated with the child's weight. Adults with binge eating disorders describe their childhood environment and the parenting they received more negatively than healthy controls[28]. During childhood, they might have used eating as a strategy to cope with negative feelings. The effect of father's psychopathology on the child's weight may also be mediated through parenting. Knowledge of the mechanisms involved may help us to modify dysfunctional associations and improve the child's adjustment.

On a community level, the only variable that showed a relationship with weight status was living near a traffic dense route (<300 m), which was only associated with z-BMI at age 3. Growing evidence suggests air pollution as a risk factor for the development of obesity and overweight. Several epidemiological studies have reported an association between various ambient and indoor air pollutants and obesity[29].

Evidence-based research to link children's health, physiology, and behavior to atmospheric extremes is an important area of future research.

This study indicates that greater understanding of the risk factors identified might help with early prevention and intervention programs. The fact that we included a community population of young children within a small age range specific to preschool age group adds to existing knowledge. The main study strengths are the longitudinal assessment of risk factors of overweight in preschool children, the inclusion of a large set of potential predictors including individual-, family- and community-level factors and a large community sample (from the general population). Some of the study's limitations should also be considered when interpreting the results. Had the data been available, additional relevant risk factors potentially contributing to weight gain in childhood could have been explored, such as, parental overweight, physical activity or energy expenditure. However, this study is the first to examine a broad variety of risk factors for overweight in Spanish preschoolers. Future studies should explore more detailed information on these risk factors. Another study limitation is that measurements of the children's weight and height were taken from medical records, although routine weight measurements have been found to be highly accurate, which supports their usefulness in both clinical practice and research[30]. The preschool years are a period of rapid growth and habit formation. Knowledge of the age at which the association between early specific risk factors and weight status becomes significant can provide avenues for early interventions.

Conclusions

The present study identified several risk factors for the presence of overweight in preschoolers. Low socioeconomic status and high birth weight emerged as two groups where the risk of overweight was especially high. It would appear to be appropriate to monitor the health status in these groups and to implement focused preventive measures.

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Table 1. Descriptives for the sample at baseline (age 3 years-old)

		Non-overweight (N= 558)		Overweight (N= 53)		*p*
Gender (male); *n (%)*		278	(49.8%)	27	(50.9%)	.876
Ethnicity; *n (%)*	Caucasian	505	(90.5%)	40	(75.5%)	.006
	American-Hispanic	37	(6.6%)	10	(18.9%)	
	Other	16	(2.9%)	3	(5.7%)	
SES; *n (%)*	High	194	(34.8%)	9	(17.0%)	.005
	Mean-High	178	(31.9%)	14	(26.4%)	
	Mean	77	(13.8%)	9	(17.0%)	
	Mean-Low	81	(14.5%)	15	(28.3%)	
	Low	28	(5.0%)	6	(11.3%)	
BMI; *mean (standard deviation)*		15.5	(1.59)	20.7	(2.79)	<.001

p-value obtained through χ^2 for categorical measures and T-TEST for quantitative measures.

BMI, body mass index (kg/m^2); SES, Socioeconomic status.

Table 2. Final predictive models for the children's group of weight

	Significant predictors	B	SE(B)	Sig	OR	95%CI for OR		ΔR^2
Overweight at age 3								
Child characteristics	Birth-weight (kg)	0.639	0.324	.049	1.895	1.004	3.576	0.04
	Number delays in development	0.464	0.165	.005	1.591	1.150	2.201	
CBQ-Temperament	Attention focusing	-0.347	0.141	.014	0.707	0.536	0.932	0.02
Family	SES (1=high to 5=low)	0.386	0.127	.002	1.472	1.147	1.888	0.07
	Smoking during pregnancy	0.770	0.367	.036	2.161	1.051	4.440	
ASR-Mother	*None*							
ASR-Father	*None*							
APQ Parenting style	Inconsistence	0.135	0.062	.029	1.144	1.014	1.291	0.02
Community	None							
Overweight at age 4								
Child characteristics	Ethnic (non- Caucasian)	0.856	0.430	0.046	2.354	1.014	5.464	0.10
	Television viewing (minutes)	0.009	0.003	0.004	1.009	1.003	1.016	
	Presence of feeding symptoms	-1.129	0.518	0.029	0.323	0.117	0.893	
	Birth-weight (kg)	0.624	0.319	0.050	1.866	1.000	3.487	
	Number delays in development	0.361	0.170	0.034	1.435	1.027	2.004	
CBQ	*None*							
Family	SES (1=high to 5=low)	0.466	0.117	<.001	1.593	1.266	2.005	0.06
ASR-Mother	*None*							
ASR-Father	Total score	0.023	0.008	0.003	1.023	1.008	1.038	0.04
APQ Parenting style	Norms	-0.149	0.047	0.002	0.862	0.786	0.945	0.04
Community	*None*							
Overweight at age 5								
Child characteristics	Ethnic (non-Caucasian)	0.933	0.453	.040	2.543	1.046	6.186	0.09
	Birth-weight (kg)	0.853	0.327	.009	2.347	1.237	4.454	
	Frequent doctor appointments	0.859	0.424	.043	2.360	1.027	5.421	
	Daily medication	0.730	0.376	.050	2.076	1.000	4.338	
CBQ	*None*							
Family	SES (1=high to 5=low)	0.354	0.119	.003	1.425	1.128	1.801	0.03
ASR-Mother	*None*							
ASR-Father	Total score	0.020	0.007	.007	1.020	1.005	1.035	0.03
APQ Parenting style	*None*							
Community	*None*							

Models obtained through binary logistic regressions (stepwise procedure) adjusted for socioeconomic status and child's sex. APQ, Alabama Parenting Questionnaire; ASR, Adult Self Report; CBQ, Children's Behaviour Questionnaire; SES, Socioeconomic status; ΔR2,Change in R2.

Table 1-online. List of risk factors considered in the study.

Variable (risk factor)	Instrument (measure)	Level scale	Codification
Child characteristics			
Gender	SRF	Nominal: binary	0=Female, 1=Male
Ethnicity	SRF	Nominal: binary	0=Caucasian, 1=Non-Caucasian
Gestational age: prematurity	SRF	Nominal: binary	0=Non-prematurity, 1=Prematurity
Birth weight	SRF	Metrical	Total grams
Breast feeding	SRF	Nominal: binary	0=No, 1=Yes
Hospitalization	SRF	Nominal: binary	0=No, 1=Yes
Doctor appointments	SRF	Nominal: binary	0=No, 1=Yes
Child medical condition	SRF	Nominal: binary	0=No, 1=Yes
Daily Medication	SRF	Nominal: binary	0=No, 1=Yes
Special Diet	SRF	Nominal: binary	0=No, 1=Yes
Attendance to child daycare	SRF	Nominal: binary	0=No, 1=Yes
Number of delays in development	SRF	Metrical	Total days
Clumsy	SRF	Nominal: binary	0=No, 1=Yes
Feeding difficulties	DICA	DICA	0=No, 1=Yes
School absenteeism	SRF	Nominal: binary	0=No, 1=Yes
Teasing of weight	SRF	Nominal: binary	0=No, 1=Yes
Duration of night time sleep	SRF	Metrical	Total daily-hours
Total TV watching (minutes)	SRF	Metrical	Total daily-minutes
Leisure activity time (hours)	SRF	Metrical	Total daily-hours
Total computer use (minutes)	SRF	Metrical	Total daily-minutes
Child temperament	CBQ	Metrical	Raw-scale-scores
Family characteristics			
Family socioeconomic status	Hollinsghead	Ordinal	1=Low, … , 5=High
Maternal parity (first pregnancy)	SRF	Nominal: binary	0=Non-first-pregnancy, 1=First pregnancy
Fertility treatment	SRF	Nominal: binary	0=No, 1=Yes
Maternal smoking during pregnancy	SRF	Nominal: binary	0=No, 1=Yes
Gestational weight gain	SRF	Nominal: binary	0=Less than 14 kg; 1=More than 14 kg
Mother's age at delivery	SRF	Nominal: binary	Years
Delivery type: cesarean	SRF	Nominal: binary	0=No, 1=Yes
Maternal postnatal depression	SRF	Nominal: binary	0=No, 1=Yes
Single-parent family	SRF	Nominal: binary	0=No, 1=Yes
Number of fetuses	SRF	Metrical	Count 0-1-2-3-…
Father's age	SRF	Metrical	Count 0-1-2-3-…
Number of child's siblings	SRF	Metrical	Count 0-1-2-3-…
Working situation: unemployed	SRF	Nominal: binary	0=No, 1=Yes
Mother mental health	ASR-Mother	Metrical	Raw-scale-scores
Father mental health	ASR-Father	Metrical	Raw-scale-scores
Parenting style	APQ	Metrical	Raw-scale-scores
	Norms-scale	Metrical	Raw-scale-score
	Autonomy-scale	Metrical	Raw-scale-score
Community			
Distance to dense route	SRF	Nominal: binary	Nominal: binary
Distance to school	SRF	Nominal: binary	Nominal: binary
Distance to park	SRF	Nominal: binary	Nominal: binary
Distance park during pregnancy	SRF	Metrical	Metrical

APQ, Alabama Parenting Questionnaire; ASR, Adult Self Report; CBQ, Children's Behaviour Questionnaire; Diagnostic Interview for Children and Adolescents; SRF, Schedule of Risk Factors.

Table 2-online. Final predictive models for the children's z-BMI.

Z-BMI at age 3	Significant predictors	B	SE (B)	Beta	Sig	95%CI for B		ΔR^2
Child characteristics	Ethnic (non-Caucasian)	0.763	0.248	0.128	.002	0.275	1.250	.04
	Presence of feeding symptoms	-0.334	0.161	-0.083	.038	-0.650	-0.019	
	Birth-weight (kg)	0.395	0.115	0.140	.001	0.170	0.621	
CBQ	Attention focusing	-0.139	0.061	-0.092	.024	-0.260	-0.019	.01
Family	SES (1=high to 5=low)	0.175	0.056	0.127	.002	0.066	0.285	.02
ASR-mother	*None*							
ASR-father	Externalizing	0.024	0.012	0.086	.048	0.000	0.048	.01
APQ-Parenting style	Corporal punishment	0.144	0.063	0.093	.023	0.020	0.269	.01
Community	Distance dense route (< 300 m)	0.289	0.141	0.086	.041	0.012	0.566	.01
Z-BMI at age 4								
Child characteristics	Ethnic (non-Spanish)	0.767	0.230	0.139	.001	0.315	1.220	.08
	Birth-weight (kg)	0.415	0.124	0.163	.001	0.172	0.658	
	Prematurity	0.651	0.260	0.120	.012	0.141	1.161	
	Breastfeeding	0.316	0.147	0.087	.032	0.027	0.606	
	Television viewing (minutes)	0.003	0.001	0.108	.013	0.001	0.006	
	Teased for appearance	1.527	0.637	0.096	.017	0.276	2.777	
	Presence of feeding symptoms	-0.289	0.146	-0.080	.048	-0.576	-0.002	
CBQ	*None*							
Family	SES (1=high to 5=low)	0.209	0.051	0.166	<.001	0.109	0.310	.03
ASR-Mother	*None*							
ASR-Father	Total score	0.008	0.003	0.104	.018	0.001	0.014	.01
Parenting style	Norms	-0.047	0.023	-0.082	.044	-0.093	-0.001	.01
Community	*None*							
Z-BMI at age 5								
Child characteristics	Ethnic (non-Spanish)	0.666	0.234	0.120	.005	0.206	1.126	.06
	Birth-weight (kg)	0.366	0.104	0.147	<.001	0.162	0.570	
	Clumsy	0.545	0.183	0.123	.003	0.186	0.904	
	Frequent doctor appointments	0.397	0.202	0.082	.049	0.001	0.794	
CBQ	*None*							
Family	SES (1=high to 5=low)	0.247	0.052	0.197	<.001	0.145	0.349	.04
ASR-Mother	*None*							
ASR-Father	Total	0.010	0.004	0.131	.003	0.004	0.017	.02
Parenting style	*None*							
Community	*None*							

Models obtained through binary logistic regressions (stepwise procedure) adjusted for socioeconomic status and child's sex. APQ, Alabama Parenting Questionnaire; ASR, Adult Self Report; CBQ, Children's Behaviour Questionnaire; SES, Socioeconomic status; ΔR2,Change in R2.

CHAPTER SIX:

DISCUSSION

6. GENERAL DISCUSSION

6.1. Summary of findings

This thesis had two main aims. First, it was aimed to examine possible associations between behavioral and peer problems and overweight in preschoolers. Secondly, it aimed at identifying risk factors in early life for overweight in preschoolers.

As previously mentioned, a relationship between mental health and weight status has been documented in several studies. However, research has tended to focus either on adults or on school-aged children, creating a gap in the literature regarding the preschool years. Moreover, the direction of the relationship between mental health and weight status remains unclear, as most of the studies are cross-sectional. Furthermore, in existing studies, the psychopathology is usually based only on dimensional measures, no study has used a diagnosis from the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000) as an outcome. Finally, most of the limited research in this area has been carried out in the United States, Australia and northern European countries. Given the importance of cultural and social factors in the prevalence of overweight (Costa-Font & Gil, 2013) and the high rates of overweight and obesity across southern European countries (van Stralen et al., 2012), there is a need for further studies of preschoolers in countries such as Spain Accordingly, the aim of this study was to investigate cross-sectional and longitudinal associations between weight status and behavioral problems in a community sample of Spanish preschool children aged 3 to 5.

To the best of our knowledge, this is the first study to assess the relationship between weight status and behavioral problems in a large and representative sample of preschoolers, using a diagnostic interview based on DSM-IV-TR taxonomy. In general, results from this thesis confirmed that a higher BMI and overweight status are associated with specific behavioral problems at young ages. In accordance with previous findings (Anderson, He, Schoppe-Sullivan, & Must, 2010), conduct problems and ODD were associated cross-sectionally with overweight and a higher BMI at age 3 and 4 years. Moreover, ADHD was associated cross-sectionally with overweight and a higher BMI at age 4 and 5. This result is consistent with previous findings (Waring & Lapane, 2008) but, to the best of our knowledge, this is the first community-based study

that using a diagnostic interview reveals this relationship as early as in the preschool years. The literature has suggested three possible explanations for this correlation. First, ADHD symptoms may lead to deficient inhibitory control and delay aversion, which may foster poor planning and difficulties in adherence to regular patterns, leading to abnormal eating behaviors and consequent weight gain (Cortese et al., 2008). Second, being overweight may contribute to ADHD symptoms via neural or other mechanisms, possibly through sleep-disordered breathing (Bass et al., 2004). Finally, ADHD and overweight status may be two manifestations of a common biological mechanism (Liu, Li, Yang, & Wang, 2008). Furthermore, prospective analyses showed that the probability of having ADHD symptoms at age 4 years was higher for children who had a higher BMI score at age 3 years. However, after controlling for potential confounding factors such as SES and behavioral problems at baseline, the magnitude of the differential odds was small and not clinically significant. Indeed, ADHD is a neurodevelopmental disorder that starts early in life, and its detection is based on clinical features that may only become evident as the child grows.

In line with previous research that related weight problems and peer teasing (Griffiths, Dezateux, & Hill, 2011), our results indicated that overweight status in young children was associated cross-sectionally and prospectively with higher scores in peer relationship problems at ages 4 and 5 years. This result suggests that relationships with peers may become a problem for young overweight children. A number of related mechanisms might explain this link. Among them, teasing and stigmatization at a young age may play an important role because they can lead to social marginalization and low self-esteem (Storch et al., 2007). Children as young as 3 years old attribute already negative and positive adjectives to overweight and non-overweight individuals, respectively (Lowes & Tiggemann, 2003). In sum, our results revealed that in the preschool years there is an association between overweight and specific aspects of peer problems and behavioral problems including conduct problems, ODD and ADHD. These findings suggest the importance of early detection of psychological problems and difficulties with their peers in children who are overweight. This might help to reduce the negative long-term consequences of children suffering from weight and psychological issues.

This thesis was also aimed at examining the prevalence of overweight among a community sample of Spanish preschoolers. As expected, using the conservative WHO international age- and sex-specific child growth standards (World Health Organization,

2006), the overall proportion of overweight children in our study was 9%, which is a figure that is consistent with European data for 2010 (11.7%, 95% CI 8.9–15.3; de Onis, Blössner, & Borghi, 2010). Furthermore, in line with previous studies (Anderson, He, Schoppe-Sullivan, & Must, 2010; Stamatakis, Wardie, & Cole, 2010), our results indicated that ethnic minorities and families in low SES categories had higher rates of overweight among their children, in comparison to Caucasian families and high SES categories. This finding suggests that targeted intervention programs for children in low-income and minority-group families are needed as early as the preschool years.

The second aim of the present thesis was to explore risk factors in early life for overweight among Spanish preschoolers. Nowadays, there is a paucity of this type of studies in southern European countries, especially countries like Spain, where the rates of overweight are among the highest in Europe (Ahrens et al., 2014). The stepwise regression analysis performed revealed several risk factors associated with overweight and higher BMI. Among them, low socioeconomic status and high birth weight emerged as two strong risk factors. They were independently associated with overweight, and this pattern remained for both genders over the 3-year assessment. Therefore, in line with other studies performed with older children (Stamatakis, Wardie, & Cole, 2010), we observed a gradient whereby children of socioeconomically disadvantaged families were more likely to be overweight. This finding suggest that differences in adiposity by socioeconomic status may emerge early in life. Moreover, in line with other studies, we found an association between high birth weight and later overweight in children (Weng, Redsell, Swift, Yang, & Glazebrook, 2012) underlining the importance of weight monitoring from postpartum.

This last investigation carried out in the frame of this thesis also revealed other relevant results. In our sample, American-Hispanic children had tripled the prevalence of overweight found in Caucasian children. Similarly to other studies, this finding highlight that ethnic minorities are more prone to overweight in many European countries (Veldhuis et al., 2013). Our results also showed that maternal smoking during pregnancy was associated with overweight at age 3. These results are in line with evidence indicating that there is a catch-up growth following low birth weight caused by smoking during pregnancy or the poorer eating habits of smoking mothers (Hui, Nelson, Yu, Li, & Fok, 2003). In line with other reports (Kuhle, Allen, & Veugelers, 2010), in our study, excess television screen time, before the age of 3 years-old was associated with overweight at 4 years-old. Various mechanisms may explain this association;

prolonged periods of inactivity, the opportunity to eat snacks, a decline in energy expenditure, and the influence of commercials on food choices and nutrition. Our results also showed that lower scores in the child CBQ attention focusing scale were associated with overweight at age 3, supporting studies linking attention deficit with excess weight in childhood (Waring & Lapane, 2008). It might be that reduced attention span interferes in the development of self-regulatory eating and satiety recognition, leaving the child relatively inattentive to hunger and satiety cues. Moreover, our results reported that some aspects of early parenting style were associated with later excess of body weight such as inconsistent discipline, fewer rules and corporal punishment. Whitaker et al. (2007) reported that the odds of obesity for 3-year-old children were 50% higher for those who experienced neglect in the previous year. In another study, those adults who reported experiencing harsh physical punishment during childhood had a higher likelihood of obesity (Afifi, Mota, MacMillan, & Sareen, 2013). Moreover, lack of effective rules in families with obese children often interferes with the development of regulated eating patterns. In our study, among fathers, some psychological symptoms scales, such as externalizing symptoms and total number of symptoms, were associated with the child's weight. Adults with binge eating disorders describe their childhood environment and the parenting they received more negatively than healthy controls (Hodges, Cochrane, & Brewerton, 1998). During childhood, they might have used eating as a strategy to cope with negative feelings. Finally, on a community level, in our study the only variable that showed a relationship with weight status at age 3 was living near a traffic dense route. A possible explanation would be that air pollution might alter metabolic processes in the body and let to weight gain and consequently contribute to the development of overweight (Limaye & Salvi, 2014). To sum up, many factors increase the child's risk for becoming overweight already in the preschool years. Identifying those factors offers the potential for early effective prevention and intervention programs.

6.2. Limitations

The present thesis has two main limitations that should be considered when interpreting the results. On the one hand, given the ages of the children we relied upon parents' reports of their child's behavior, which may introduce bias (Seifer, 2005).

Nonetheless, parents' reports on child behavior have considerable value since they are based on their observations in a naturalistic setting over a long period. On the other hand, rather taking the anthropometrical measures in person for research purposes, we took the measures from the children's medical records. Nevertheless, the measures were taken using standardized protocols at all time periods and at all sites. In fact, routine weight measurements have been found to be highly accurate, which supports their usefulness for both clinical practice and research (Howe, Tilling, & Lawlor, 2009).

6.3. Strengths

This study has a number of strengths. Firstly, a community sample of young children within a small age range specific to preschool age group was followed prospectively. Secondly, ADHD and other DSM-IV-TR disorders were assessed using a standardized, validated, strictly DSM-based instrument with good diagnostic properties designed specifically for use with preschoolers. Finally, the study was carried out in Spain, a country that although it has one of the highest rates of overweight in all Europe, has a paucity of empirical research in overweight in the preschool years. For all these reasons, this thesis makes a significant contribution to the field, since the results might help to design early prevention and intervention programs for overweight and obesity.

6.4. Recommendations and implications

Children who are overweight face psychological problems and peer issues as early as the preschool years, compared with their non-overweight peers. Therefore, more attention should be focused on the emotional effect of childhood overweight to provide more holistic care for this pediatric population. Due to the fact that rates of overweight are alarmingly high in young children, public agencies should be aware of this relationship when designing weight management programs. Early assessment and treatment of psychological and peer problems in children with overweight is important as they can easily lead to more serious consequences for which more intensive and expensive interventions are required and they can cause weight loss resistance. Thus, it is crucial that pediatricians and other primary care professionals screen for

psychological problems and peer difficulties when they encounter a child who is overweight. Similarly, it is also essential that psychologists and psychiatrists refer the cases to pediatricians when they have a child who is overweight. To sum up, in cases where the child with overweight suffers from psychological problems, there should be active collaboration between a pediatrician and a child psychologist or psychiatrist to reduce the negative long-term consequences of both conditions.

As early as the preschool years, a child with overweight is more likely to suffer from peer problems. Youngsters express negative and stereotypical attitudes toward peers who are perceived as overweight (Cramer & Steinwert, 1998) and, by elementary school, weight-based teasing and bullying are well established (Puhl, & Latner, 2007). Youths with obesity are significantly more likely to be bullied than their thinner classmates, and longitudinal evidence indicates that a child's likelihood of being teased or bullied in the future can be predicted by his or her weight status. At school, weight-based bullying is reported by adolescents to be among the most frequent forms of peer harassment (Bucchianeri, Eisenberg, & Neumark-Sztainer, 2013). Parents similarly view weight-based bullying as the most common form of bullying that youngsters face (Puhl, Luedicke, & Depierre, 2013). Further corroborating these findings are teachers who report a link between high body mass index (BMI) and victimization (Jansen et al., 2014). Thus, there is a strong need to intervene to stop this circle of weight-teasing and bullying by peers linked with serious short and long-term consequences. Prevention and intervention programs should begin in kindergarten when kids experience school for the first time. Bullying behavior has been shown to begin as early as 3 years old in girls and boys. However, while much attention is paid to bullying among older children, both in the media and in research, there has been relatively little focus on bullying in early childhood. It is vital that the focus of evidence-based prevention policies for weight-based bullying extends from older children to the first years of kindergarten.

This work provides a summary of variables that should be taken into account regarding the risk factors for becoming overweight in childhood. It's clear that overweight is an intricate, complex problem. But multiple causes also means there are many angles from which behavioral health experts can have an impact on the epidemic. A greater understanding of the risk factors involved in the development of overweight is the key to successful prevention and intervention programs. These programs should take into account several significant early-life risk factors. Among them, the results of this thesis show that targeted intervention programs for children in low-income families are

needed as early as the preschool years. The results also show that monitoring children born with high birth weight might help reduce the prevalence of overweight among preschoolers.

Primary care providers should universally assess children for overweight risk as early as the preschool years to improve early identification of elevated BMI, and medical and psychological risks. It is also crucial to identify and track patients at risk through family history, birth weight, or socioeconomic, ethnic, cultural, or environmental factors.

Finally, when approaching the weight issue in preschoolers, a precise definition should be maintained. Measuring overweight and obesity in children aged 3 to 5 is difficult as there is no standard definition applied worldwide. However, the use of the WHO Child Growth Standards has been suggested as reasonable in both research and clinical practice since it has a specific definition for overweight amongst children aged less than five years old.

6.5. Future directions for research

In spite of the fact that this thesis tried to answer some questions regarding overweight in the preschool years, there are others which remain unanswered and should be considered in further investigations.

Future research should explore the relationship between emotional problems (i.e., anxiety, depression) and overweight in the preschool years using a diagnostic DSM-based instrument. This will contribute to a better understanding of the complex relationship between psychological problems and weight issues. If this relationship is confirmed, it will indicate that not only are conduct problems related to higher weight in youngsters but emotional problems are too. This will suggest that screening for emotional and behavioral problems in children with overweight is a top priority in the preschool years.

Future studies should investigate prospectively the association between overweight and ADHD in older children or adolescents. The literature around this topic is controversial: some authors state that ADHD symptoms may lead to overweight, other authors affirm that being overweight may contribute to ADHD and others state

that they may be two manifestations of a common mechanism. Research in this area will provide more insight into the longitudinal pathways of this relationship.

Additional relevant risk factors potentially contributing to weight gain in the preschool years should be explored in future research carried out in Spain. Studies from other countries have reported risk factors such as parental overweight, physical activity and energy expenditure as relevant to becoming overweight. Thus, there is a need to confirm these results in Spain with the aim of designing better strategies to tackle the weight issue in preschoolers. Furthermore, future research will help to investigate the role of each specific risk factor: independent variable, mediator (intermediate variable) or moderator (effect modifier). This will help to understand the possible multiple casual paths, some involving complex chains of casual risk factors, leading to overweight or obesity. This information will be crucial in deciding correctly for whom, when, and how to intervene to prevent the onset of overweight or to facilitate weight loss.

Finally, future research should explore whether implementing evidence-based programs for overweight is beneficial for children as young as preschoolers in Spain. As described above, in Spain there is paucity of studies and intervention programs for children with overweight. Especially on the preschool years, little research has been done although these years are a critical window for obesity prevention. Thus, given the high rates of overweight in Spain and the importance of tackling overweight early in life, there is an urgent need to study feasible multi-component intervention programs for preschoolers.

CHAPTER SEVEN:

CONCLUSIONS

7. CONCLUSIONS

The empirical work of the present thesis allowed a set of inferences to be drawn, which are outlined below:

- Children who are overweight and have a higher BMI are at increased risk of peer problems, conduct disorders and ADHD symptoms in the preschool years.

- A higher BMI at age 3 is predictive of peer problems and ADHD symptoms in the preschool years.

- There is a need for screening for psychological problems in children who are overweight or at risk of becoming overweight.

- Psychological problems and peer problems should be tackled when designing and implementing programs for overweight as early as the preschool years.

- In Spain, using the conservative World Health Organization classification for overweight in the preschool years, 7.2% of children at age 3 years are overweight, 8.2% at 4 years and 8.7% at 5 years.

- Several potential early-life risk factors in preschool children are associated with later overweight. Among them, low socioeconomic status and high birth-weight stand out as the factors studied representing the highest risk for becoming overweight in the preschool years.

- Monitoring the health status of children with either low socioeconomic status and/or high birth-weight might be beneficial in preventing overweight among preschoolers.

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APPENDIX

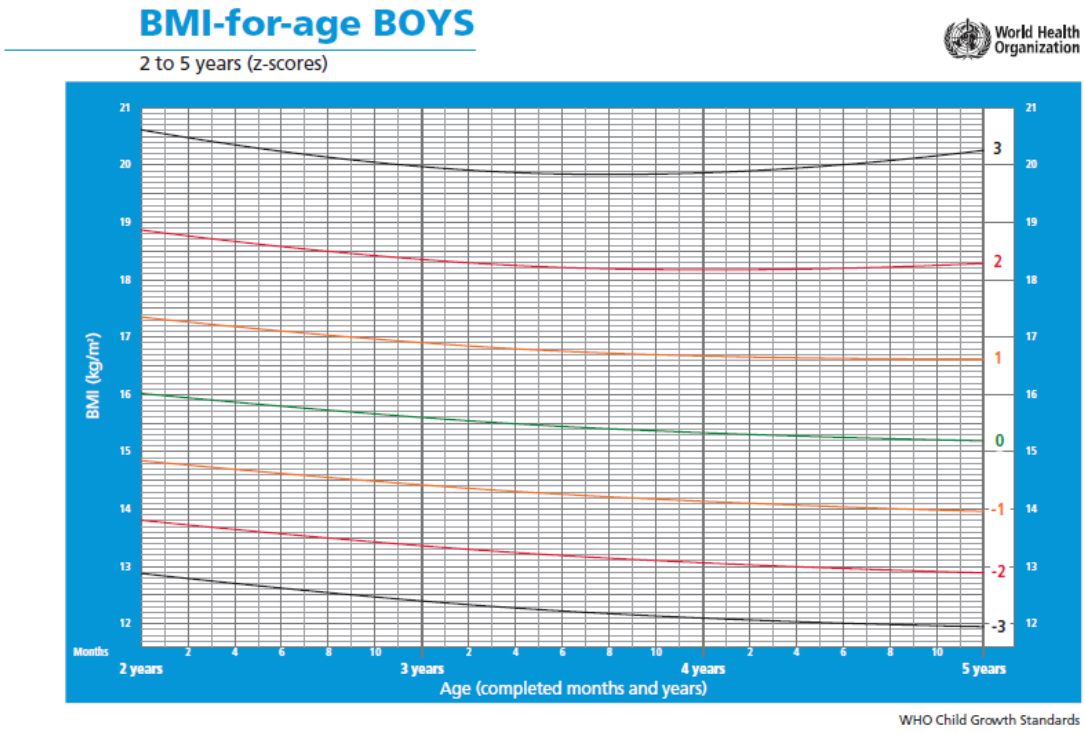
The World Health Organization Child Growth Standards

Appendix Table 1. BMI-for age for boys 2 to 5 years (z-scores)

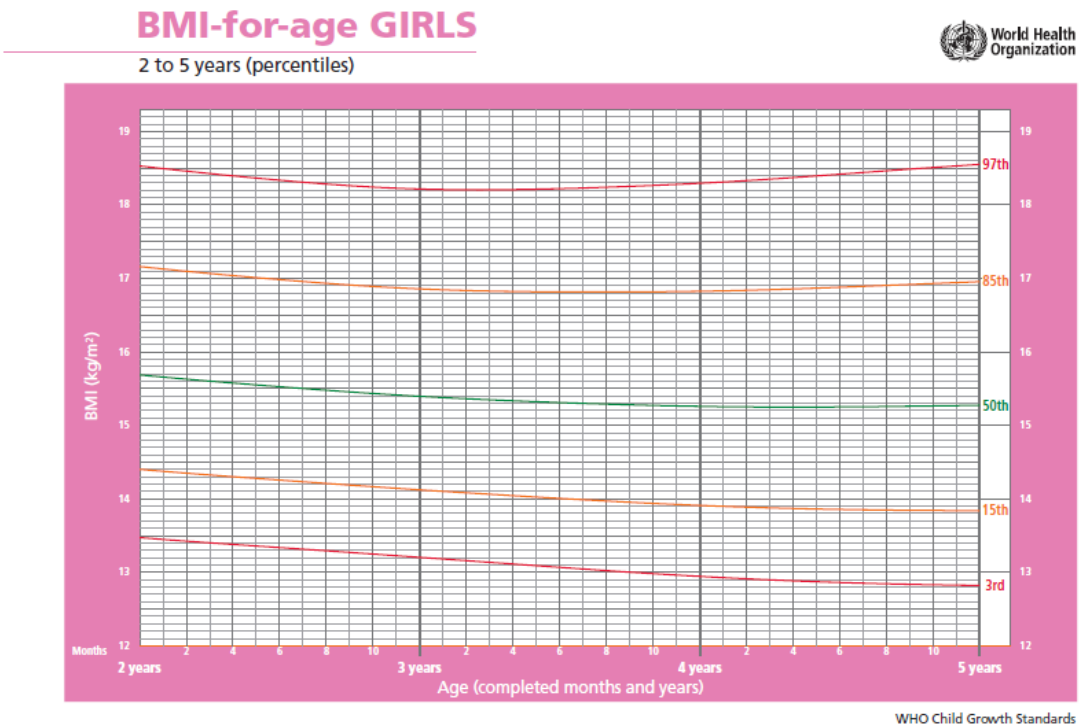
Month	L	M	S	SD3neg	SD2neg	SD1neg	SD0	SD1	SD2	SD3
24	-0.6187	16.0189	0.07785	12.9	13.8	14.8	16.0	17.3	18.9	20.6
25	-0.5840	15.9800	0.07792	12.8	13.8	14.8	16.0	17.3	18.8	20.5
26	-0.5497	15.9414	0.07800	12.8	13.7	14.8	15.9	17.3	18.8	20.5
27	-0.5166	15.9036	0.07808	12.7	13.7	14.7	15.9	17.2	18.7	20.4
28	-0.4850	15.8667	0.07818	12.7	13.6	14.7	15.9	17.2	18.7	20.4
29	-0.4552	15.8306	0.07829	12.7	13.6	14.7	15.8	17.1	18.6	20.3
30	-0.4274	15.7953	0.07841	12.6	13.6	14.6	15.8	17.1	18.6	20.2
31	-0.4016	15.7606	0.07854	12.6	13.5	14.6	15.8	17.1	18.5	20.2
32	-0.3782	15.7267	0.07867	12.5	13.5	14.6	15.7	17.0	18.5	20.1
33	-0.3572	15.6934	0.07882	12.5	13.5	14.5	15.7	17.0	18.5	20.1
34	-0.3388	15.6610	0.07897	12.5	13.4	14.5	15.7	17.0	18.4	20.0
35	-0.3231	15.6294	0.07914	12.4	13.4	14.5	15.6	16.9	18.4	20.0
36	-0.3101	15.5988	0.07931	12.4	13.4	14.4	15.6	16.9	18.4	20.0
37	-0.3000	15.5693	0.07950	12.4	13.3	14.4	15.6	16.9	18.3	19.9
38	-0.2927	15.5410	0.07969	12.3	13.3	14.4	15.5	16.8	18.3	19.9
39	-0.2884	15.5140	0.07990	12.3	13.3	14.3	15.5	16.8	18.3	19.9
40	-0.2869	15.4885	0.08012	12.3	13.2	14.3	15.5	16.8	18.2	19.9
41	-0.2881	15.4645	0.08036	12.2	13.2	14.3	15.5	16.8	18.2	19.9
42	-0.2919	15.4420	0.08061	12.2	13.2	14.3	15.4	16.8	18.2	19.8
43	-0.2981	15.4210	0.08087	12.2	13.2	14.2	15.4	16.7	18.2	19.8
44	-0.3067	15.4013	0.08115	12.2	13.1	14.2	15.4	16.7	18.2	19.8
45	-0.3174	15.3827	0.08144	12.2	13.1	14.2	15.4	16.7	18.2	19.8
46	-0.3303	15.3652	0.08174	12.1	13.1	14.2	15.4	16.7	18.2	19.8
47	-0.3452	15.3485	0.08205	12.1	13.1	14.2	15.3	16.7	18.2	19.9
48	-0.3622	15.3326	0.08238	12.1	13.1	14.1	15.3	16.7	18.2	19.9
49	-0.3811	15.3174	0.08272	12.1	13.0	14.1	15.3	16.7	18.2	19.9
50	-0.4019	15.3029	0.08307	12.1	13.0	14.1	15.3	16.7	18.2	19.9
51	-0.4245	15.2891	0.08343	12.1	13.0	14.1	15.3	16.6	18.2	19.9
52	-0.4488	15.2759	0.08380	12.0	13.0	14.1	15.3	16.6	18.2	19.9
53	-0.4747	15.2633	0.08418	12.0	13.0	14.1	15.3	16.6	18.2	20.0
54	-0.5019	15.2514	0.08457	12.0	13.0	14.0	15.3	16.6	18.2	20.0
55	-0.5303	15.2400	0.08496	12.0	13.0	14.0	15.2	16.6	18.2	20.0
56	-0.5599	15.2291	0.08536	12.0	12.9	14.0	15.2	16.6	18.2	20.1
57	-0.5905	15.2188	0.08577	12.0	12.9	14.0	15.2	16.6	18.2	20.1
58	-0.6223	15.2091	0.08617	12.0	12.9	14.0	15.2	16.6	18.3	20.2
59	-0.6552	15.2000	0.08659	12.0	12.9	14.0	15.2	16.6	18.3	20.2
60	-0.6892	15.1916	0.08700	12.0	12.9	14.0	15.2	16.6	18.3	20.3

Appendix Table 2. BMI-for age for girls 2 to 5 years (z-scores)

Month	L	M	S	SD3neg	SD2neg	SD1neg	SD0	SD1	SD2	SD3
24	-0.5684	15.6881	0.08454	12.4	13.3	14.4	15.7	17.1	18.7	20.6
25	-0.5684	15.6590	0.08452	12.4	13.3	14.4	15.7	17.1	18.7	20.6
26	-0.5684	15.6308	0.08449	12.3	13.3	14.4	15.6	17.0	18.7	20.6
27	-0.5684	15.6037	0.08446	12.3	13.3	14.4	15.6	17.0	18.6	20.5
28	-0.5684	15.5777	0.08444	12.3	13.3	14.3	15.6	17.0	18.6	20.5
29	-0.5684	15.5523	0.08443	12.3	13.2	14.3	15.6	17.0	18.6	20.4
30	-0.5684	15.5276	0.08444	12.3	13.2	14.3	15.5	16.9	18.5	20.4
31	-0.5684	15.5034	0.08448	12.2	13.2	14.3	15.5	16.9	18.5	20.4
32	-0.5684	15.4798	0.08455	12.2	13.2	14.3	15.5	16.9	18.5	20.4
33	-0.5684	15.4572	0.08467	12.2	13.1	14.2	15.5	16.9	18.5	20.3
34	-0.5684	15.4356	0.08484	12.2	13.1	14.2	15.4	16.8	18.5	20.3
35	-0.5684	15.4155	0.08506	12.1	13.1	14.2	15.4	16.8	18.4	20.3
36	-0.5684	15.3968	0.08535	12.1	13.1	14.2	15.4	16.8	18.4	20.3
37	-0.5684	15.3796	0.08569	12.1	13.1	14.1	15.4	16.8	18.4	20.3
38	-0.5684	15.3638	0.08609	12.1	13.0	14.1	15.4	16.8	18.4	20.3
39	-0.5684	15.3493	0.08654	12.0	13.0	14.1	15.3	16.8	18.4	20.3
40	-0.5684	15.3358	0.08704	12.0	13.0	14.1	15.3	16.8	18.4	20.3
41	-0.5684	15.3233	0.08757	12.0	13.0	14.1	15.3	16.8	18.4	20.4
42	-0.5684	15.3116	0.08813	12.0	12.9	14.0	15.3	16.8	18.4	20.4
43	-0.5684	15.3007	0.08872	11.9	12.9	14.0	15.3	16.8	18.4	20.4
44	-0.5684	15.2905	0.08931	11.9	12.9	14.0	15.3	16.8	18.5	20.4
45	-0.5684	15.2814	0.08991	11.9	12.9	14.0	15.3	16.8	18.5	20.5
46	-0.5684	15.2732	0.09051	11.9	12.9	14.0	15.3	16.8	18.5	20.5
47	-0.5684	15.2661	0.09110	11.8	12.8	14.0	15.3	16.8	18.5	20.5
48	-0.5684	15.2602	0.09168	11.8	12.8	14.0	15.3	16.8	18.5	20.6
49	-0.5684	15.2556	0.09227	11.8	12.8	13.9	15.3	16.8	18.5	20.6
50	-0.5684	15.2523	0.09286	11.8	12.8	13.9	15.3	16.8	18.6	20.7
51	-0.5684	15.2503	0.09345	11.8	12.8	13.9	15.3	16.8	18.6	20.7
52	-0.5684	15.2496	0.09403	11.7	12.8	13.9	15.2	16.8	18.6	20.7
53	-0.5684	15.2502	0.09460	11.7	12.7	13.9	15.3	16.8	18.6	20.8
54	-0.5684	15.2519	0.09515	11.7	12.7	13.9	15.3	16.8	18.7	20.8
55	-0.5684	15.2544	0.09568	11.7	12.7	13.9	15.3	16.8	18.7	20.9
56	-0.5684	15.2575	0.09618	11.7	12.7	13.9	15.3	16.8	18.7	20.9
57	-0.5684	15.2612	0.09665	11.7	12.7	13.9	15.3	16.9	18.7	21.0
58	-0.5684	15.2653	0.09709	11.7	12.7	13.9	15.3	16.9	18.8	21.0
59	-0.5684	15.2698	0.09750	11.6	12.7	13.9	15.3	16.9	18.8	21.0
60	-0.5684	15.2747	0.09789	11.6	12.7	13.9	15.3	16.9	18.8	21.1



Appendix Figure 1. Chart of BMI-for age for boys 2 to 5 years (z-scores)



Appendix Figure 2. Chart of BMI-for age for girls 2 to 5 years (z-scores)